The Transformation of Traditional Asian Medical Knowledge into International Commodities – the Link between Traditional Medicines and the International Market

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Abstract

Aims and Objectives

Medicinal plant (herbal medicine) value chains have generally been overlooked compared with food commodities. Not surprisingly, revenue generation tends to be weighted towards the retail end of the chain and consequently the farm labourers, farmers and processors of the crude raw materials (the primary producers) are the lowest beneficiaries. This project aims to investigate medicinal plant value chains and interpret the impact different value chains have on the livelihoods of primary producers in developing countries and for the first time analytically assess the quality implications for the manufacturers (secondary producers) and end users in Europe.

Methodological Approach

This interdisciplinary project uses a mixed methods approach. Case studies were undertaken on three separate sites in India. Data were initially gathered on medicinal plant value chains by means of semi-structured interviews and non-participant observation. Samples were collected from locations in India, China, Europe and the USA and analysed using nuclear magnetic resonance spectroscopy and high performance thin layer chromatography.

Results

There were benefits for primary producers that belonged to a vertically integrated value chain and resulting products were subject to a higher standard of processing and storage. The analysis demonstrated that there was variation in the chemical composition of the samples tested and that products obtained from a vertically integrated value chain were more similar chemically to fresh turmeric rhizomes than other samples tested.

Conclusions

By using analytical methods, it has been possible to correlate important variations in product composition for selected samples and identify strengths and weaknesses of some key value chains. Through establishing direct contracts with farmers in India, the vertically integrated value chain investigated was able to exert greater control over cultivation and manufacturing processes than found in other chains. Consequently the vertically integrated value chain is able to produce a higher quality product than generally found on the market. This results in a value addition that can be passed back down the chain for the benefit of the primary producers.

I, Anthony Booker, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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ATHSC:	Anhui Tienho Herb Sourcing Company
CAM:	Complementary and alternative medicine
CBD:	Convention on Biodiversity
CFDA:	China Food and Drug Administration
CITES:	Convention on International Trade of Endangered Species
FMCG:	Fast moving consumer goods
FRLHT:	Foundation for the Revitalization of Local Health Traditions
FSA:	Food Standards Agency (UK)
GAP:	Good agricultural practice
GMP:	Good manufacturing practice
GVC:	Global value chain
HMP:	Herbal medicinal product
HPTLC:	High performance thin layer chromatography
^{1}H-NMR:	Proton nuclear magnetic resonance
LCIRAH:	Leverhulme Centre for Integrative Research on Agriculture and Health
LEDC:	Less economically developed country
MPVC:	Medicinal plant value chain
MS:	Mass spectrometry
NGO:	Non-governmental organisation
NMR:	Nuclear magnetic resonance
OTC:	Over the counter
PC:	Principal component
RSC:	Royal Society of Chemistry (UK)
SOAS:	School of Oriental and African Studies (UK)
STPCL	Sun Ten Pharmaceutical Co. Ltd
TAM:	Traditional Asian medicine
TCM:	Traditional Chinese medicine
TIM:	Traditional Indian medicine
TMQP:	Total metabolite quality profile
UCLSOP:	University College London School of Pharmacy (UK)
VIVC:	Vertically integrated value chain
WHO:	World Health Organisation

Thesis related publications:

Booker, A. J., Zloh, M., Said, M., Suter, A., Heinrich, M. 2011 Abstract. Metabolomic profiling of Saw Palmetto products using proton-NMR spectroscopy and multi-variate analysis. *Planta Medica* 12 (77): 1249

Booker, A., Johnston, D., Heinrich, M., 2012. Sowing the seeds, reaping the benefits: How an ethos of quality and ethical trading can improve health in Asia and Europe. *European Journal of Pharmacology* 668. DOI:10.1016/j.ejphar.2011.09.279

Booker, A., Johnston, D., Heinrich, M., 2012. Leverhulme centre for integrative research on agriculture and health (LCIRAH*)* *European Journal of Pharmacology* 668. DOI:10.1016/j.ejphar.2011.09.278

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Booker, A., Suter, A., Krnjic, A., Strassel, B., Zloh, M., Said, M., Heinrich, M., 2014. A phytochemical comparison of saw palmetto products using gas chromatography and ^{1}H nuclear magnetic resonance spectroscopy metabolomic profiling. Journal of Pharmacy and Pharmacology doi: 10.1111/jphp.12198.

Booker, A., Frommenwiler, D., Johnston, D., Umealajekwu, C., Reich, E., Heinrich, M., 2014. Chemical variability along the value chains of turmeric (Curcuma longa): A comparison of Nuclear Magnetic Resonance Spectroscopy and High Performance Thin Layer Chromatography. Journal of Ethnopharmacology. DOI:10.1016/j.jep.2013.12.042

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1.0 Introduction

This study was initiated through collaboration between the former London School of Pharmacy (now UCL School of Pharmacy) and the Leverhulme Centre for Research on Agriculture and Health (LCIRAH). LCIRAH was established under a five-year grant from The Leverhulme Trust to build a new inter-sectoral and interdisciplinary platform for integrating research in agriculture and health, with a focus on international development goals. The over-arching aim of LCIRAH is to better assess the complex global issues surrounding the need to find sustainable food and agriculture systems which are able to promote health and well-being for all people.

The Centre for Pharmacognosy and Phytotherapy, UCL School of Pharmacy, has had many years of experience in investigating medicinal plants, their traditional and modern uses and how their quality and safety can be best assessed. It was a logical step to form an interdisciplinary partnership with LCIRAH in order to blend this scientific perspective with the disciplines of economics and international development.

The analysis of agriculture value chains, in the context of international development, has tended to focus on food crops, including, tea, coffee and cocoa and on cash crops e.g. cotton. The mass production of these consumables has provided large-scale employment for rural workers in less economically developed countries (LEDCs) (Kaplinsky, 2004).

The impact on livelihoods has in some cases been positive but also there have been many concerns. These have been most clearly documented for the plantation production of export crops, and particularly for the tea industry. It is claimed that the employment and management of rural workers by international companies has led to a negative outcome, with workers' wages being squeezed to a minimum (Hilary and Dromey, 2010, Fairtrade, 2010).

Moreover, there is concern that small farmers[1] are often unable to gain access to value chains due to an inability to make the necessary connections to the lead firms or not being able to meet the standards and/or the entry requirements set (Henson and Humphrey, 2010). Another concern being that once integrated into a value chain, farmers may lose power within the chain (Oya, 2012).

[1] Those farmers with land of less than 0.4 hectare (one acre) in size

It is within this environment that I have investigated medicinal plant value chains[2] (MPVCs).

MPVCs have rarely been examined in relation to international development and livelihoods and never before has any kind of analytical investigation been performed alongside more traditional methods of assessment.

The central backbone of this thesis is underpinned by two published papers that describe the key elements of the work undertaken during my PhD, including the concepts of growing medicinal plants to improve livelihoods and the link between value chains and the production of a quality product (see appendix 1 and 2).

The forerunner of these papers was a paper written prior to my PhD. This investigated the possibility of using a nuclear magnetic resonance (NMR) spectroscopy platform coupled with multi-variate analysis software to determine variation in the chemical composition of different saw palmetto (*Serenoa repens* (W.Bartram) Small) products (Booker et al., 2014). It was essentially a method development project which constituted a major part of my MSc in pharmacognosy. The results of the saw palmetto study demonstrated that it was possible to determine important differences in the products and that there was major variability between the products and the claims made on the labels.

The PhD project that I began with LCIRAH, did not initially include any analytical component, and although being interdisciplinary in terms of bringing together expertise from several academic disciplines, was firmly rooted in the social sciences.

The method development process focused on conducting fieldwork and accumulating data regarding value chains and the livelihoods of farm labourers, farmers and processors of the crude raw materials (the primary producers) in LEDCs.

It was hypothesised that, consumers believe that through purchasing ethically sourced goods, they are making a contribution towards the welfare of primary producers in LEDCs and that the finished goods produced are in some way superior to others found on the market. In other words through fair trade, there is value addition.

[2] Value chain has generally superseded the term supply chain to indicate that as a product progresses from a raw material to a finished product, it may be subjected to various sequential inputs that add value to its market worth.

Although there has been limited work carried out previously concerning the value chains of medicinal plants (Wynberg et al., 2003, Kala, 2003, Alam and Belt, 2009, Shahidullah and Haque, 2010), my proposal was to analyse products that were produced through a vertically integrated value chain (VIVC)[3] in order to provide evidence that there were tangible benefits for the consumer in addition to any benefits for the primary producers. This is the first time that this type of interdisciplinary approach to value chain analysis has been attempted and the results gained will help to determine the benefits and costs of certain kinds of industry arrangements. More specifically, the results will help determine whether the premiums paid to primary producers can be supported from an analytical perspective. Moreover it will provide evidence regarding the quality of products produced from these chains.

From this point, my project developed two separate but interconnected arms, one born from the socio-economic sciences and one rooted in the natural sciences and phytochemical analysis.

For the socio-economic arm, I conducted fieldwork in India to compare different value chains and determine how VIVCs may offer advantages to primary producers. The main driver for the fieldwork was to understand thoroughly and in detail how a medicinal plant could be affected through its progress along a particular value chain; what were the sources of the value addition and how this impacted on the various actors' involved in the chain? During the fieldwork stage, I also collected product samples for analysis. The medicinal plant chosen as a case-study for the project was turmeric, *Curcuma longa* L. (Zingiberaceae). This was chosen following some initial research using an on-line questionnaire.

For the analytical arm, it was necessary to further develop the method I used for saw palmetto analysis, in relation to curcuma species and turmeric products. Together with Professor Michael Heinrich, I supervised an MSc student (Chinenye Umealajekwu) who worked on developing a method for turmeric products. The MSc student submitted an initial 32 samples for ^{1}H-NMR spectroscopy analysis and compared them using multivariate analysis software. This formed the basis of her MSc project.

During my second fieldwork visit, I collected further samples for ^{1}H-NMR spectroscopy and HPTLC analysis. This gave me a total of 52 samples for comparison.

[3] Where direct contracts are established that link wholesalers and manufacturers to farmers and primary producers.

I acquired some fresh turmeric rhizomes and with the knowledge gained from fieldwork, that turmeric is commonly stored for long periods of up to five years, I developed the hypothesis that the VIVC products examined would be more similar chemically to the fresh rhizomes than products obtained through the traditional market system and together with the ethnographical research regarding different value chains and how they impact on livelihoods, this forms the second central question of my thesis.

In order to gain more detailed information on individual samples, I additionally analysed the turmeric samples using high performance thin layer chromatography (HPTLC). After some initial experiments, performed by scientists at CAMAG laboratories, in Muttenz, Switzerland, I travelled to CAMAG and performed a detailed analysis of the more variable samples as determined by the initial ^{1}H-NMR spectroscopy and multivariate analysis experiments.

1.1 Background

This project specifically deals with MPVCs, but it is not possible to examine these in isolation without first considering value chains in general and how these sit within the global economic and political framework.

Global economic integration (globalisation) is not a new concept. The imperialistic period from 1870s to 1914 is regarded by some as the first age of globalisation (Stone et al., 2000). However, some assert that it began as far back as 2500 BCE with the spreading of world religions, the building of empires and the establishment of trading cities that bridged continents (Al-Rodhan and Stoudmann, 2006). Whereas others argue that 'historical globalisation' is a term generally used to refer to the period post 1492 and Columbus's arrival in the Caribbean while on his quest to find spices in India (Hall, 2006). However, the history surrounding how and when globalisation arrived is not the only topic for contemporary debate and an equally contentious and important issue, and highly relevant to this project, is whether or not the impact of globalisation, particularly on actors in LEDCs has positive or negative outcomes.

The Nobel-Prize winning economist Amartya Sen considers globalisation beneficial, arguing that,

> "Globalisation has enriched the world scientifically and culturally, and benefited many people economically as well".

However others disagree and globalisation has been attacked by critics of free market economics, including the economists Joseph Stiglitz and Ha-Joon Chang, for perpetuating inequality in the world rather than reducing it (CR, 2013).

One dimension of globalisation - *trade in international commodities* - has had a particular impact on the livelihoods of workers in LEDCs through changing domestic commodity prices and inducing the widespread reallocation of resources within national economies (O'Rourke and Williamson, 2000) and one key emerging area, where one of the largest groups of workers have been affected - *farmers and agricultural workers* - can be seen in relation to the production of herbal medicinal products (HMPs) and associated commodities.

Global value chain (GVC) analysis has been commonly applied to food sectors, including tea, coffee and cocoa (Fullbright, 2008, Gibbon and Ponte, 2005, Kaplinsky, 2004) and on certain crops that provide a cash income e.g. cotton (Poulton et al., 2004), but little work has been undertaken in this area regarding medicinal plants. There have been a range of concerns about the division of benefits in GVCs. And while VIVCs have been seen as providing greater support to primary producers (e.g. term contracts, technical assistance, inputs and credit), they have also been seen as a site of tension and struggle (Oya, 2012).

Agricultural production is generally in developing countries, while consumption is both in developing and developed countries. Such a usage impacts on public health, both potentially in a beneficial but also detrimental way and it has a direct relevance in the context of ethnopharmacology, pharmacy and agrarian economics.

While ethnopharmacology has historically been focused on the 'traditional' uses of 'medicines' in LEDCs, it is now more and more accepted that the complex interrelationship between the producers, middlemen and consumers of these raw materials and products needs to be studied from a trans-disciplinary perspective (Heinrich et al., 2011).

Ethnopharmacological research has generally focused on crude herbal drug material and their composition and effects or on the final products available to the consumer. There has been a limited focus on the interconnectivities that link producers, middlemen and consumers. It is an important area for research since the production of high value products is an emerging but poorly understood sector within many developing countries, and particularly within India and China, both with a long history of trading in such commodities.

Moreover, until now research studies in agrarian-economics has tended to focus on the production and delivery of food and cash crops and to a large extent value chain analysis has primarily been directed at the major products, e.g. tea, coffee and cocoa (Kaplinsky, 2004, Fullbright, 2008). The cultivation of medicinal plants may be a smaller industry compared with these 'big three' but it is an industry that provides employment to a large number of people in LEDCs and particularly those belonging to minority groups (Hamilton, 2004, Jha, 2006), and is a globally significant, but poorly recognised element of trade (see below).

Traditional practices have chiefly involved collection of medicinal plants from the wild, with the rarest of plants often being the most sought after (Schippmann et al., 2006). However, many argue it is not the collectors who are the main beneficiaries but the *middlemen* who have a detailed knowledge of the market and who are able to sell the raw materials to the customer (Kala, 2003).

According to the World Health Organisation (WHO), world trade in herbal medicine was estimated at US$83 billion in 2008 (Robinson and Zhang, 2012). Much of the trade in medicinal plants has been based within national market systems. While global trade in high value products like spices and medicines has a long history (e.g. the spice route, (Freedman, 2003)), over the last 30 years international trade has flourished and a main thoroughfare of this trade exists between Asia and Europe, the US and Australia.

Although this global trade has potential benefits for the manufacturers and retailers of HMPs, what is less clear is the impact that international trade between these economically different geographical areas has on the livelihood of primary producers in LEDCs. It is argued that the adoption of the quality standards that are generally devised and implemented in more developed countries as a requirement to trade in HMPs will lead to benefits for those actors who are involved at the beginning stages of the value chain (Vasisht and Kumar, 2002) (although it may also lead to costs) (Henson and Humphrey, 2010, Patel, 2006).

From a global perspective, Europe has been leading the way in terms of supplying high quality HMPs. Firstly with diverse national initiatives and with the development of quality standards, for example, in the European Pharmacopoeia and, in 2004, with the introduction of the EU-wide, Traditional Herbal Medicinal Products Directive (THMPD), which requires well defined standards of quality and safety to be assured before a product can be released onto the market. Although as of December 2012, there has been over one thousand traditional use registrations licences granted in Europe (EMA, 2013), there has been little interest in the scheme from Asian producers as it is often considered by stakeholders as being too costly to obtain product approval (Patwardhan, 2011). However in February 2012 the first product that was entirely produced in Asia (China), was approved for use in the Netherlands (Gilbert, 2011). Moreover organically produced medicinal herbs continue to be sought after for the export market and the Indian domestic market has also been developing an appetite for these niche products (Kumar Sharma, 2013).

The situation is complicated further by the blurred boundaries between what constitutes a food (including health foods) and what constitutes a medicine. Such boundaries are often defined based on political decisions by regulatory agencies but are also driven by consumer choices. This is a reflection of a long and complex interface between food and medicine (Etkin and Ross, 1991) which is linked to legal, political, scientific, economic and socio-cultural debates. Therefore, compared with many food crops, medicinal plants may be more attractive economically (Alam and Belt, 2009, Sharmin, 2004)

Herbal medicines, nutraceuticals and functional foods have all been traded within the European community and beyond for hundreds and probably thousands of years (Freedman, 2003, Wicke, 1998). In modernity, the use of herbal medicines fell out of fashion, particularly during the 1960's and 1970's when pharmaceutical products were heavily promoted as being panaceas for health and dominated the market, particularly in the USA and Northern European countries (Walsh, 2010). However, because of the high cost of pharmaceutical products, the rise in antibiotic resistance, and the common public perception that pharmaceuticals often have unpleasant side-effects, herbal medicines and other complementary and alternative medicines began to make a return to favour (Ehrlich, 2011).

HMPs are often regarded by the public as being safer than pharmaceuticals and free of side-effects (IpsosMORI, 2009). Unfortunately, poor quality control and lack of effective regulation has led to numerous cases of adverse reactions to HMPs, sometimes with serious or even fatal consequences (MHRA, 2008), confirming that these products are not free of dangers and that there is an urgent need for high quality products, manufactured and administered by well qualified and well regulated professionals.

Countries such as Germany have a strong tradition of using HMPs and have a well-developed manufacturing industry within a well regulated system, where the majority of these products are mainly regarded as medicines and prescribed by bio-medical doctors (Harrison, 1998) or as over the counter (OTC) products, commonly sold in pharmacies. Whereas in the UK, a country also with a strong herbal tradition, an exemption in the 1968 medicines act, has resulted in herbal practitioners being the main prescribers of herbal medicines. What distinguishes UK herbalists from herbalists in other European countries is arguably in their level of training and level of professional (voluntary) regulation.

In many parts of Europe herbal medicine is typically practised either as part of mainstream medicine, by bio-medically trained doctors or according to ‘traditional knowledge’ by practitioners who are generally self-taught or have gone through a form of apprenticeship. The typical route for UK herbalists is through academic qualifications set at BSc or MSc level (AGCAS, 2012), obtained alongside practical training as determined by the relevant professional bodies. This has allowed for a closer dialogue to develop between more bio-medically focused approaches to the study of plants and the medicines derived from these, leading to the emergence of new terms such as *phytomedicines* and *phytomedicine practitioners*.

These terms suggest a move away from more traditional practices, that have sometimes been criticised as being non-scientific and non-evidence based, towards a more integrative approach that combines key elements from traditional knowledge and bio-medicine.

Over-the counter type trade, however, has been generally delivered by a mixture of health food shops, supermarkets and internet trade which has left the consumers with little guarantees of the products being fit for purpose. The introduction of the European directive for herbal medicines, which came into effect in April 2011, following a five year transitional period, has resulted in an increase in product quality for those products sold through retail outlets but has had less of an effect on products available from outside the EU and marketed through the internet (MHRA, 2013a).

The effect of these new regulations on products originating outside of the EU and particularly in Asia has been substantial, with protests being voiced from trade associations and government officials. This has been particularly noticeable in China and India, two countries who have had a long history of trade in herbal medicinal products with the UK and the rest of Europe (Das, 2013, InfoseekChina, 2011)

The main problems highlighted and voiced by manufactures are that the more sophisticated inputs involved in meeting the standards and the costs attached to these registered products are seen as being too high for many companies that operate within Asia and particularly within India (Patel, 2006).

These concerns are similar to those held generally on the impact of standards (Henson and Humphrey, 2010).

However, changes in regulatory requirements or the setting of higher entry bars, although presenting many challenges to the industry, can also offer opportunities. An increase in quality standards is often regarded as a positive step by consumers, particularly when related to food or medicines and these improvements in quality and safety can be regarded as adding value to a product. If companies are able to use these added requirements to their advantage it may be possible for new and more sustainable enterprises to be established, particularly if there is co-operation between Asian and European actors.

The creation of VIVCs is one way to achieve this co-operation and for producers in LEDCs to gain access to highly regulated markets. The investigation of the different chains and the impact these chains have on producers and the resulting products, forms the main aims of this project, which investigates the link between the establishment of a VIVC and the impact this may have on the livelihoods of primary producers in India and the quality of a selected product produced through this chain.

I use a mixed methods approach, employing fieldwork investigations and, for the first time, use analytical laboratory techniques to investigate different HMPs in relation to the value chain from which they originate.

The provenance and traceability of the raw materials used in HMPs has always been problematic (Newmaster et al., 2013). It is common practice for plants to be collected from the wild or cultivated on small farms and then either stored, for sometimes long periods, sold in the local market or auctioned at one of the designated auction sites (Alam and Belt, 2009, Kala et al., 2006, van de Kop et al., 2006). Middlemen are usually involved in the supply of plant material to herbal manufacturers (Shahidullah and Haque, 2010) and any information regarding its origin and primary processing is mainly lost. This lack of a traceable supply chain can lead to uncertainty (from buyers and regulatory groups) regarding the authenticity of products and the possibility of contamination or adulteration.

The consequence of this situation can be that the buyer is forced to perform additional testing, leading to downward pressure on the seller to reduce the price of the crop or even that the material is deemed not of an acceptable standard for export. Conversely, in cases where the product is exported it can result in sub-standard material being available on the high street.

An alternative to this approach has been the implementation of VIVCs where contracts are made between the primary producers in LEDCs and the secondary manufacturers, typically located in more economically developed countries.

A VIVC can be defined as when ‘a lead organisation’ is responsible for two or more intertwined steps of the manufacturing or value chain process (Strategy-Train, 2009). Connection to a VIVC has advantages for the farmer in that a premium is paid for the crop above the market price. Moreover, order size and type of crop grown can be well defined in advance, allowing for an effective planting and cultivation strategy to be developed. For the buyer, the advantages include that the crop has traceability, a price has been agreed in advance, and so market fluctuations become less important, and greater confidence that good cultivation practice has been employed. However, in order for this to work well, good governance is essential. For the farmer, a certain amount of freedom is given up and the lead firm gains power in, and greater control of, the chain. Conversely, once tied into the chain, the buyer is ‘locked in’ for a specified time period and so can also lose a certain amount of operational freedom. Moreover the costs involved in effectively managing a VIVC can be high.

India was chosen as a research site as it is a fast developing country with a long tradition of medicinal plant use. It has an established HMP manufacturing base and a thriving export market (Polshettiwar, 2006).

Following market research, using an on-line survey to investigate a self-selecting group's knowledge, attitudes and preferences towards traditional Asian medicine (TAM) and Asian medicinal herbs, turmeric (C*urcuma longa*) was chosen as a suitable case study.

Turmeric's use as both food and a medicine presents an opportunity to show how a value chain may be different for a food and a drug and how investing in quality can lead to genuine value addition. There are concerns over the quality of material available commercially. It is acknowledged that the chemical composition is variable and miss-identification of species and adulteration are frequently reported problems (Dixit et al., 2009, Govindarajan, 1980). This situation is not conducive to the development of a sustainable export market.

If it can be shown that the establishment of a VIVC can lead to a better and more consistent quality profile, if governance is appropriate, this could have a beneficial impact on primary producers. The contracted farmers can benefit from integration through having an assured income, receiving essential inputs, including training, and being paid a premium for producing crops using good agricultural practice (GAP).

Primary producers may also realise some benefits; working in a more regulated industry and one that is integrated into a structured value chain, where the end retailer is able to use 'fair trade' as a means to market and promote products. These benefits are likely to be in the form of improved conditions, better training and more work stability; as in order to produce a quality product, it is necessary to have a workforce that is better trained in and is able to implement GAP and good manufacturing practice (GMP). This usually translates into having a work force that is experienced and well-motivated.

In order for these benefits to be realised and to be sustainable, there needs to be some evidence to suggest that the quality driven strategies, policies and practices that are implemented along the chain can lead to a final product that is 'superior' in a measureable way to other products on the market that are obtained through the traditional route of supply. A major objective of this study is to determine whether this evidence exists and what is the best way to measure it?

Rather than use a conventional approach, my aim has been to assess quality in the context of value addition. There are many products on the market, all claiming to have particular benefits. However, in an attempt to increase the concentration of one particular compound, other (important) compounds may be lost. Moreover, the safety implications of developing ‘high potency extracts’, may not have been full considered.

Although curcumin has been focused on as being the main active ingredient found in *Curcuma longa*, the bio-availability of this compound is poor (Shoba et al., 1998). Other research has suggested that it is the combination of curcuminoids that is important (Ahmed and Gilani, 2013).

Curcuminoids belong to the group of di-phenylheptanoids, having a phenyl-C7-phenyl skeleton. Typically these polyphenols are present in 3-15% of Curcuma longa rhizomes with curcumin as the principal compound. Commercial ‘curcumin’ is usually made up of a mixture of three curcuminoids made up of approximately 71.5% curcumin, 19.4% demethoxycurcumin and 9.1% bis-demethoxycurcumin (Li et al., 2011).

There are also other groups of compounds present, e.g. volatile oils and polysaccharides that may have therapeutic effects.

The main sesquiterpene constituents found in the essential oil include, ar-tumerone, α-tumerone and β-tumerone. Tumerone being responsible for turmeric’s distinctive aroma (Ravindran et al., 2007). Other compounds that have been isolated from the essential oil include α-felandrene, 1,8-cineole, ar-curcumene, α-zingiberene, β-sesquifelandrene, (Z)-ç-atlantona and (E)-ç-atlantona (Chassagnez-Me´ndez et al., 2000)

The main water-soluble components found in turmeric are polysaccharides. The polysaccharides present in turmeric have also been suggested as having some anti-inflammatory action (Tohda et al., 2006).

Turmeric has a long history of use as a food and medicine and has been used in its natural unprocessed form to treat a wide range of conditions. Often modern processing techniques can change the composition (and therefore the medicinal properties) of a raw herbal drug. I have used a concept of quality that compares products to the unprocessed, fresh material. This strategy allows for a product to be assessed in terms of its ability to retain compounds and importantly allows for a potential marketing structure that can be linked to ‘value-addition’ and ultimately, livelihoods.

In order to investigate the complex and variable phytochemistry across a wide range of samples, metabolomics offers some novel and scientifically robust opportunities. It provides what has been called a 'holistic view' of the metabolites of a set of organisms (Kim et al., 2011) and has been used in a wide range of research fields like plant biotechnology, ethnopharmacology, ecological toxicology and plant physiology e.g. (Verpoorte et al., 2005, Kim et al., 2011, Liu et al., 2011, Michl et al., 2011), and is ideally suited for comparing large number of samples as one would encounter them, for example, along a value chain.

At the same time it is a method which as such is not validated and data can potentially be manipulated in a biased way, and so it needs to be compared to a standard method like HPTLC, widely used in the authentication and quality control of herbal substances (Reich and Schibli, 2007).

I have used these analytical techniques in combination in order to provide a depth of information that is unique. Moreover, never before have the results of a laboratory investigation been directly linked to value chain analysis and ultimately the livelihoods of producers.

2.0 Thesis statement

The livelihoods of primary producers of herbal medicines, in India, can be linked to the type of value chain that they are contracted to. Moreover, the value chain and its endogenous variables have a direct impact on the quality of the final herbal medicinal product.

3.0 Review of the current literature

Literature was reviewed using the University College London School of Pharmacy (UCLSOP) Library databases, Embase and Web of Knowledge and performing on line searches using, Google, Google Scholar and Pubmed. Hard copies of books and journals were accessed via the UCLSOP library, the School of Oriental and African Studies (SOAS) library and the Libraries of The Royal Society of Chemistry (RSC) and The Linnean Society. Grey material was accessed from the internet and from local publications during the fieldwork stages.

3.1 Traditional Asian medicine

TAM covers a wide range of treatment modalities from many different countries. Most Asian countries have a long history of using traditional herbal medicines, which are more recently becoming popular in the US and in Europe (IpsosMORI, 2009, NIH, 2007, UOM, 2011).

The two most well-known of these are traditional Chinese medicine (TCM) and traditional Indian medicine (TIM), the most commonly recognised sub section of TIM being Ayurveda[4] (NIH, 2009). Although there are subtle and sometimes major differences between TCM and TIM, their underlying medico-philosophy is similar and distinguishes them from more orthodox bio-medical practice.

According to many of the world's medical traditions, including TAM, disease firstly begins with minor imbalances within the body. Often the body will correct these imbalances naturally through homeostasis and physiological regulatory processes. However, if the body is weak or continually subject to external influences, which can prevent a return to a healthy state, then over time, disease processes will manifest, eventually leading to symptoms that will be well recognised through bio-medical diagnostics. The primary focus of TAM therefore is to treat the individual before any major symptoms have arisen. In TAM philosophy, no one is considered in perfect health, just that some people are less sick than others. This sentiment is summed up in an ancient Chinese text;

> "Trying to cure disease once symptoms have arisen is like digging a well once you are already thirsty or forging a warrior's spear once the battle has already begun..."

Source: *Yellow emperor's classic of internal medicine* (Anon., 947–951 CE)

This is not to infer practitioners of TAM only deal with healthy individuals, but that the emphasis is ideally on prevention rather than on cure. This thread of traditional medical philosophy continues when treating those with symptoms, where a practitioner of TAM will attempt to establish the underlying cause of disease based on traditional medico-philosophical principles.

[4] Ayurvedic medicine is the most common system of traditional medicine found in India and stems from ancient texts of the Hindu religion. Other Indian traditional medical systems include Unani, derived from Greek-Islamic medicine, and Siddha, the folk medicine of Southern India.

This, what is often perceived by the general public as a more preventative, holistic way of treating human beings, has become increasingly popular in North America, Australia, New Zealand and many European countries and has led to significant increases in exports of traditional Asian medicines (Vasisht and Kumar, 2002) along with other non-plant based practices such as acupuncture, tai chi, yoga, and various forms of Asian massage and physical therapy.

In the UK there are well over 10,000 practitioners of acupuncture alone, affiliated to the three largest professional bodies (The British Acupuncture Council, The British Medical Acupuncture Society and The Acupuncture Association of Chartered Physiotherapists).

These health focused interventions have begun to develop an evidence base (Kayne and Booker, 2010), indicating that they may be useful in the following areas:

Oral herbal preparations have been shown to be beneficial in the treatment of eczema, atopic dermatitis, allergic rhinitis, primary dysmenorrhoea and in alleviating short-term side effects of chemotherapy (Sheehan and Atherton, 1992, Hon et al., 2007, Xue et al., 2003, Kotani et al., 1997, Zhang et al., 2009). The British Medical Association concluded in their report on acupuncture that there was clear evidence for its efficacy in the treatment of nausea and vomiting post-operatively and during chemotherapy, back pain, post-operative dental pain and migraine (Silvert, 2000) and there is evidence that tai chi reduces injury through falls and improves mobility of the ankle, hip and knee in people with rheumatoid arthritis (Han et al., 2004, Wolf et al., 2003)

However, poor practice and a lack of regulatory standards can also have the potential to do harm and there have been numerous instances of quality problems and poor practice, including heavy metal and pesticide contamination, misidentification of herbal ingredients and the addition pharmaceutical active ingredients (MHRA, 2013a). This has led to the UK government proceeding with plans to subject herbal medicine practitioners to further regulation and a new regulatory framework.

On 16th February 2011, the Secretary of State for Heath, Andrew Lansley announced in a written statement to the UK Parliament, that all UK practitioners prescribing herbal medicines are to be statutorily regulated via the Health Professions Council. The Health Secretary went on to explain that,

> "This would ensure that practitioners would meet specified registration standards, giving practitioners and consumers continuing access to unlicensed manufactured herbal medicines to meet individual patient needs after the introduction of new EU legislation after April 30th this year" (Lansley, 2011).

This further regulation of the herbal profession will come with some expectations attached and the Medicines and Healthcare Products Regulatory Agency (MHRA), the UK's medicines' regulators, have indicated that they would like to see a positive list of plant medicines established that can be used safely in daily practice (MHRA, 2006). The plants and plant products that make up this list will be required to satisfy standards of quality and safety appropriate to the United Kingdom.

For plant material obtained from outside the European Union, this is likely to present some challenges but also some opportunities for Asian producers to benefit from a regulated and quality driven medicinal plant industry (see chapter 1.0).

However, there has been some opposition to the statutory regulation of herbalists, with objections being raised that it lacks a credible evidence base and may give false credibility to the profession (Ernst, 2012). This opposition, coupled with a lack of a single voice from the profession, with a proportion of herbalists themselves being 'anti-regulation' (Jones and Evans, 2013) has led to a delay in the process. With further consultation planned, the prospect of full statutory regulation is far from being assured, with 'softer' regulatory options being considered.

The government's stance in May 2013 was,

> "The legislation around this policy is complex and there are a number of issues that have arisen which the government needs to work through. I appreciate that the delay in going out to consult on this matter is causing concern, but it is important that any new legislation is proportionate and fit for purpose" (Hansard, 2013)

The outcome of these proposals will have a direct impact on the herbal profession and the HMP manufacturing industry in the UK and, to a lesser extent, the rest of Europe.

This in turn will impact on both home producers of medicinal plants but also suppliers outside of Europe and particularly in Asia.

3.2 The value chain

The global commodity chain literature has moved away from the term *commodity chain or supply chain* in favour of the term *value chain*. The latter is thought to better describe a wider variety of products and services, while also focusing on the distribution of benefits. As a result, the global commodity chain approach is now known as GVC analysis (Gibbon and Ponte, 2005).

> “Value chain analysis describes the activities within and attached to an organisation, and relates them to an analysis of the competitive strength of the organisation. Therefore, in economic terms, it evaluates that value each particular activity adds to the organisations’ commodities or services. This idea was founded upon the insight that any company is more than a random assembly of machinery, people and finance and only if these things are arranged into definable systems will it become possible to produce something for which customers are willing to pay a price. Therefore, it is argued that the ability to perform particular activities and to manage the linkages between these activities is a source of competitive advantage” (Recklies, 2001).

Changes in production, distribution and finance systems, in synergy with the globalisation of markets and the spread of information and communication technologies, suggest that more attention needs to be paid to both external and internal linkages within a company structure. The concept of the value chain allows us to shift the focus from manufacturing only to the other activities involved in the supply of goods and services, including distribution and marketing.

> “Value chain research focuses on the nature of the relationships among the various participants involved in the chain, and on their implications for development. At any point in the chain, some degree of governance or coordination is necessary in order to take decisions on how the chain should be managed effectively” (Giuliani et al., 2005).

However, value chain analysis has also been criticised for not giving enough attention to wider social, economic and political factors. Its strength lies in describing the value chain linkages but it does not explain how and why these linkages have developed. And so any research investigating the value chain should also include a wider exploration of these surrounding issues.

3.3 The medicinal plant value chain

Value chain analysis has been applied to a variety of consumer goods but only recently has it been applied to medicinal plant production, (Wynberg et al., 2003, Alam and Belt, 2009, Kala, 2003, Shahidullah and Haque, 2010, van de Kop et al., 2006)

By examining MPVCs, it will allow us to better understand the role of different actors and inputs in the chain and their influence over chain management. Understanding the process is a vital step towards suggesting any meaningful strategies for improvement. In one example of an investigation into new opportunities and challenges for Ayurvedic small businesses, Torri (2012) argues that the current structure of the supply chain, being one of high fragmentation, renders it unable to improve the livelihoods of producers and highlights the need for community based enterprise initiatives to better represent the rights of farmers and small scale producers at the community level.

The cultivation of medicinal plants is a relatively new industry and wild collection represents the main route of supply in terms of the number of species collected (Schippmann et al., 2006, Kuipers, 1997). On many occasions, wild medicinal plants are preferred by traditional healers and consumers over the cultivated ones (Giblette, 2006), as there is a general feeling that wild plant species are more clinically effective.

Researchers, Kala et al. (2006) and Manish (2011) claim that worldwide, medicinal plant species are depleting at a rapid pace due to over-collection from their natural habitats. The collection and marketing of medicinal plants from the wild is an important source of livelihood for many of the poor in LEDCs. In Nepal, more than three hundred thousand households are engaged in the collection of medicinal plants (Alam and Belt, 2009). It is claimed that up to 15,000 species of medicinal plants are globally threatened (Hawkins, 2008) and two ways are identified to conserve threatened species; firstly by tightening restrictions on collection practices, and secondly by cultivation on a large scale (Schippmann et al., 2002).

3.4 Medicinal plant value chains in Asia

Kala et al. (2006) assert that the marketing system in India is largely unregulated and inequitable. The medicinal plant cultivators are generally the marginal farmers and labourers. They receive a cash income to meet their basic requirements for food, health and the education of their children. They are often unaware of the real market prices of many of the medicinal plant species. Often it is difficult for farmers to sell certain herbs due to their lack of knowledge of the marketing system and conversely many medicinal plants are destined to be traded through illegal channels. Other constraints are slow rate of production, a long gestation period, shortage of cultivation technology, low yields, unscientific harvesting, poor processing, lack of quality control, scarcity of good manufacturers and poor marketing infrastructure.

In the paper by van de Kop et al. (2006), a review of fieldwork conducted in Uttaranchal, one of India's poorest states, the authors document that resource-poor people collect plants from the wild to supplement their low income. They point out that high risks, transaction costs and a lack of trust amongst chain actors prevent small-holder producers from taking up the cultivation of medicinal plants and suggest that public-private collaboration as a way of reducing these constraints and secure market accessibility for small producers.

They analyse the opportunities for and the constraints on developing medicinal plant chains and aim to identify the role of medicinal plant chains in poverty reduction.

Most of the medicinal plants in this area are collected from the wild. Permits are issued to co-operative groups in the area, which in turn employ contractors to organise collection. The contractors employ collectors, usually land owning farmers or landless labourers. The contractor can sell the collected plants either to the local co-operatives or directly to independent traders after paying royalties to the co-operative.

The co-operatives sell either to local agents or wholesalers, traders in large cities, or to drug manufacturers. The traders supply the domestic market and international markets.

The authors suggest that in the value chain, the collectors and local contractors are in a weak position as they cannot sell directly to the large trading companies in the cities, and depend on the local traders for marketing. This weak position often results in them receiving a considerably lower price than the true market price.

Cultivation is seen as a way of breaking free from some of these ties and small scale projects have commenced in the area. There are difficulties and risks attached to cultivation and public-private collaborations are suggested as a way of minimising these constraints. However, these collaborations have remained small and further promotion, regulation and investment is needed if these ventures are to produce a meaningful result (Alam and Belt, 2009).

Alam and Belts work focused on a project in Uttarakhand, northern India, where 80% of the population rely on agriculture as their main economic activity and 40% of people live below the poverty line. It was proposed that the cultivation of a medicinal plant, *kutki*, *Picrorhiza kurroa* Royle ex Benth. Scrophulariaceae, would benefit the farmers financially, provide social benefits and help preserve wild species. The European buyer would also have a secure supply of the plant from a fully traceable source. Although the authors claim that this was the first initiative of its kind between Indian farmers and a European company, the VIVC investigated during the fieldwork stage of this project has similar contractual agreements in place with farmers in India.

The Uttarakhand project produced disappointing results and in their paper the authors highlighted the reasons for this as being poor quality of planting material, planting on small, poorly irrigated plots, and the emergence of apples as a profitable cash crop, resulting in farmers switching from kutki to apples.

Alam and Belt concluded that the cultivation of medicinal plants is more difficult than usually suggested in the scientific literature and government promotional material and stress the importance of agencies and non-governmental organisations (NGOs) taking these difficulties into account and take steps to minimise these. The authors further argue that a thorough technical and economic feasibility study of the value chain, long term involvement of governmental and NGOs, and an understanding of the prevalent farming system are necessary to ensure the success of the chain.

Conversely, in a project conducted in Bangladesh, Shahidullah and Haque (2010) appear more optimistic with respect to the economic potential of medicinal plants and suggest vertical integration as a vehicle to benefit and empower producers and processors at the beginning of the value chain.

The Bangladesh project indicated that the primary and wholesale secondary markets were dominated by middlemen and their study challenged the view that medicinal plant cultivation was only appropriate for relatively well-off people with better access to land, capital and information.

The authors built on previous work by researchers van de Kop et al. (2006) and argue that some of the mechanisms employed in developing and sustaining institutional relationships may also apply equally well to defining the MPVC and list *contracts*, *quasi-vertical integration* (an especially close and long term relationship), *tapered vertical integration* (when a company sources inputs externally from independent suppliers as well as internally within the same company), *cost plus agreements* (where the contractor is paid a negotiated amount regardless of incurred expenses), *joint ventures* and *strategic alliances* as examples of these potential relationships.

Moreover, they argue that the benefits of an integrated value chain are numerous.

> "It enables primary producers to become active participants in the process, it removes market access barriers, and it results in better commercialisation of products and is attractive to companies as they can have greater control over quality and supply."

In their study, Shahidullah and Haque, contrary to previous views, found that the cultivation or production of medicinal plants could play an important role in improving the livelihoods of those poor or very poor people who may own only small pieces of land.

They argue that in order to sustain growth in medicinal plant production,

> "A fair distribution of the gross margin to the primary producers is necessary."

In the value chain system examined by Shahidullah and Haque (2010), it was found that downstream buyers, especially manufacturers and consumers pay most of their money for middlemen's value additive opportunistic pricing due to inherent weaknesses in the chain.

A vertically integrated chain, with only producers and processors as commercial actors and NGO's as promoters could create a better and more equitable situation.

However, there are some studies that suggest that vertically integrated chains, particularly ones that are dominated by a powerful company can lead to negative effects on the livelihoods of small producers.

This has been illustrated in the work of van Niekerk and Wynberg (2012), where the authors present evidence to suggest that (based on their assessment) the monopolistic behaviour of one large German company threatened the livelihoods of farmers in South Africa (for a single botanical drug) and that there were major inequalities between the bargaining powers of the local manufacturers and the primary producers.

And so the literature presents a different and sometimes conflicting view of the potential of VIVCs.

3.5 Land and Livelihoods

In the context of international development, a common view has been that the answer to global poverty lies in the promotion of farm-based activities and in the redistribution of land resources (IFAD, 2008) and this level of thinking has often set the trajectory for development interventions and the introduction of new and more efficient technologies for increasing output.

However, this fundamental precept does not go unchallenged and Rigg (2006) presents the argument that non-farm activities are becoming central to rural livelihoods. Quantitative data exists to shore up this hypothesis. One African study conducted by the De-agrarianization and Rural Employment (DARE) research programme undertaken in six African countries during 1996 to 1998, found non-farm activities contributed to 60 to 80 per cent of rural household income (Bryceson, 2002) and in India, the National Council of Applied Economic Research conducted a study in 240 villages across 16 states between 1971 to 1999 and found that the share of non-farm incomes increased from 19 per cent to 48 per cent of total income (Foster and Rosenzweig, 2004). As a result, there needs to be greater consideration of *who* farms and who is involved in non-farming activities.

The commercialisation of non-timber forest products and in particular medicinal plants is a means for rural communities to increase their incomes and consequently their standard of living but as pointed out by Wynberg et al. (2003),

> "As well as bringing opportunities for rural growth, there are also pitfalls to be considered and the benefits obtained from commercialisation must be weighed against any negative impacts on livelihoods and cultures that are integrated within a social network of subsistence farming."

In India, approximately 84 per cent of rural households operate less than 0.4 hectare of land (Turner, 2004). During 1993 to 1994 and 1999 to 2000, the growth of jobs in the farm sector was only 0.2 per cent (Kisan, 2006).

According to Mitra and Josling (2009), agricultural wage, which directly impacts on rural living standards, is a complex endogenous variable and is influenced by several other variables in turn. Rural-to-urban migration may cause labour shortages in rural areas, particularly during the peak agricultural seasons, and this tends to raise wages.

Farm labourers, however, who find employment in less-developed regions and help other workers' migrate by bearing the initial costs of migration, take for themselves a percentage of the workers income and thus the actual gains to work due to rise in demand, get substantially suppressed. On the other hand, the rural work market and the credit market are often interconnected, and thus it is difficult to make a meaningful separation between the wage earned from the work undertaken and the costs and benefits associated with long term loans received from the employer.

There is little validated data in the literature on the production of cultivated medicinal species since these are not recorded at the grass root level for want of adequate knowledge and interest by the record keeping authorities. All species are considered as one commodity. The area of 2,720,150 hectares listed under important medicinal plants, are estimated on the basis of consolidation made from the fragmented information available in literature.

The National Medicinal Plant Board, Government of India, has identified 32 prioritised medicinal plants. The cumulative annual demand of all thirty two plants was estimated to be 141,398 tonnes during 2004 to 2005 (Commission, 2007).

In order to have a point of reference when examining the effects that a particular value chain has on livelihoods, it was important to establish what the current literature revealed about current wage distribution and working practices and how different endogenous factors may impact on livelihoods. Improving the rural wage in India has been found to be the single most significant factor in reducing poverty among the rural poor (the national minimum wage is 100rps, (US$1.6 per day)) (Singh et al., 2012).

One of the case studies examined during the fieldwork stage cultivates medicinal plants organically and therefore the current literature available in this area is of particular importance.

The value chain itself is one factor to consider, but what are the others?

1. The size of farm

It is known that plantation workers earn less than other farm workers but is this connected with the size of the farm?

In India, small farms account for approximately 84 per cent of all operational holdings and are responsible for farming 42 per cent of the country's total cultivated area (Turner, 2004). Small farms maximise labour use, add maximum value to their products, and have higher yields than large farms (i.e. are more efficient).

2. The geographical location

Some states are very poor and the wages reflect this - what evidence is available to back this up? Is there much difference in wages between Karnataka and Tamil Nadu and could this explain why the traditional method farm workers (case study 1) were paid more than the vertically integrated workers (case study 2)? Gujarat, a region in western India which achieved a 10 per cent annual growth in agriculture over the last decade, has a lower average wage for both permanent and casual rural labour than other Indian states such as Maharashtra, Andhra Pradesh, Tamil Nadu and The Punjab. It was also lower than the national average wage rate in 2007 to 2008. Farm labourers in West Bengal earn wages as low as 70 rupees (approximately US$1.0 per day) for male workers at high season (Barua, 2010).

The difference in wages between genders in the northern states is much lower than in the states of southern India (Mahajan and Ramaswami, 2012).

A relatively higher growth of real wages in the southern states and a negative growth of real wages in Punjab and, to a lesser extent, Haryana, is a reflection of the agriculture performance of these states. By and large, the investigation of figures suggests that the increase of real wages for agriculture workers has been significant. Agricultural productivity however, increased only marginally during the 1990s. This further raises the issue of what exactly determines the real wages for agricultural workers in the country? (Jha, 2006).

3. Wage variation within a state

Barua's survey found that wages in Nadia, West Bengal varied due to the season and ranged from 40 rupees in low season to 80 to 90 rupees per day for men and 35 to 50 rupees for women. In Jalparguiri, West Bengal high season wages ranged from 70 to 80 rupees per day for men and 50 rupees for women (Barua, 2010).

4. The type of crop

The type of crop being cultivated, e.g. organic, non-organic, niche product, rare plant, and CITES-controlled, can have significance to wages. There is evidence that higher wages are paid for picking difficult crops in harsh conditions e.g. tobacco.

> "The wages for agricultural workers (known as coolies) vary in men from 120 to 220 rupees per day and 80 to 100 rupees per day for women in the Tirupur region. One exception is in the area of tobacco growing where a male worker can earn up to 300 rupees per day. This is because the tobacco season is relatively short and the picking and processing is unpleasant" (Carswell, 2010).

> "The organic farming movement in India suffers from lack of adequate institutional support in the areas of research, extension and marketing. Organic farming requires more scientific support than chemical farming. Internationally accepted certification procedures need strengthening and must be farmer-friendly and affordable. Organic farming zones could be identified, like some of the hill areas and islands where currently chemical fertiliser use is very low, and for medicinal plants where the use of chemical pesticides and fertilisers is not advisable. Food safety and quality specifications should conform to the Codex Alimentarius standards since there are occasional reports of heavy metals being present in organic foods. Subsidies or loans similar to those given to farmers to buy chemical fertilisers / pesticides should be available for organic manures like

> farm yard manure, compost and bio-fertilisers and bio-pesticides also. Farmers engaged in organic farming should be linked to niche markets where they will obtain a premium price, in order to compensate for any loss in yield" (Kisan, 2006).

5. The value chain

VIVCs can pay premiums (Fairtrade, 2010, Nelson and Pound, 2009). However, pressure on small farms in value chains to compete on the open market may encourage the exploitation of workers in terms of the wages smallholder-employers can offer; the working conditions they can provide; and the temptation to use child labour in, for example, cotton production for domestic and multinational firms in India (Nelson and Pound, 2009).

There is an argument that contracting agri-business firms do not pay attention to or take responsibility for labour issues. They protest that they do not contract farmers directly because contract farming in India's seed sector is conducted through seed organisers – which are usually small local companies, large farmers or farm produce traders. However, Singh et al. (2012) suggest that large agri-businesses leverage costs onto smallholders through mechanisms like contract farming, which is based on the exploitation of hired and family labour and that farm and allied labour is not seen as a stakeholder in agriculture at all and is treated as just an element of production. Therefore, the livelihoods and concerns of paid agricultural labourers are more or less ignored in discussions of smallholder agriculture.

6. The value of the end product

It has been observed in the grocery market that the end price of a commodity cannot always be positively correlated to producer income. For example, retail coffee prices have remained relatively stable, despite producer prices dropping to less than one third of their 1960 level leading to accusations of flagrant profiteering from the exploitation of millions of smallholders (DFID, 2004).

7. Caste / gender

Nearly 70 per cent of Indian rural women are employed in agriculture and they are responsible for 60-80 per cent of food production. Most of the women cultivators are involved in food crops rather than cash crops since cash crops need more marketing efforts, which are traditionally taken care of by men. Most of the women farmers are marginal or small farmers, landless tenant farmers and farm labourers. They don't have enough land to cultivate, have low capital and poor access to credit, and have less knowledge of, and limited access to, innovative technologies (Yashwanth, 2011).

'Scheduled tribes,'[5] account for approximately nine per cent of the total population of the country. A majority of minority groups across the country are dependent on forests and animal husbandry for their livelihoods. These include cultivation (shifting cultivation in many cases), collection of fuel, fodder and a range of non-timber forest produce. According to Kisan (2006), tribal farmers are among the most disadvantaged category of farmers.

There is a significant gender gap in agricultural wages and working conditions in the developing world. In India in 2004 to 2005, women working on farms earned only 70 per cent of what men earned. Over 80 per cent of women did not get the minimum wage, compared with 41 per cent of men (Singh et al., 2012).

8. Do some of the farmers also own livestock?

Livestock production is one of the important sources of livelihood for farmers in India. The contribution of livestock, especially in the drier regions, where crop cultivation has limited possibility, is very well recognised (FAO, 2013). Livestock, including poultry, is the second major land-based livelihood, contributing 26 per cent of the agricultural GDP in 2004 to 2005. It is clear that livestock and livelihoods are very intimately related in India and that crop-livestock integrated farming is a pathway to farmers' well-being (Kisan, 2006).

9. Seasonality

It has been reported that farmers' wages will vary according to the season. Barua's survey found that wages in Nadia, West Bengal varied due to the season and ranged from 40 rupees in low season to 80 to 90 rupees per day in high season (Harvesting and sowing, where time bound work is crucial to end yield) (Barua, 2010). A quarter, (29 per cent), of households are engaged in agricultural labour, but this work tends to

[5] The Indian government has recognised a number of minority groups across India and has designated them as Scheduled Tribes. NCST (2005) *National Commission for Scheduled Tribes.* Govt. of India, [cited: 17-6-2013]. Available from http://ncst.nic.in/index.asp?langid=1.

be seasonal and the income accounts for only seven per cent of total income (Vanneman and Dubey, 2010).

10. Farming is the sole income or only part of the income

Non-farm employment is considered to be particularly important to the landless and small and marginal farmers (Coppard, 2001). The non-farm sector in rural India has grown steadily in the period since 1983, with some acceleration during the late 1990s and into the 2000s, but levelled off again in the period post 2004 to 2005. This process of transformation has contributed to declining rural poverty both directly, through employment generation and also indirectly through its impact on wages (Himanshu et al., 2011).

This review suggests that the nature of the crop, the value chain, the season, the location of the farm, its size and worker characteristics will all play a factor in the determination of wages.

3.6 Medicinal plant production in China and India

a) China

China has a long history of using plants for medicinal purposes (Petrovska, 2012). There are hundreds of state-owned and increasingly shared ownership companies producing traditional Chinese medicines, many of which export their products internationally (PMMI, 2001).

China has partly addressed its own difficulties relating to the manufacture and supply of TCM products by modernising its traditional medicines profession with government sponsored GAPs and GMPs. All manufacturers of TCM products must comply with standards set down by the China Food and Drug Administration (CFDA) in order to gain GMP certification. Only around 1500 companies have achieved this standard.

However, TCM products originating in China are of particular concern to the UK regulatory authorities and instances of poor quality and adulterated material are commonly reported (MHRA, 2008, MHRA, 2013b, MHRA, 2013c).

b) India

Kala et al. (2006) assert that of the 17,000 higher plant species to be found in India, 7,500 are known for medicinal uses, with Ayurvedic medicine claiming to use 2,000 of these. Most plants used in Indian systems of medicine are collected from the wild. More than 60 species are in great demand and the ‘tribal belt’ of India is abundant in these plants and minority groups mainly depend on this trade for their livelihoods (Patwardhan et al., 2005). The annual turnover of the Indian herbal medicine industry has been estimated by different authors to be between US$377 million and US$1 billion per annum (Sharma et al., 2008, Kala et al., 2006), between 0.5 and 0.8 per cent of world trade.

The globalisation of Ayurvedic practices gained momentum during the 1990s and onwards into the 2000s and Ayurvedic products are commonly used as food supplements in North America, Australia, New Zealand, Europe and Japan (Ravishankar and Shukla, 2007). While Indian exports, valued at US$132 million in 2008, contributed less than one per cent to the global herbal market, industry observers suggest that growth is rapid and that Indian companies are fast emerging as key international suppliers of medicinal plants (Seale, 2011).

A study commissioned by India’s National Medicinal Plants Board and conducted by the Bangalore-based institution, the Foundation for the Revitalization of Local Health Traditions (FRLHT) has estimated that 177,000 tonnes of medicinal plants are used each year by India’s domestic herbal industry, that 86,000 tonnes are used within rural Indian households, and that 56,500 tonnes are exported through international trade (Cavaliere, 2010).

The structure of the industry is quite diverse. Herbal medicinal products are produced by several thousand companies in India, most of whom are quite small, including numerous neighbourhood pharmacies that compound ingredients to make their own remedies (Dharmananda, 2003).

The products of these companies are included within the broad category of ‘fast moving consumer goods’ (FMCG) which mainly involves foods, beverages, toiletries, cigarettes, but may also contain certain types of pharmaceutical (LBS, 2009). Most of the larger HMP suppliers provide materials other than herbal medicines, particularly in the areas of foods and toiletries (Dharmananda, 2003).

The exact number of manufactures is unclear. Subrat et al. (2002) suggest that there are approximately 6,000 licensed manufacturers and about the same number of unlicensed ones, with about 70 per cent of the market share belonging to Ayurveda.

Whereas Polshettiwar (2006) proposes that about 1200 licensed small manufacturers in India are on record, with about 20 well-recognised manufactures of HMPs and 140 small to medium size manufactures.

However, what is generally agreed is that the formal sector of the industry is dominated by less than a dozen major companies. In 2012, Emami was the leading company, with a market value share of 17 per cent, followed by Darbur with 16 per cent and Proctor and Gamble, the American multi-national consumer goods company, with 11 per cent, indicating an increase in market presence from non-Indian companies (Euromonitor, 2013).

However, according to Seale (2011), there are around 30 other companies that produce US$1 million or more in Ayurvedic products each year, including small pharmacies and family-owned enterprises that formulate their own products and guard their remedy recipes closely. But while Ayurveda has traditionally been the province of home remedies and naturalist producers, like everything in India, Ayurvedic and other traditionally based products are going increasingly high-tech (Seale, 2011).

These manufacturers are supplied by local or national markets, directly from farms, or commonly through middlemen. The vast majority of medicinal plants used in India to make HMPs are still collected from the wild although there is evidence to suggest that some companies are developing more sustainable cultivation strategies (Cavaliere, 2010).

Exports

Exports of Indian herbal products increased from US$69 million in 2005 to 2006 to US$128 million in 2009 to 2010, recording a compounded annual growth rate of 16.8 per cent. North America, Pakistan, Germany, Japan, the United Kingdom, Spain, China, France, Vietnam and Mexico, were the top ten export destinations for India's herbal exports over the last three years.

The United Kingdom remained the fifth largest overseas market for Indian herbal products with exports worth US$3.7 million in 2007 to 2008, and US$5 million in 2008 to 2009. The UK had a 2.5 per cent share in the country's total herbal exports in 2009 to 2010 (Scindia, 2010).

If these figures are accurate, it indicates that UK imports in 2009 to 2010 declined to around US$3.2 million, possibly as a result of the implementation of the THMPD which, it has been argued, raises the entry bar for producers of these types of plant based medicines to enter the European market (Patwardhan, 2011).

Professional practitioners of TIM, including Ayurveda, are scarce in the UK compared with Western herbalists or TCM practitioners and Indian HMPs are generally sought out by the general public in retail health food shops or using online websites. Ayurvedic products are also available as food items in supermarkets in the form of teas. This is a juxtaposition of how these plants are administered in India, where many herbal products are regarded as potent medicines often superior in efficacy to pharmaceuticals and with fewer side-effects (Patwardhan et al., 2005).

Despite some healthy growth in Indian HMP exports, adulteration and contamination are commonplace and so the supply of good quality raw materials is limited (Patwardhan et al., 2005). This has in turn stunted the industry's growth in previous years. A national organisation, The Ayurvedic Drugs Manufacturers Association is reportedly taking a pro-active role to improve quality and research but has so far been unable to make any significant change.

More and more species are being gradually added to the Indian herbal materia medica and the standards for purity and identification do not always keep pace with this expansion process (Kala et al., 2006). This potentially lucrative position has led to the over-exploitation and depletion of medicinal plants.

Kala et al. state that more than 95 per cent of the 400 species used in the herbal industry are wild collected and argue that developing agro-technology should be a research priority. It is argued that farming will foster the production of uniform material from which standardised products can be readily obtained. Moreover by cultivating plant species, identification can be controlled from the seed stage.

One feeling is that the medicinal plant sector can be improved if the agricultural support agencies would come forward to help strengthen the medicinal plant growers and if research institutions would aid the plant growers by improving their basic knowledge of plant cultivation practices (Kala et al., 2006).

Vaidya and Devasagayam (2007) are more positive about the condition of the industry and propose that evidence-based herbals are widely used and manufactured, as per the guidelines, by a well-organised industry and suggest that newer approaches, utilising collaborative research and modern technology in combination with established traditional health principles will yield rich dividends in improving health.

However, as indicated below (see 3.8, The tea value chain and 3.9, The ginseng value chain), there is some debate and no firm resolution concerning the long term effects of a move to cultivation, the impact of closer regulation and of the implementation of VIVCs.

Table 1 Estimated annual values of Herbal medicines and foodstuffs

Global value of herbal medicine	US$83 billion (2008)
Value Indian herbal Trade	US$1 billion (2006)
Value of Indian herbal exports	US$128 million (2010)
Value of UK imports of Indian herbal medicine	US$5 million (2009)
Value of herb trade at Bozhou market, China	US$735 million (2011)
Value of Canadian ginseng trade	US$68 million (2001)
Value of USA turmeric imports	US$4 million (2008)

(Source: (Robinson and Zhang, 2012), (Sharma et al., 2008, Kala et al., 2006), (Scindia, 2010), (Brion, 2011), (UPA, 2003), (Hallquist et al., 2010).

According to Patwardhan et al. (2005), India should take the lead from China in developing a more quality-driven ethos towards medicinal plant production. However, Gong (2006), points out that despite the fact that China outpaces India in economic development, the Indian pharmaceutical industry excels in the international market while Chinese companies lag behind and argues that the critical success factors of Indian pharmaceuticals can be explained from both the macro level of the industry environment to the micro level of enterprises (see table 2).

Table 2 Success Factors for the Indian pharmaceutical industry (Gong, 2006)

Macro Level	Micro Level
The development of the pharmaceutical industry is driven by societal development and innovation	Well-established privately owned enterprises (POE's) are commonplace in India
The Indian government provides incentives for exporting active pharmaceutical ingredients and reduces taxation to promote trade	Resources are well utilised and enterprises are efficiently managed
To Investors India is more attractive than China because of better corporate governance, more regulated finances, more transparent IPR protection, and a more business friendly legal system.	Indian companies have a longer history and deeper understanding of International markets than their Chinese counterparts.
Exceptional patent protection exists in India	Indian companies place a high priority on applying technologies and expertise to business management.

Pharmaco-economic studies on TIM and TCM are rare but can help in understanding cost-effectiveness and cost benefit of traditional medicine. Patwardhan et al. (2005) argue that in all such attempts, Chinese medicine regulation can help India at various levels, including with policies, quality standards, research models and integration into the health system.

There is no doubt that China has a lot of experience in this arena but it may also be productive for India to make collaborations with the countries in which their products are destined in order that they can fully comply with international standards and regulations. As discussed above, India has already achieved this in the allopathic pharmaceutical arena where it appears ahead of China in terms of its achievements.

3.7 Supply, demand and sustainability

As experienced in connection with the expansion of traditional medical systems globally, rapid growth in the TAM industry has led to the over-exploitation and depletion of medicinal plants, not only affecting bio-diversity and the ecology but also having a serious detrimental impact on the livelihoods of the indigenous forest peoples.

It has been estimated that over 2000 medicinal and aromatic plant species are used commercially in Europe, of which 1200 to 1300 are European native species.

Approximately 90 per cent of the European species are collected from the wild, with eastern Europe and the Mediterranean regions being the main suppliers (Lange, 1998). In India it has been estimated that approximately 7500 species are used for medicinal and veterinary purposes (Uniyal et al., 2000). Over 10,000 species are used medicinally in China (He and Cheng, 1991), with 1,000 species commonly used in medicinal preparations, of which 80 per cent are wild-collected (He and Sheng, 1997)[6].

Kala et al. (2006) state that more than 95 per cent of the plant species used in the herbal industry are wild collected and argue that developing agro-technology should be a research priority.

> "Farming will foster the production of uniform material from which standardised products can be readily obtained. Moreover, by cultivating plant species, identification can be controlled from the seed stage. The medicinal plant sector can be improved if the agricultural support agencies would come forward to help strengthen the medicinal plant growers and if research institutions would aid the plant growers by improving their basic knowledge of plant cultivation practices."

Opportunities for governments to develop legislation to control and monitor harvest and trade of medicinal plant species and to consider conservation and sustainable use of medicinal plants as a priority in establishing protected areas have been greatly improved through the addition of medicinal plant species to the Convention on International Trade of Endangered Species (CITES) and the entry into force of the Convention on Biodiversity (CBD) (Schippmann et al., 2006).

The following case studies consider some aspects. The debate centres on how private companies and other agencies are likely to be able to support agricultural initiatives and whether this leads to better pay and conditions.

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[6] These figures are difficult to obtain and to validate and thus there may well be a high degree of conflicting data.

3.8 The tea value chain

The tea industry, including green tea and other niche products, provides a good example of how value may be added to a product. As with turmeric, it has uses as a food, a medicine and also in the cosmetic industry (Cabrera et al., 2006, Katiyar et al., 2000). It is a product that has a history of being exported and has been subject to value chain analysis. Moreover the cultivation of this product can have a considerable impact on the livelihoods of farm workers in LEDCs (Agrifood, 2004).

It is widely reported that tea cultivation in the countries where it is prevalent has historically demonstrated a positive impact on the economy of the poorer rural areas (Fairtrade, 2010, Groosman, 2011).

Tea cultivation often requires companies to provide employment to large numbers of the least privileged segments of society, mostly in remote areas where there is little other infrastructure. As a result, roads, electricity, water, etc., become more widely available to the general populace in these isolated districts.

In India for instance, the major tea plantation companies provide affordable housing, medical care and education to their employees and their employees' families. Wage agreements are usually industry-wide and salaries are above the national average (Menon and Rodgers, 2008).

Green tea production is chiefly located in south-east Asia and particularly in China, which is responsible for 75 per cent of all green tea produced (Groosman, 2011). Although much of Chinese tea production is conducted on small farms rather than large tea plantations, according to Liu (2010), Unilever has invested tens of millions of Yuan in establishing a research centre for tea and traditional Chinese medicine in Anhui province. The plant has a production capacity of more than 100 million Yuan (US$16.5 million) every year.

Although this seems to be a beneficial situation for rural workers, as outlined below, there is a counter argument suggesting that it is the tea companies who are the biggest winners through their exploitation of the farmers and their' workers, who have few alternatives other than to subjugate themselves either to the multi-national or state run companies, finding themselves increasingly dependent on a wide range of exterior inputs ranging from seed to fertilisers to pesticides.

The bargaining power of producers at the cultivation end of the value chain appears relatively weak compared to the processors and retailers who are able to exert control on both the price paid for the raw crops and the essential inputs needed to produce economically viable yields (Hilary and Dromey, 2010).

One initiative that is claimed to have a beneficial effect on both the incomes of farmers and the quality of produce is the Fairtrade® initiative (Fairtrade, 2010).

This has been particularly noticeable in the tea and coffee markets and the broad based aim of the Fairtrade® movement is to offer a better deal for farmers by paying above the market rate for the commodity in question and in return the farmers are expected to adhere to the Fairtrade® policies on production and follow quality-driven requirements in key areas, particularly in the cultivation and collection stages.

Although basically, this is a positive step forward, the scheme is far from a panacea as it only represents a small section of the total market and may be more suitable in some countries than others (Nelson and Pound, 2009).

Fairtrade® schemes tend to favour larger companies and have little influence on the wages of the workers. The market-price for tea in China and the 'Fair' price, according to the Fairtrade® database was US$1.20 per kg and US$1.70 respectively. According to Hodge (2009), even low quality Chinese tea typically costs more than US$1.70, indicating that the bar is set very low for Fairtrade® certification. Hodge asserts that in China, Fairtrade® is not relevant at all in relationship to good quality tea and argues that the producers of this level of quality tea do financially well compared to peasant farmers that are growing other crops. Chinese agriculture tends not to be based on the corporate, plantation model, as it is in the rest of the world and, therefore, many Fairtrade® initiatives are less implementable into the Chinese framework than they are for the huge plantations of Africa and South America.

Although consumer support is needed, it appears that the issues are much more complicated than just price. Since virtually all farming in China is done by small farmers, the organisational issues are very different than for an international plantation model. This view appears to have some credibility; the Fairtrade® website has little mention of Chinese Fairtrade® tea whereas it does list bean products from Inner Mongolia as one of their success stories in terms of supporting poorer communities.

However, in terms of using Fairtrade® as a vehicle to help develop organic, sustainable farming, there are a few small specialist farms in China beginning to emerge.

Moreover, in a ten year review of the Fairtrade® literature conducted by Nelson and Pound (2009), the authors conclude that although the evidence base is patchy, there are producer and gender inequalities and Fairtrade® has not shown to be a solution to rural poverty. The information gathered indicated that Fairtrade® was valuable in providing organised small export producers with the stability and security they needed to make longer term investments and that most Fairtrade® cooperatives are becoming stronger, particularly where producer ownership further along the chain is achieved.

One of the major reasons for the price of some tea being kept so low is due to the domination of the tea sector by a few companies and it is seen in the breakdown of who accrues the largest share of the value chain that the highest earners are the traders and retailers. According to the Fairtrade (2010) statistics, approximately 40 per cent of the retail price of tea accrues to the tea traders and manufacturers, and a further 40 per cent goes to the processors and blenders, packagers and retailers, based mainly in rich countries. In tea-producing countries, around 15 per cent of the retail price goes to the plantation and factory, and less than one per cent to the auction broker. The plantation worker is likely to earn one per cent or less of the retail value.

This un-appreciation and under-investment of the agricultural workforce as a valuable human resource is not only grossly unfair and a cause of huge social inequity, but may also lead to quality problems that will be carried through the length of the production process, potentially resulting in a finished product that will be difficult to sell as an aid to health in the hugely competitive functional food and nutraceutical arena (see below).

The future for the growth of tea and particularly green tea production is inextricably linked to its health claims, but it is not only the health of consumers in Europe that are affected, but also the workers and farmers in the countries of origin. In Vietnam, tea producers often benefit from better living standards than producers of other crops, with reports of incomes doubling through tea production, this benefit appears mainly dependent on the ability of producers to connect to a value chain, which in turn opens up access to a more lucrative export market (Agrifood, 2004).

However, one of the more concerning reports suggests that the over-use of pesticides by producers in Darjeeling, India leads to pesticide residue rates, which far exceed international limits, exposing tea pickers to high levels of toxins that are hazardous to health (Gurusubramanian et al., 2008).

One pesticide, which is of particular concern, is the organo-chlorine pesticide (OCP), Endosulfan®. Although Endosulfan® has been banned or severely restricted in more than 60 countries, it is still widely used in many LEDCs, including India and China, due to its high effectiveness and low application cost. Endosulfan® is a 'persistent organic pollutant' (POP) as defined under the Stockholm Convention: it is persistent in the environment, bio-accumulative, demonstrates long range environmental transport, and causes adverse effects to human health and the environment (PAN, 2008).

One central question is how can the tea industry be sustainably developed to optimise the health benefits at both ends of the value chain? Workers and small farmers have historically been weakened and marginalised and today hold a relatively minor position in the tea value chain. A downward pressure on the price paid for tea to the farmers and subsequently on the daily wages of the workers, causes poverty and distress among hundreds of thousands of people whose living depends entirely on tea production. At the same time traders and tea packers are continuing to realise large profits. It is claimed that large companies have a policy of deliberately reducing differences in quality among the different teas produced all over the world, enabling teas to be purchased at the lowest cost and maximising profits from the blending, packaging and marketing stages which tend to be in the hands of the large tea oligopolies (Oldenziel, 2006).

3.9 The ginseng value chain

Another value chain, which has been well documented, and that gives a good account of how value can be added to a product, is that of *Panax ginseng* and some related species. It is of particular relevance to this project as the literature shows that buyer perceptions of what constitutes a good quality and desirable product can make huge value additions to a product. Moreover it is seen through examination of this literature that the lead firms in a value chain are not always at the retail end of the chain and more power can sometimes be held by farmers.

During the 14 year period from 1989 to 2003, approximately 17 tonnes of dried American ginseng (*Panax quinquefolius* L.) root were harvested from Pennsylvania. Using a conservative price of US$600 per kg paid to collectors, the contribution from the ginseng trade to Pennsylvania's economy can be estimated at more than US$10 million during this period and this figure does not include income received from downstream and value added processing (Burkhart and Jacobson, 2004). In 2012 the USA exported approximately 20 tonnes of wild or wild-simulated[7] American ginseng, worth US$27 million (Schulz, 2013). When the market was at its peak, ginseng root was one of the world's most profitable legal crops (in terms of its value per kg), selling for as much as US$770 per kg for semi-wild woodland crops (UPA, 2003).

Ginseng values are dependent on the production method. The lowest investment and production costs are for wild-simulated ginseng, while the greatest expenses are required for intensively cultivated field grown ginseng under artificial shade. Wild ginseng is considered the most profitable, selling for US$990 per kg of dry weight in 1999, compared with wild simulated at US$550 per kg and woods cultivated at US$330 per kg. This translates to revenues of US$ 17,700 per hectare for wild-simulated over an eight to ten year period and US$31,500 per hectare for woods-cultivated over a five year period and so although the wild-simulated approach requires less input, the longer cultivation period reduces overall revenue (Burkhart and Jacobson, 2007).

Field cultivated ginseng had a value of under US$44 per kg in the same year (Lucio, 2002). This difference in price is at first difficult to comprehend but it may be linked in some way to the ginsenoside content of the herbal material and consequently its effectiveness. The potency of herbal products can vary from manufacturer to manufacturer and from batch to batch, partly because of non-standard processing methods but also due to the variability of cultivation conditions e.g. soil, temperature, moisture, length of cultivation and harvest season (Yuan et al., 2002).

Asian buyers consider wild ginseng to be more potent than cultivated ginseng and connect value to morphology (wild roots look more human in shape). Consequently the root value is highly dependent on its appearance. However, in a study conducted by Schlag and McIntosh (2006), the authors fail to find a significant difference between wild and cultivated plants with reference to total ginsenoside content. This could indicate that Asian traditional beliefs surrounding ginseng are based on the subjective value of a wild crop or linked to experiences of taste, colour etc., or it could mean that total ginsenoside contents is not a clinically relevant measure of ginseng potency and other metrics such as relative ginsenoside composition may prove to be more

[7] Plants are cultivated in areas and under conditions that reproduce as closely as possible a wild environment

meaningful. In the Schlag and McIntosh study, significant variations were found between the ginsenoside composition of wild and cultivated ginsengs and two distinct chemotypes were identified. However, chemotypical differences in composition were also observed between wild ginsengs grown in different areas of the US and so it is not such a simple picture of wild versus farmed.

Whereas the price paid for semi-wild ginseng has doubled from 1999 to 2009, the price for farmed ginseng has dropped by 75 per cent. Current prices for farmed roots are below the cost of production and consequently the artificial shade cultivated industry in North America is in a state of collapse. One of the primary reasons for this decline in prices in North America is increased cultivation of *Panax quinquefolius* in China. It is unlikely that this situation will extend to wild-simulated ginseng or even woods-cultivated as China has long since gone through a process of deforestation.

Although high yielding, the main problem for farmed ginseng is that it is susceptible to disease and requires the heavy use of pesticides and fungicides in order to thrive (Hankins, 2009). This can be a real drawback when presented as an aid to good health, especially in a market that historically sets high entry bar standards for non-EU commodities. China seems to be responding in typical fashion and along the highways you can now see small trees several rows deep. These are part of China's reforestation programme and once they reach a suitable age they are transferred to where forests once stood for re-planting. It may take some time for these new forests to mature, but there is a real prospect of wild ginseng growing once again in the country that made it a global commodity.

3.10 *Curcuma longa* L. Zingiberaceae (Turmeric)

The ancient peoples of India called turmeric the Oushadhi – The medicinal herb (Ravindran et al., 2007). Turmeric is probably native to south-east Asia. Although many related species of the genus Curcuma occur in the wild, turmeric (*Curcuma longa*) is not known to occur in the wild and is only cultivated. The name 'turmeric' may originate from the old English word, *tamaret*, possibly coming from the Latin name *terra merita*, becoming *terre merite* in French – deserving earth (Dictionaries, 2013). In English it was also known as yellow root or Indian saffron (Ravindran et al., 2007).

Annual Indian production of turmeric for export was approximately 44,000 tonnes for 2007 to 2008 (Hindu, 2008). India produces most of the world's turmeric crop and consumes 80 per cent of it (Prasad and Aggarwal, 2011). Indian turmeric is regarded by many as the best in the world because of its high curcumin content with the Alleppey variety being highest at over six per cent (Ravindran et al., 2007). The earliest reference to turmeric is in the Atharvaveda (ca. 6000yrs B.P.) where it is prescribed for jaundice and used in the treatment of leprosy. It is probable that true turmeric, *Curcuma longa*, came to India from Cochinchina (present day Vietnam) either through migration of peoples or with the spread of Buddhism. To the classic Indian cultures, turmeric was not a spice but a dye and a medicine used to treat many ailments (Food-History, 2010).

3.10.1 Important related species

According to the Kew Gardens database (The Plant List), there are 92 species with accepted names in this genus (Kew, 2013). The presence of this large genus containing similar looking plants highlights the potential risks of confusion and possible adulteration between species.

Curcuma amada Roxb., (mango ginger), is endemic to South Asia and found wild in northeast and southern India. It is cultivated for the edible ginger-like rhizome which has a flavour like green mango. Although mainly used in food preparations, it also has been used in TIM for digestive disorders and as an anti-inflammatory and it has been found to have similar biological properties to *Curcuma longa*. The major chemical components include starch, phenolic acids, volatile oils, curcuminoids and terpenoids (Policegoudra et al., 2011)

Curcuma angustifolia Roxb., (wild or Indian arrowroot) is native to India and found wild in Bengal, north-east regions of India and western coastal plains and hills. It is also abundant in Madhya Pradesh, Chhattisgarh, Orissa, Andhra Pradesh and the hills of Tamil Nadu and Kerala. It was cultivated as a source of arrowroot starch, which is used as a food and medicine. Different parts of the plant have been used as a dietary aid, in gastro-intestinal disorders, including intestinal parasites, and to treat painful, inflamed or irritated mucous membranes (Sharma, 2011).

Curcuma aromatica Salisb., (wild turmeric) is distributed from China southwards to Sri Lanka, it grows wild in many parts of India and is cultivated in Andhra Pradesh and Orissa. It gives out a strong camphoraceous smell. It is valued as a dye, medicine and cosmetic (Ravindran et al., 2007).

Curcuma caesia Roxb., (black turmeric, black zedoary) is native to north-east India. The rhizome has a deep bluish black or grey-black colour. It is used in folk medicine to treat tumours, skin conditions, asthma and bronchitis (Das et al., 2013).

Curcuma zanthorrhiza Roxb., (Javanese turmeric) is monographed in the British and European Pharmacopoeias. The largest of the curcuma species, it is indigenous to Indonesia and is used as a food and for medicinal purposes (Ravindran et al., 2007).

Curcuma zedoaria (Christm.) Roscoe, (the long and the round zedoary) mainly occurs in the northeastern and western coastal regions of India. It is used in traditional medicine as a stimulant and carminative (Ravindran et al., 2007).

3.10.2 Typical chemical composition of *Curcuma longa*

Moisture	6-13 %
Carbohydrates	60-70 %
Protein	6-8 %
Fibre	2-7 %
Mineral matter	3-7 %
Fat	5-10 %
Volatile oil	3-7 %
Curcuminoids	2-6 %

Nutritional composition per 100 g

Moisture	6 g
Food energy	390 kcal
Protein	8.5 g
Fat	8.9 g
Carbohydrate	69.9 g
Ash	6.8 g

Calcium	200 mg
Phosphorous	260 mg
Potassium	2500 mg
Iron	47.5 mg
Thiamine	0.09 mg
Riboflavin	0.19 mg
Niacin	4.8 mg
Ascorbic acid	50 mg

Phytosterols, tocopherols and fatty acids have also been identified.

3.10.3 Cultivation

Curcuma longa, a perennial herb, is cultivated extensively in India and China and other countries with a tropical climate (Velayudhan et al., 2012). The rhizome is used medicinally. It is usually boiled, cleaned, and dried, yielding a yellow powder. Dried *Curcuma longa* is the source of the intensely yellow coloured spice turmeric and is used extensively in foods as well as having a long tradition of use in the Chinese and Ayurvedic systems of medicine (Ravindran et al., 2007).

The growing area in India for turmeric rose from 150,000 hectares in 2002 to 2003 to 194,000 hectares in 2007 to 2008 and production increased from 526,000 tonnes to 892,000 tonnes in the same period. However from 2007 to 2008, turmeric output started declining as farmers shifted to other remunerative crops e.g. cotton and sugar cane (ICEX, 2010). In 2008, the USA imported over 4 million kg of turmeric, worth approximately US$ 4.2 million (Hallquist et al., 2010). Andhra Pradesh is the main cultivation region within India, accounting for 47 per cent of area and 63 per cent of production (Deepa, 2010) (see fig. 1). Tamil Nadu is the second biggest producer and also is the leader in terms of yields. The city of Erode, Tamil Nadu, is regarded as the most important trading centre of turmeric in Asia. There are a number of cultivars available in India and they are recognised chiefly by the name of the locality where they are cultivated.

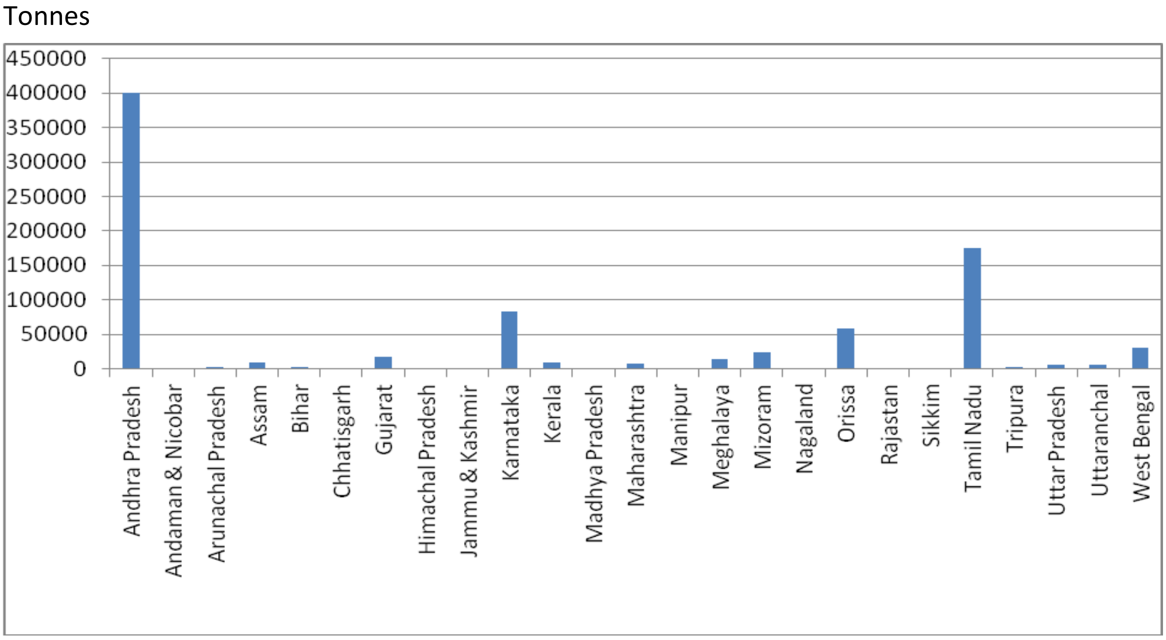


Figure 1 2006 - 2007 Regional turmeric production in India / tonnes (Source ICEX, 2010)

Turmeric requires a hot and moist climate, a good water supply and well-drained soil. It thrives best on loamy or alluvial, loose, friable and fertile soils (ICEX, 2010). Turmeric is ready to harvest in eight to nine months after planting. In India the harvest season typically begins in February. Care must be taken not to cut or bruise the rhizome. Harvested rhizomes are cleaned by washing with water, and dried as soon as possible to minimise contamination, mould growth and fermentation (DEA, 2010).

Processing typically consists of 3 stages: curing, drying and polishing.

Curing essentially involves boiling fresh rhizomes in water for about an hour, until soft before drying. Boiling destroys the vitality of the fresh rhizome, removes the raw odour, reduces drying time, reduces the microbial load and produces a more uniformly coloured product. Curing should be done within two or three days of harvest to avoid spoilage (Prasad and Aggarwal, 2011).

Sodium bicarbonate is sometimes added to the water to make it slightly alkaline in order to improve the colour. Lead chromate has also been used but this method is now discouraged due to the health implications. According to Ravindran et al. (2007), although curing does not affect the volatile oil content, the curcuminoid content may be reduced. The cooked rhizomes are allowed to cool and spread out to dry in the open, it may take 10 to 15 days to become completely dry (5-10 % moisture).

Slicing the rhizomes prior to drying reduces drying time and produces turmeric with lower moisture content and higher curcuminoid extractability (Douglas et al., 2006).

In most areas the rhizomes are dried in the sun but mechanical driers are also used in regions with high humidity. Artificial drying gives a brighter product than sun drying. Improper drying can lead to microbial growth and infestation by storage pests. Fumigation is sometimes used if the rhizomes are to be stored for a long time. Dried turmeric has a rough appearance and dull surface colour. The outer surface can be polished to give a better finish. Polishing is undertaken by growers on a small scale, but largely by dealers or exporters in commercial quantities (NABARD, 2007).

To improve the surface colour, the dried rhizomes are sometimes coated with turmeric powder in the course of polishing. The use of lead chromate, once practiced to achieve the same result, has now been reportedly abandoned due to potential toxicity but a more common practice is the adulteration with related curcuma species (Jansen, 2005).

In India, in the Sangli district of Maharashtra, another of the country's key centres for turmeric trade, the local spice merchants follow a centuries old tradition of storing turmeric in pits. The bags of turmeric are put into the pits and covered with soil where they can be left for up to four years, and according to Babu et al. (2013), with little change in quality. As with tea and ginseng, chemical treatment is often used to prevent decay of material upon storage.

The chemicals recommended by The Spice Board of India for the treatment of turmeric seed material are Quinalphos® and Mancozeb® (Kandiannan et al., 2009). Quinalphos® is a highly toxic organophosphorous compound, it is an endocrine disruptor and cholinesterase inhibitor and has been banned in most developed countries (PAN, 2010b). Mancozeb® is also a cholinesterase inhibitor, is teratogenic and has been linked to thyroid cancer (PAN, 2010a).

As seed material treatments, these do not present so much of a problem but contamination of the turmeric rhizomes with these chemicals clearly presents a potential risk.

Table 3 Major turmeric regions and examples of local varieties

Growing Region	Variety	Features
Andhra Pradesh	Amruthapani	Medium duration crop (8 months), highly resistant to leaf spot but susceptible to leaf blotch.
	Armoor	Long duration crop (9months) Resistant to leaf blotch. Popular variety
	Duggirala	Long duration crop (9 months) tolerant to leaf blotch. Major regional variety. Larger rhizomes
	Tekkurpeta	Long duration crop (9months) Resistant to leaf blotch. Popular variety. Good colour
Bengal and Assam	Pattant	Best colour and aroma amongst regional varieties
	Deshi	Regional variety
Kerala	Moovattupuzha	High colour variety, generally marketed as Allepey type
	Alleppey	High colour variety. High curcumin content
Maharashtra	Rajapuri	Major regional variety
	Waigon	Major regional variety
Tamil Nadu	Chinnanadan	Generally marketed as Madras type, popular variety
	Erode Local	Major regional variety, generally marketed as Madras type
	Salem	Good quality variety
	Roma	Good quality variety

Source: (NMCE, 2010)

In domestic and international markets, Salem turmeric (Tamil Nadu) is established as the best quality and is more expensive than other varieties. The superior quality is reportedly due to good soil conditions and less cross contamination (NMCE, 2010).

This discussion implies that a study of turmeric economics in India should be open to issues of contamination linked to processing.

3.10.4 Cultural and religious use

Turmeric is used in various rituals and ceremonies throughout India. It is associated with the cleansing of the body and is commonly used by women on the last day of menstruation where is applied as a paste before a bath in order to purify themselves and regain ‘touchability’ and a bride must take a turmeric bath and sprinkle the wedding clothes with a turmeric solution before the marriage ceremony can take place (Velayudhan et al., 2012).

3.10.5 Local and traditional use

It is traditionally indicated as an anti-inflammatory and for the treatment of flatulence, jaundice, menstrual difficulties, haematuria, haemorrhage, and colic. As an external treatment, it is used in poultices to relieve pain and inflammation (Thorne, 2002).

In China, different parts of the root and rhizome are accorded different medicinal properties. Turmeric rhizome (jianghuang) is oval in shape and yellow in colour, with numerous secondary garlic bulb-like projections. The root tuber, (yujin), although similar in action, is regarded as having an additional calming effect. Yujin is normally *Curcuma aromatica* but the root tuber of *Curcuma longa* is sometimes used as a substitute. Jianghuang is used to invigorate the blood, relieve menstrual cramps, and treat the pain and swelling associated with trauma. Yujin is said to be cooler in action and used more to break up blood stasis and relieve constrained liver energy. Another species, *Curcuma zedoaria* (ezhu) is also used medicinally in Chinese medicine for removing blood stagnation and regulating qi flow and is indicated for use in treating abdominal pain and dysmenorrhoea (Bensky and Gamble, 1993).

3.10.6 Medicinal properties and research

Current research has focused on turmeric's antioxidant, hepato-protective, anti-inflammatory, anti-carcinogenic, and antimicrobial properties, in addition to its use in cardiovascular disease and gastrointestinal disorders (Thorne, 2002).

There have been many claims made about the therapeutic value of *Curcuma longa* (turmeric), *Curcuma aromatica* (wild turmeric) and *Curcuma zanthorrhiza* (Javanese turmeric) and these plants have been subject to various in-vitro and in-vivo investigations, including some intervention studies. Particular reference has been made to *Curcuma longa* and its application as an anti-inflammatory and cancer preventative. (Jurenka, 2009, Kim et al., 2012, Sandur et al., 2007) suggest that turmeric can effectively block the proliferation of tumour cells through the suppression of NF-kB and STAT3 pathways. Another mechanism for chemoprevention has been linked to NRF2 and its ability to regulate reactive oxygen species and reactive nitrogen species (Shureiqi and Baron, 2011) although some caution is needed as NRF2 has also been linked to oncogenesis because of its ability to create a more favourable intracellular environment for the survival of tumour cells (Sporn and Liby, 2012).

It has been established that curcumin, often cited as the main active ingredient, modulates the inflammatory response by down regulating the activity of cyclooxygenase-2 (COX-2), lipoxygenase-5, (LOX-5) and inducible nitric oxide synthase (iNOS) by inhibiting the production of the inflammatory cytokines, tumour necrosis factor-alpha (TNF-α), interleukin 1, 2, 6, 8, and 12, monocyte chemo-attractant protein (MCP) and migration inhibitory protein (MIP); and by down regulating mitogen-activated and Janus kinases (Abe et al., 1999).

Curcumin may be of use in the prevention and treatment of cognitive decline, including Alzheimer's disease (AD). The mechanisms for this remain unproven but apart from its anti-inflammatory action, curcumin has been shown to induce hemoxygenase, a protein that protects the cell from oxidative stress, reduce cholesterol, reduce levels of metals that may cause neuro-toxicity and reduce beta-amyloid plaques, the most prominent characteristic feature found in AD. It may also possess an anti-depressant action, most likely due to inhibition of monoamine oxidase (Mishra and Palanivelu, 2008, Howes and Houghton, 2003).

However, Ahmed and Gilani (2013) assert that whereas curcumin is often cited as being the most important therapeutic agent, careful scrutiny of the literature reveals that a mixture of the curcuminoids found in turmeric offers better medicinal value than curcumin alone.

Although curcumin appears promising in many therapeutic areas, it is recognised that the clinical effectiveness of curcumin is hampered by its poor bio-availability and large prescribed doses, e.g. 8 g / daily are required to achieve any therapeutic benefit (Jurenka, 2009). This has also led to the development of high potency curcumin extracts and various chemically modified spin off products purported to be more easily absorbed. The product development strategies include combining turmeric with pepper to inhibit glucorinidation (Shoba et al., 1998) and increase thermogenesis (Westerterp-Plantenga et al., 2006) and embedding curcumin into a lipophilic phospholipid to improve bio-availability (Mignet et al., 2013).

Curcumin is often regarded as being responsible for the therapeutic effect of turmeric. However, this does not explain the use of turmeric in TCM, where aqueous decoctions are the main phytopharmaceutical preparations used. As curcumin is poorly soluble in aqueous solution, any therapeutic effect must be due to other, more polar compounds found within turmeric which are more readily soluble in water.

This hypothesis is backed up by some research conducted by Japanese researchers on the anti-inflammatory effects of different turmeric species. The researchers found that the optimum results, in their in-vivo study, were obtained with *Curcuma phaeocaulis*, a curcuma species that contained less curcuminoids than the other species in the study. Consequently, the authors proposed a curcumin-independent pathway in the anti-inflammatory process, and identified *Curcuma phaeocaulis* as a potential COX-2 inhibitor and suggested that curcuminoid content does not relate to inhibition of inflammation (Tohda et al., 2006). Moreover, in a 2012 clinical trial examining patients with osteo-arthritis of the knee, researchers reported an anti-inflammatory action for an aqueous, polysaccharide extract of *Curcuma longa* (Madhu et al., 2013).

In an assessment report conducted by the EMEA (2010), the overall conclusions were that there was insufficient data to support a “well established use” indication for any of the conditions claimed but considered it suitable for classification as a traditional herbal medicinal product with plausible indications in the treatment of dyspeptic complaints and possibly for skin complaints if sufficient data regarding the preparation and posology were presented.

3.10.7 Quality assurance

Dried and fresh turmeric rhizomes are generally free from adulteration. The major quality problems are more evident in the powder, which is prone to adulteration, and in which various quality deficits have been identified (Dixit et al., 2009, Govindarajan, 1980). These include adulteration with species other than *Curcuma longa*; mixing with low curcumin content powders and the addition of starches or artificial colours. Officially only *Curcuma longa* is allowed in the production of turmeric but there have been reports that the related species of *C. aromatica, C. amada, C. malabarrica* and *C. zedoaria* or their left-over matrices after extraction have found their way to the retail market (Dixit et al., 2009) and a survey conducted by Dixit et al. (2009) demonstrated that the curcumin content of branded turmeric powders ranged from 2.2 to 3.7 per cent and non-branded loose powders ranged from 0.3 to a maximum of 2.6 per cent. Moreover none of the branded powders contained artificial colourings whereas 17 per cent of the non-branded powders contained metanil yellow, a non-permitted food colouring that has been shown in animal studies to cause testicular damage (Kaur et al., 2010).

Lead chromate, causing anaemia, blindness, and other disabilities, is another contaminant that has been found added to the powder or even painted on the root (Ashfaq and Masud, 2002).

Turmeric used with a ‘medicinal’ claim has its own quality problems and in 2009 The Food Standards Agency (FSA) issued a warning to the UK public to avoid a brand of turmeric food supplement after it was found that it contained a drug called nimesulide. This drug was linked to two deaths and several liver damage cases in Scandinavia**.** The product in question, branded as Fortodol® or Leppin Miradin®, was being sold in the UK via the internet as a food supplement, often accompanied by unsubstantiated claims to relieve arthritis, muscle pains and headaches (Starling, 2009).

Angles et al. (2011) highlighted that the main reason that less than ten per cent of Indian turmeric was exported was due to quality related issues and particularly the over-use of chemical treatments and related post-harvesting processing deficiencies and suggested that more importance should be directed to research and development in this area.

3.10.8 Intellectual property and ‘biopiracy’

Biopiracy refers to the appropriation of the knowledge and genetic resources of farming and indigenous communities by individuals or institutions that seek exclusive monopoly control (patents or intellectual property) over these resources and knowledge (ETC, 2014).

In 1995, a US patent was granted to the University of Mississippi Medical Health Centre for turmeric for its use in wound healing. The university claimed that its use as a vulnerary was novel. The claim was challenged by the Council of Scientific and Industrial Research (CSIR), India and after a long legal battle it was acknowledged by the courts that this use had been described and documented previously in ancient Ayurvedic texts and consequently the patent was revoked in 1997 (Velayudhan et al., 2012).

The European Parliament has adopted a resolution in an attempt to prevent the plundering of the medicinal plants found in some LEDCs by multi-national companies without sharing the profits with the indigenous people.

> "Biopiracy - the practice of patenting and marketing the use of traditional knowledge and genetic resources of indigenous peoples without authorisation from source countries - can impede the economic progress of developing countries and runs counter to EU development policy goals, says the resolution, which notes that 70 per cent of the world's poor depend directly on biodiversity for their survival and well-being" (Krivade, 2013).

3.11 Metabolomics and nuclear magnetic resonance spectroscopy

Metabolomics is the term used for the comprehensive, nonbiased, high throughput analyses of complex metabolite mixtures such as those typically seen in plant extracts. Achieving a broad overview of metabolic composition requires the establishment of a fully integrated approach for the optimisation of sample extraction, metabolite separation / detection / identification, automated data gathering, processing and analysis, and quantification (Hall et al., 2002). Metabolomics has become a well-recognised method for the study of all types of organisms; and complements the data obtained by the other, omics-technologies: genomics, transcriptomics and proteomics (Schripsema, 2010).

One of the main problems associated with metabolomics is that the metabolome consists of a wide range of compounds at very different concentrations and with different polarities and other chemical characteristics. At present, there is no single solvent capable of solubilising the whole range of chemical constituents. The choice of extraction solvent is thus limiting the view on the metabolome. In general, metabolomic studies should be designed to detect as many metabolites as possible in an organism (Kim and Verpoorte, 2010).

It is widely accepted that a single analytical technique will not provide sufficient visualisation of the metabolome and therefore, multiple techniques are needed for a comprehensive view. However, practical reasons can force us to choose an optimum analytical tool for metabolomic profiling. Consequently, it may be preferable to use a wide spectrum chemical analysis technique, which is rapid, reproducible, and stable in time, while needing only the very basic sample preparation. NMR spectroscopy is potentially an analytical tool that could meet these requirements (Choi et al., 2004). NMR spectroscopy is a physical measurement of the resonances of magnetic nuclei, such as 1H, 13C, or 15N in a strong magnetic field.

Each compound has a highly specific spectrum. The only variables are the solvent used and the magnetic field strength (Verpoorte et al., 2005).

NMR spectroscopy is an effective tool for the quality control of medicinal plants or HMPs (Shyur and Yang, 2008). The advantages of NMR spectroscopy over other techniques such as mass spectrometry (MS) for metabolomics applications include the relative ease of sample preparation, non-destructive analysis, potential to identify a broad range of compounds, enhanced capacity for definitive chemical compound identification, and provision of structural information for unknown entities (Zulak et al., 2008).

Recent advances in analytical chemistry, combined with multi-variate analysis techniques, have brought us closer to the final goal of metabolomics: the comprehensive evaluation of all the metabolites, both qualitatively and quantitatively in living organisms.

NMR spectroscopy and MS have been successfully used for metabolic fingerprinting analysis. These two techniques have their respective advantages and limitations; however, as a tool for metabolomics, NMR spectroscopy has some unique advantages over MS-based methods. It can provide a detailed analysis on the bio-molecular composition very quickly with relatively simple sample preparation. It is a universal detector for all molecules containing NMR-active nuclei. Using a proper internal standard, the real concentration of metabolites can be easily calculated and because NMR spectroscopy is based on the physical characteristics of compounds, it has very high reproducibility (van der Kooy et al., 2009). In any metabolomics application, the robustness and reproducibility of data collection is vitally important.

^{1}H-NMR spectroscopy is an ideal tool for large scale plant metabolomics data collection. In a study by Ward et al. (2010), it was concluded that "with attention to experimental design and careful set up, data collection for large scale plant metabolite fingerprinting using ^{1}H-NMR spectroscopy can be carried out as a dispersed activity across laboratories, using different NMR spectroscopy instruments." Moreover, a number of techniques have now been devised to develop ^{1}H-NMR spectroscopy as a fingerprinting tool for the quality assessment of crude plant materials.

Multivariate or pattern recognition techniques such as principal component analysis (PCA) are valuable techniques for the analysis of data obtained by ^{1}H-NMR spectroscopy. In combination with PCA, ^{1}H-NMR spectroscopy has been applied to the metabolomic profiling of plants and herbal medicines (Kim et al., 2005). In the case of feverfew, ^{1}H-NMR spectroscopy and principal component analysis was used to differentiate between 14 commercial batches of samples based on their multi-component metabolite profile (Bailey et al., 2002). In the case of *Hypericum perforatum*, (St John's Wort) principal component analysis of the NMR spectra from different commercial extracts was used to differentiate between various preparations according to their metabolomic profile. This included differentiation between various batches obtained from the same supplier. This highlighted the potential to use the method for assessing whether the species extract variability versus the manufacturing process accounts for the variability (Heinrich, 2008). Further studies carried out on herbal tinctures have shown that ^{1}H-NMR spectroscopy and adjuvant techniques can potentially be applied to the quality control of plant extracts, including batch-to-batch consistency and stability studies (Politi et al., 2009).

3.11.1 Metabolomic analysis

Metabolomic analysis consists of three separate experimental parts. First, the sample preparation, followed by the collection of data using analytical chemical methods and the third and final step is data analysis using defined chemo-metric methods. Whereas the data collection step is generally automated for high throughput analysis, sample preparation is still mostly manual, resulting in high operating costs. Thus, in order to handle large numbers of samples simultaneously and to minimise the risk of sample degradation, it is important to keep the procedure as simple and fast as possible (Kim and Verpoorte, 2010).

Data collection and spectral processing are also important to ensure that, for example, replicate samples provide identical ^{1}H-NMR spectroscopy fingerprints. In practice small differences in line shape and chemical shift will be observed. The differences in line shape can be minimised by using exactly the same sample volume in identical NMR spectroscopy tubes and by optimising the magnetic field homogeneity before data acquisition. To compensate for differences in line width, the line-broadening parameter can be varied during processing. To minimise the misalignment of NMR spectroscopy signals, there should be strict control of sample preparation (Schripsema, 2010).

3.11.2 ^{1}H-NMR spectroscopy measurement

Following the sample preparation, they are submitted for ^{1}H-NMR spectroscopy analysis. It is possible to submit liquid samples in non-deuterated solvents but in this case a small quantity of deuterated solvent must be added to provide the lock signal for ^{1}H-NMR spectroscopy, and during the measurement, solvent suppression is applied. When the samples are dry they are dissolved in deuterated solvents. For hydrophilic extracts usually water-D_2O, methanol–D_4 or a mixture of the two is used. For lipophilic extracts, chloroform-$CDCl_3$ or Dimethyl Sulphoxide-$(CD_3)_2SO$ can be used (Schripsema, 2010).

3.11.3 Data processing and multivariate statistics

Because metabolite profiling is cheap once the hardware platforms have been established, it can be applied to a large number of samples to generate huge amounts of data. The bottleneck comes in finding ways to combine and interpret this data (Kopka et al., 2004).

Multivariate statistics commonly refers to PCA, which is the main technique employed by many analysts (Hall et al., 2002). PCA is a math based method of reorganising information found in a data set of samples. It can be used when the set contains information from only a few variables but it is most useful when there are large numbers of variables, as in spectroscopic data. What PCA does is to discover new variables, called “principal components” (PCs) which account for the main variability of the data (Davies and Fearn, 2005). Data is represented in n^{th} dimensional space, where n is the number of variables, and is reduced into a few principal components, which are descriptive dimensions that describe the maximum variation within the data.

The principal components can be displayed in a graphical fashion as a ‘scores’ plot. This plot is useful for observing any groupings in the data set and, in addition, will highlight any outliers that may occur due to errors in sample preparation or instrumentation parameters. PCA models are constructed using all the samples in the study. Coefficients by which the original variables must be multiplied to obtain the PC are called ‘loadings’. The numerical value of a loading of a given variable on a PC shows how much the variable has in common with that component.

Thus for NMR spectroscopy data, loading plots can be used to detect the spectral areas (groups of metabolites) responsible for the separation in the data (Ward et al., 2010). An important feature is that directions in the scores plot correspond to directions in the loading plot and vice versa. For example samples with negative scores are associated with negative peaks in the loadings plot (Michl et al., 2011).

3.12 High performance thin layer chromatography

HPTLC is a chromatographic technique that utilises the capillary action of a solvent (mobile phase) and a stationary phase to separate compounds in a sample mixture (Chromadex, 2011). According to the American Herbal Pharmacopoeia, it is an invaluable tool used in quality assurance for the assessment of plant materials and allows for the efficient and cost-effective analysis of a broad number of compounds (AHP, 2011).

Much like HPLC grew out of improvements in column chromatography, HPTLC grew out of improvements in the quality of sorbents and consistency of plate manufacture, use of optimised techniques and equipment for sample application, plate development, detection reagent applications, densitometric scanning and a greater understanding of chromatographic theory (Sigma-Aldrich, 2013). In comparison to more widely used column chromatography, Reich and Schibli (2007) argue that HPTLC offers some distinct advantages:

- Visual results
- Simplicity
- Parallel analysis of samples
- Rapid results
- Flexibility
- Single use of plate
- Multiple detection
- Cost efficiency

However, some limitations also have to be recognised, including that it requires more manual input, the separation power of HPTLC is lower than that of High Performance Liquid Chromatography (HPLC) and because it includes several drying steps, it is not suitable for samples that need to remain in solution. Moreover there are relative strengths and weaknesses of ^{1}H-NMR spectroscopy and HPTLC with reference to the analytical investigation of herbal value chain products (see Table 4).

Table 4 Comparison of key strengths and weaknesses of ^{1}H-NMR spectroscopy and HPTLC

1H-NMR spectroscopy	HPTLC
Equipment expensive	Equipment relatively cheap
High throughput technique with sample preservation	High throughput technique with sample preservation
One system needed to view entire range of extractable metabolites.	Three systems needed to view entire range of extractable metabolites.
Multivariate analysis is able to group the samples according to the metabolite composition.	Grouping of samples is achieved manually by visual inspection.
Multivariate analysis can be confounded by multi-ingredient samples leading to errors in groupings.	Separate systems and visual inspection reduces grouping errors.
Manipulation of data allows for individual samples to be compared in detail against other samples or to the whole group.	Comparisons are generally achieved visually.

3.13 Summary of the literature

There is a plethora of literature for *Curcuma longa*, TAM, and to a lesser extent value chains, which tend to be focused particularly on food crops and high-value commodities such as tea, coffee and cocoa and on cash crops e.g. cotton. There is a limited range of literature available concerning MPVCs in India and the impact that gathering or cultivating these crops has on livelihoods (e.g. Alam and Belt, 2009, Kala et al., 2006, van de Kop et al., 2006).

The literature is somewhat contradictory and highlights both positive and negative outcomes for the primary producers of medicinal plants, however, some reasons for poor performance have been identified and suggestions made for future work.

The literature search suggests that *very little has yet been published on the effect that different quality requirements and regulations may have on the MPVC and the impact that the farming medicinal plants may have on the livelihoods of the primary producers in LEDCs.*

Value chain analysis has been applied to a variety of consumer goods. It was found that there was a gap in the current literature with respect to MPVCs and particularly the impact that these heterogeneous chains have upon livelihoods.

In particular, the literature review raises the following questions with respect to value chains:

How easy / difficult is it for farmers and particularly small farmers to access organised value chains?

Once access has been gained to a value chain, are their real benefits for the farmers or does it lead to greater subjugation of farmers by the lead companies?

Once established, are the lead firms able to control the supply chain satisfactorily?

A European directive has been introduced for the registration of herbal medicinal products but it is not well understood what the impact of this directive will be on the livelihoods of producers. Moreover, it is not well documented how the variability of starting materials and HMPs within these value chains could affect the health, both positively and potentially negatively, of consumers in Europe and how this variability might be measured analytically.

Literature is available on ^{1}H-NMR spectroscopy and HPTLC and their application to chemical and metabolomic studies. The literature provides explanations of the differing techniques and discusses their advantages and limitations from an analytical perspective.

Analytical techniques, including metabolomic studies, have been widely used in quality assurance and drug discovery but their use in connection with the assessment of the validity of a particular product supply route is a new area and never before have these techniques been documented as having a role to play in the investigation of MPVCs.

4.0 Aims, hypotheses and research questions

Aims: To investigate MPVCs and interpret the impact different value chains have on the livelihoods of primary producers in developing countries and ultimately on the health of consumers in Europe.

Hypothesis 1 (H1): The establishment of a VIVC can have a positive impact on the livelihood of primary producers of HMPs in India.

Hypothesis 2 (H2): Differences in the composition and concentration of products obtained through separate value chains can be determined through analytical techniques.

Hypothesis 3 (H3): Differences in the concentration and composition of the products studied can be correlated to the quality of products found in the value chain.

Research questions:

- What examples of value chains can be found in India?
- What impact does the implementation of a VIVC have on the livelihoods of primary producers of medicinal plants in LEDCs?
- What impact do different value chains have on product quality?

5.0 Research strategy

5.1 Summary of research methods

Stage 1: At the beginning of the project a survey was carried out to identify potential plant candidates to be used in the case studies. This survey was developed using on-line software and distributed via electronic means (email, social media sites, interest group websites). A web-based survey was chosen in preference to more traditional methods, e.g. focus groups, face to face interviews, as it is relatively in-expensive to implement and manage and can acquire a large and diverse range of participants over a short time frame (Couper and Miller, 2008). I discovered that there was a company in the UK that had an established vertically integrated value chain and I approached this company in order to gain access to its suppliers in India. I would compare this chain against two other examples of supply.

Preliminary fieldwork study

Before I began the main fieldwork I decided to conduct a pre-fieldwork study at a well-established site in Anhui province China. I visited one of the largest medicinal plant trading centres in China, a HMP manufacturer and a university that was involved in providing assistance to local farmers regarding medicinal plant cultivation. This preliminary fieldwork acted as a bench-marking exercise and enabled me to gather important information about the current trends in cultivation and what was achievable in the long term. The herbal trade in China was an appropriate benchmark as modern Chinese companies are further advanced in implementing the infrastructure required to produce quality herbal medicines and have developed trade links with international companies using a vertically integrated model of supply. This is opposed to the instances of adulterated material found on the UK market (see 3.6), which is primarily the result of illegal activity.

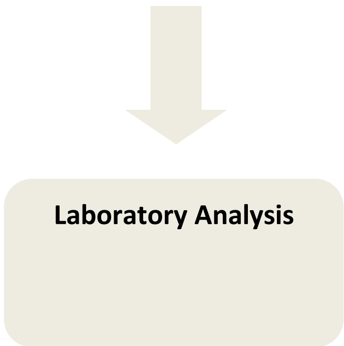
The methods used to interrogate the hypotheses H1, H2 and H3 are split into two separate but connected stages (Stage 2 and Stage 3). Firstly the methods used to answer H1 used a case study approach employing semi structured interviews (see appendix 1) and non-participant observations. Semi-structured interviews are useful in obtaining general and specific information from a sample of the population and gaining a range of insights on a specific issue. This methodology had advantages over a fully structured approach in that it was less intrusive, encouraging two way communication. It was able to both confirm what was already known and provided an avenue for learning with the interview subjects being able to provide the reasons behind their answers as described by FAO (1990). As previously outlined by Handley (2012), observational methods offered an objective insight into what people *do* rather than what they *say* they do. "Thoughtful and judicious use of observational methods provides one of the most effective ways to begin to understand what goes on in naturalistic settings." Moreover, an observational and interview approach is in line with what would be regarded as 'best practice' in research connected with GVC analysis (Kaplinsky and Morris, 2001). This recommends that actors at various stages of the value chain are interviewed in order to establish value chain dynamics.

H2 and H3 were answered using a combination of analytical techniques. ^{1}H-NMR spectroscopy coupled with multivariate analysis and HPTLC.

Stage 1: Initial on-line survey to identify potential case study candidates and pre-fieldwork in China

Stage 2: Qualitative work using a triangulated approach to answer H1

Stage 3: Analytical techniques to answer H2 and H3



5.2 Ethical approval and permissions

Ethical approval for the online questionnaire was given by the London School of Pharmacy on 15/3/2011 and approval for the fieldwork study was given on 25/11/2011 (Research Ethics Committee References REC/B/10/07 and REC/B/11/01).

Representatives of The School of Pharmacy in Udhagamandalam, Tamil Nadu agreed to organise and collaborate on a fieldwork visit to a farm in Erode, Tamil Nadu, and introduced me to various company directors and NGO officials who agreed to be interviewed. A company in Bangalore gave permission for me to spend time at their company and on their farms near Shimoga, Karnataka conducting interviews and observing farm practices. A professor at the University of Bundelkhand organised a visit to farms in Jhansi, Uttar Pradesh and introduced us to farmers who gave their permission to be interviewed.

5.3 On-line survey to identify plant candidates

Plant candidates were selected for case history analysis

I designed an on-line survey which was distributed by direct emailing, by placement of a link on discussion forums and through social networking sites. The survey questions were designed to find out how much knowledge a selection of people (mainly in the UK) had about traditional herbal medicine and in particular TIM.

The survey asked which herbs from India and China were used as medicines and what conditions were treated using herbal medicine. It asked the participants to give their views on any concerns they had about traditional systems of medicine such as TIM and TCM.

5.3.1 Inclusion and exclusion criteria

The inclusion criteria were that the plants should be of economic importance in their country of origin and are a species that is widely cultivated. They should have a plausible medicinal use and they should have a history of distribution within the European market.

The Exclusion criteria were for non-plant based medicines, plants listed on schedule 1 of The Convention on Trade in Endangered Species (CITES)[8], and Asian plants that were already widely grown and distributed within European countries.

[8] CITES schedule 1 prohibits all trade in the named species whereas schedule 2 allows trade with the appropriate certification.

6.0 Socio-economic methods and approach

6.1 Preliminary Investigation in Anhui province, China

I visited Bozhou, Anhui, China, in April 2011 to assess and document current practices and policies involved in the supply of Chinese medicinal plants to the internal and export markets. I compared and contrasted the traditional free market approach to trade with more recent initiatives that use a vertical integration strategy to make direct links between the farmers and the manufacturers.

6.2 Fieldwork in India

6.2.1 Sampling strategy

Case Studies: Three case studies were used for comparison. It was important to identify sites that had experience in the cultivation and trade of the plant product identified through the on-line survey (Turmeric, see 7.1).

The first case study examined a farm site located near to Shimoga in the state of Karnataka. This was an example of a farm that was in a chain, vertically integrated at a national level to a primary manufacturing site in Bangalore and internationally to a secondary manufacturing site in the UK). The second case study examined a farm site near to Erode in the state of Tamil Nadu. This site grew plant material that would be sold through middlemen at an auction house and represented the traditional route of supply where the plant material could be bought by any buyer for a multitude of purposes, including being purchased by a local manufacturing unit and once traded the traceability of the material was generally lost. The third site was farm in Jhansi, northern India that sold turmeric only to local market traders and had no connection with, and little understanding of, the industrial chain. At this site there was also a large farm that grew European herbs for the extracts industry which served as a good comparator.

Although arguably there would be less confounding information if all three of the sites were in the same state, these farms provided a good comparison between an integrated and non-integrated approach, organic and non-organic, high output versus low output and were located in states within southern and northern India, which allowed for a wide angled view of the current situation and broad interpretation of the available data.

When choosing the sites several factors were considered to be of prime importance.

Firstly, I wanted to examine regions that had a large trade in turmeric. Tamil Nadu and Karnataka are major growing areas for this crop (see Fig. 1) and Erode is regarded as the main trading city for turmeric in southern India.

My core sample was comprised of farmers, farm workers, processors and market traders, (a wide range of people were secured using primary respondents to recommend subsequent interviewees, i.e. through ‘snowballing’). The sample size aimed for was 20 to 30 respondents or once data saturation was reached.

Factors that were considered during the sampling stage were: age, gender, social class, experience, training, occupational group, ethnicity and situational context but I was limited to what personnel were available at the three sites and who I could communicate with effectively in English. I limited my interviews to the farmer level as it was not easy to communicate with the farm workers due to their level of spoken English, my level of Hindi, and almost no knowledge of the regional languages[9]. It was possible, however, to get an impression of their working conditions through observation and I was able to gain more detailed information about the pay and conditions of the farm workers through interviews with farmers and other actors in the chain. I used a peripheral sample as opportunities presented; this included other rural workers, regulators, NGO’s, exporters, and retailers. For more information on the research objectives and the prompts used for semi-structured interviews see appendix 3.

It was important to visit the sites during times of high productivity. The busy period for turmeric production runs from November through to April. This is the period where the majority of harvesting, drying, processing and trading takes place. I initially visited for a period of two months in January and February 2012, where I was able to visit the sites in southern India (Shimoga and Erode) and then followed this up with a second two month visit in October and November 2012, revisiting the primary manufacturing site in Bangalore and then travelling to northern India to visit farms in Jhansi, Uttar Pradesh. During the second visit I aimed to gain more detailed information from the initial sites and also to conduct interviews at the third site in the north of India for a comparison. In addition to my three main sites I also visited herbal companies, Ayurvedic hospitals and trade fairs to find additional or comparative information.

[9] Hindi is only spoken widely in the North of India and in the state of Karnataka the local language spoken is Kannada.

Experiences were sourced primarily through interviewees and observations but additionally through texts and records and I made notes from the local newspapers of any news stories relating to export trade, agriculture and herbal medicines.

6.2.2 Data recording and storage

I chose several techniques to record the data. My main method of recording the data utilised a notebook. Here I recorded information that I gained from the observations. I recorded this according to the time, place and the nature of the observation. I also used the notebook during the semi-structured interviews. I would record the person's name, their position, the site or institution visited and the date of the interview. I made extensive use of photographs as a record of observations and sometimes I made brief video clips, all with the permission of the subject(s). On occasion I used a voice recorder, although I found that there was some resistance to recording an interview in this fashion. Written data were stored in a locked office at the UCL School of Pharmacy and electronic data were stored on a password protected laptop computer.

6.2.3 Data analysis

Information was gathered firstly by reviewing the literature on Ayurvedic plants, value chains, crop production and agrarian economics. An initial step was to identify important plants that could be used as case histories for the project. From the preliminary fieldwork in China and the fieldwork in India it was necessary to interpret the findings in order to discover what had been learnt. This was achieved through reviewing the observational and interview data systematically and transposing the data into the relevant categories of analysis. This constituted using a content analysis approach for individual questions and an interpretive content analysis of complete interviews. I used a triangulation approach whenever possible using the testimony of different actors on the same subject material. For the analysis of the observations I made on the different study sites, I formulated these into a table for ease of reference. Case study analysis was used to compare one case study site against another.

6.2.4 Health and well-being survey

At the outset of the project it was intended that as a follow up strategy, I would use a questionnaire approach to elicit information regarding the relative health and well-being of the farm workers involved in the production of medicinal plants. As the first part of the study got underway it became apparent that logistics of performing a survey of this nature would be problematic in India due to time factors and government restrictions on performing this kind of study. Moreover it was agreed that the most valuable information regarding the value chain came from the farmers, the primary processors and secondary manufacturers as these were the groups that were directly linked into the chain and who were most affected by changes in value chain structures. This approach is also supported by ‘best practice’ on value chain methods (Kaplinsky and Morris, 2001)

6.2.5 Positionality

I was able to gain access to the farms through having contacts in India and China. My contacts were usually involved within the chains at the farmer and primary producer level and it was through these chain actors that I gained the majority of information about the farm workers regarding their pay and conditions. I was able to corroborate this information in part by gaining access to wages documentation. Being from a developed country and performing interviews in developing countries poses some cultural barriers that need to be overcome with care.

> “Conducting international fieldwork involves being attentive to histories of colonialism, development, globalization and local realities, to avoid exploitative research or perpetuation of relations of domination and control. It is thus imperative that ethical concerns should permeate the entire process of the research, from conceptualization to dissemination, and that researchers are especially mindful of negotiated ethics in the field” (Sultana, 2007).

It was necessary to spend time interacting with the participants in order to gain their trust and attempt to break down some of the barriers that separated us. This was not generally directed towards the project itself but comprised of talking in more general terms about the differences between countries, family life, education, health and even football. In a broad sense I think I achieved a position where the participants felt comfortable with my comings and goings, my sometimes strange questions, and my constant note taking and photographic documentation. I felt that the participants in the study offered information freely, however, because different levels of management were perceived as being involved in the process and I was perceived as being connected in some way to actors in the higher management positions or to university faculty, it is unlikely that I was given the most negative aspects of employment on the farm or in a factory or heard grievances regarding poor pay and / or working conditions.

7.0 Socio-economic findings

7.1 On-line survey

Overall 230 reponders participated to the on-line survey, but not all answered all questions. The survey ran over a two year time frame and I was able to gather information regarding the attitudes and beliefs of a self-selecting sample group regarding herbal medicine and HMPs and more specifically, TIM and its supply chain.

Over 85 per cent (of 230 respondents) had tried some form of herbal medicine with over a quarter using herbal medicines or using herbs in cooking but for health reasons, at least monthly (Fig. 2).

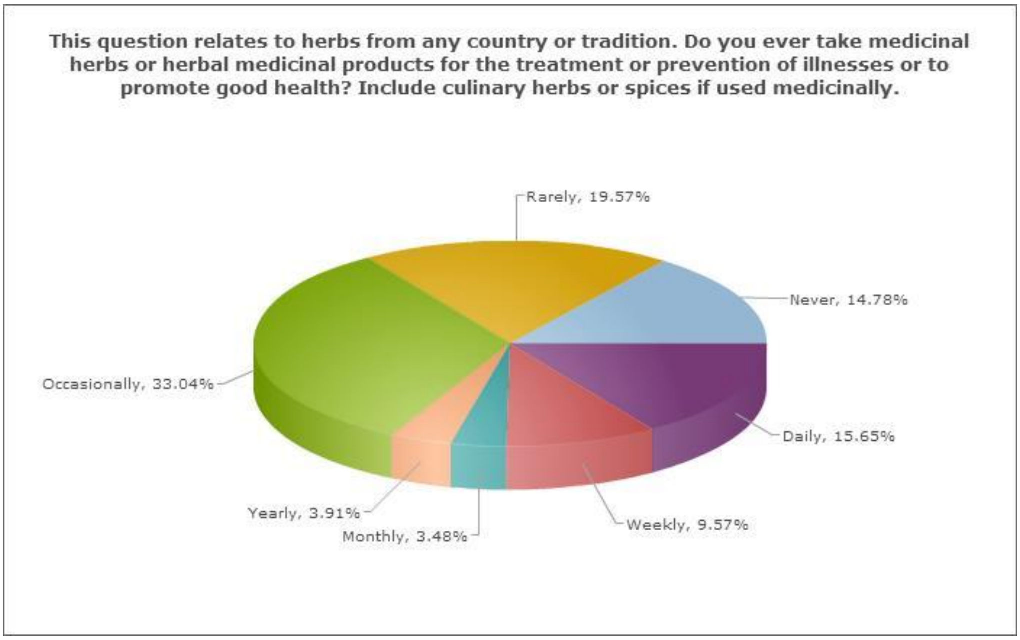


Figure 2, Overall usage of herbal medicine, n = 230

Fewer respondents, however, had used Indian herbs or HMPs, with almost 53 per cent (of 226 respondents) having never used them (Fig. 3). This could be to a lack of knowledge, problems obtaining these herbs or it could be due to fears and concerns over the quality and safety of HMPs originating from India (see Figs 10 and 11).

However, only approximately 15 per cent (of 225 respondents) would never try Indian herbal medicine, and almost 50 per cent would use them (Fig.4). This information supports the hypothesis that there is a demand for Indian HMPs providing that the quality and safety can be better assured (e.g. by complying with the THMPD) and that the consumer has sufficient information to choose the appropriate product.

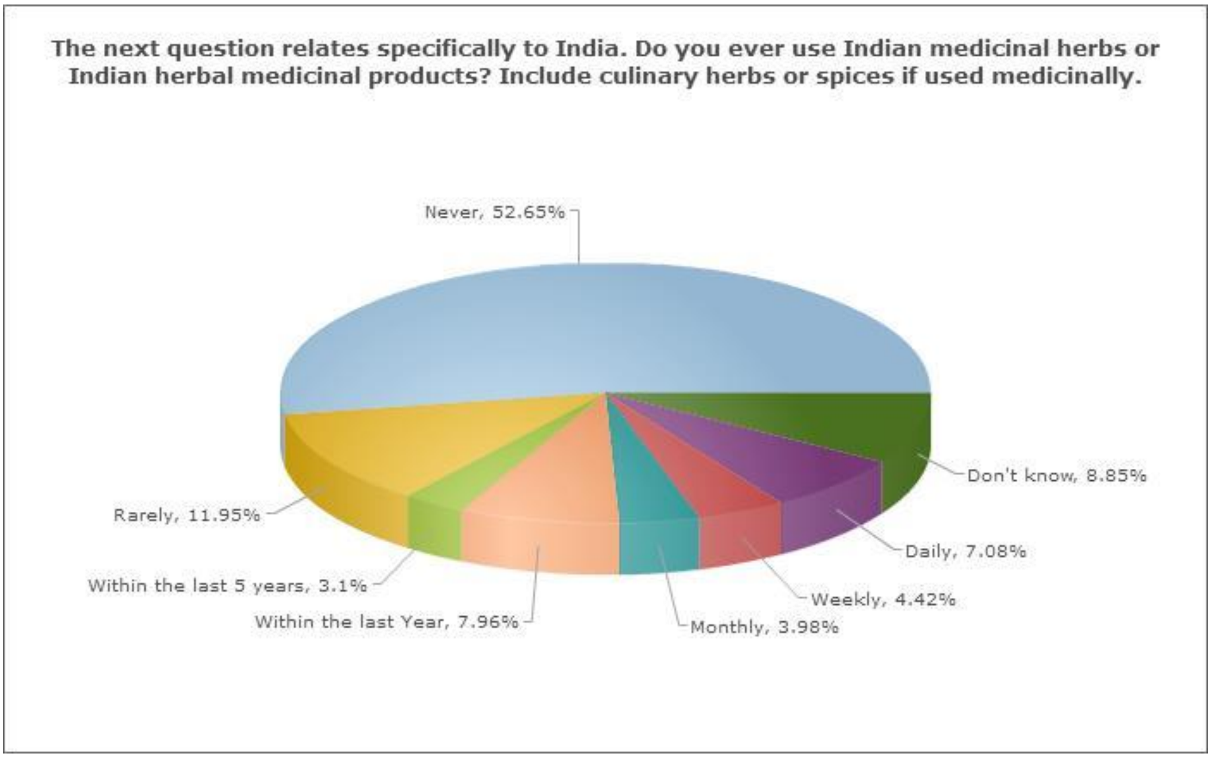


Figure 3, Usage of Indian medicinal herbs as an aid to health, n = 226

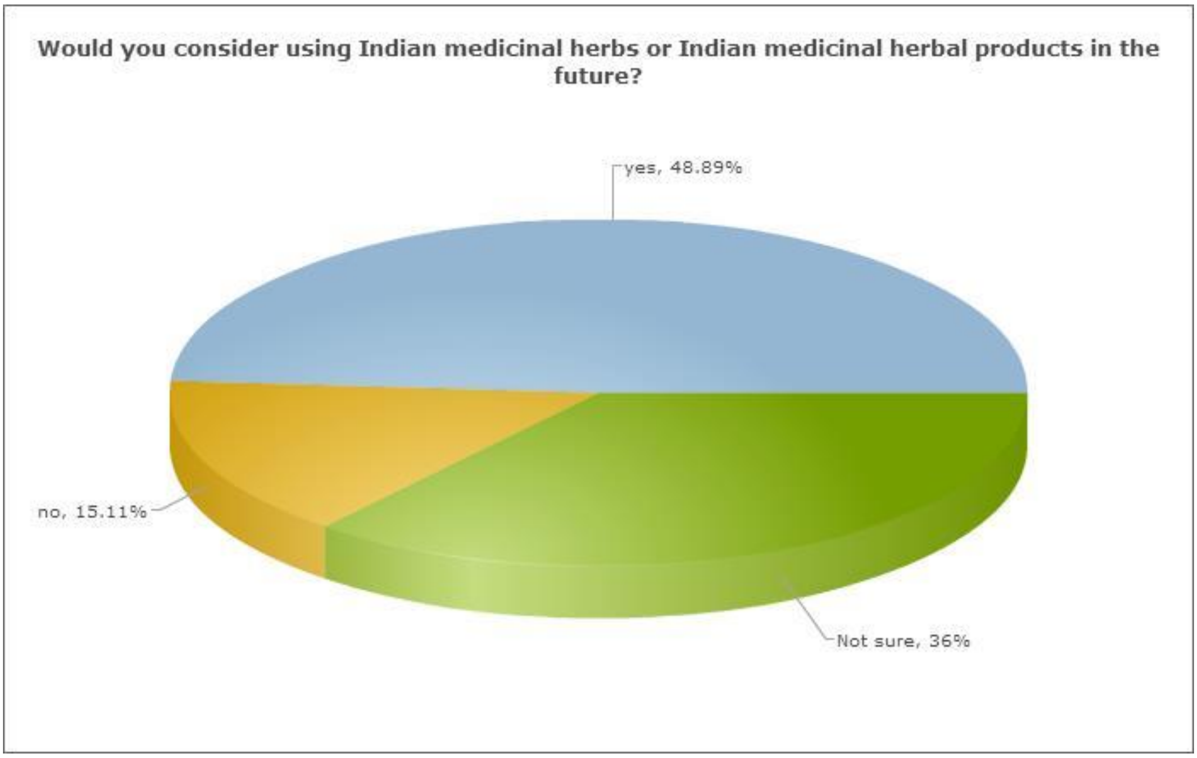


Figure 4, Future attitudes towards Indian products, n = 225

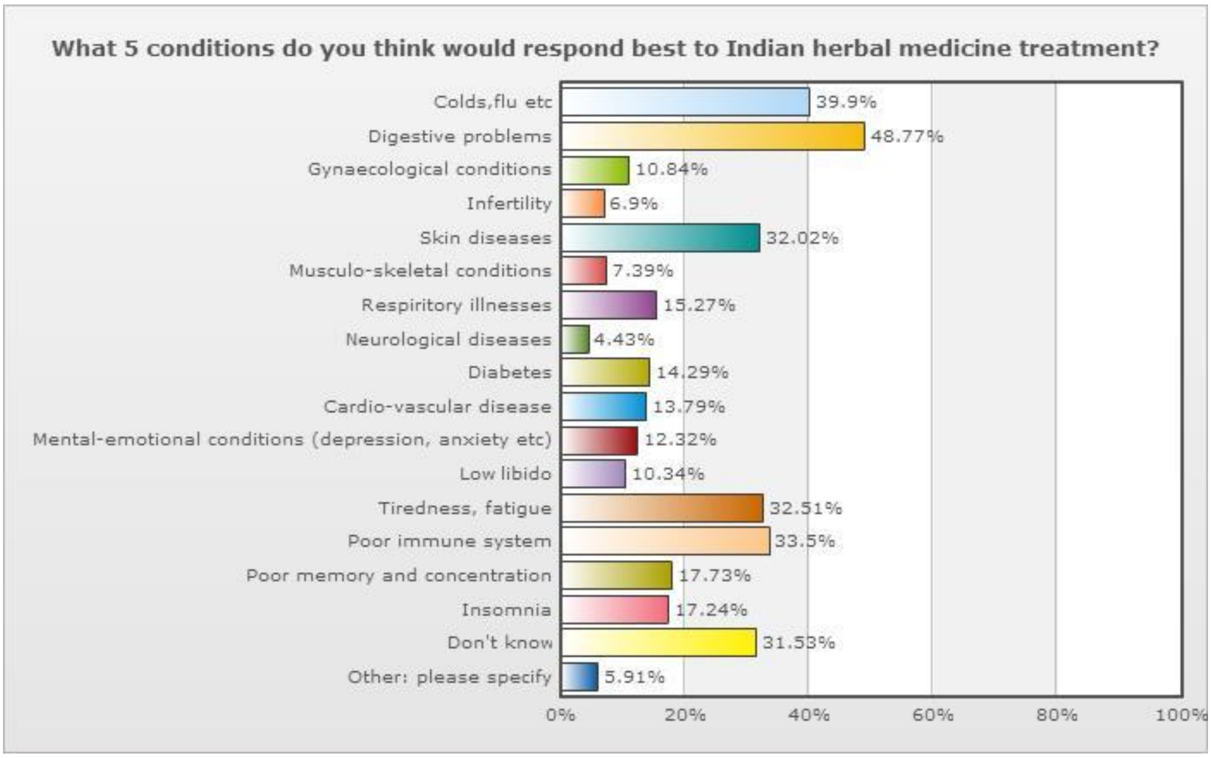


Figure 5, Perceived benefits of Indian herbal medicine, n = 203

Respondents (203) perceptions of the health benefits of Indian herbal medicine suggested that the main area of treatment was digestive problems, followed by cold and flu type conditions (Fig. 5). These are two treatment areas that are feasible to satisfy the conditions regarding ‘indications’ for a traditional herbal product registration (THR).

Turmeric is mainly used for the treatment of digestive problems and inflammatory conditions. It also has a history of traditional use for the treatment of sore throat and so the results of this question helped to strengthen the case for using *Curcuma longa* as a case study and when respondents were asked to name the most important Indian medicinal herbs, turmeric was by far the most frequently mentioned (Fig. 6)

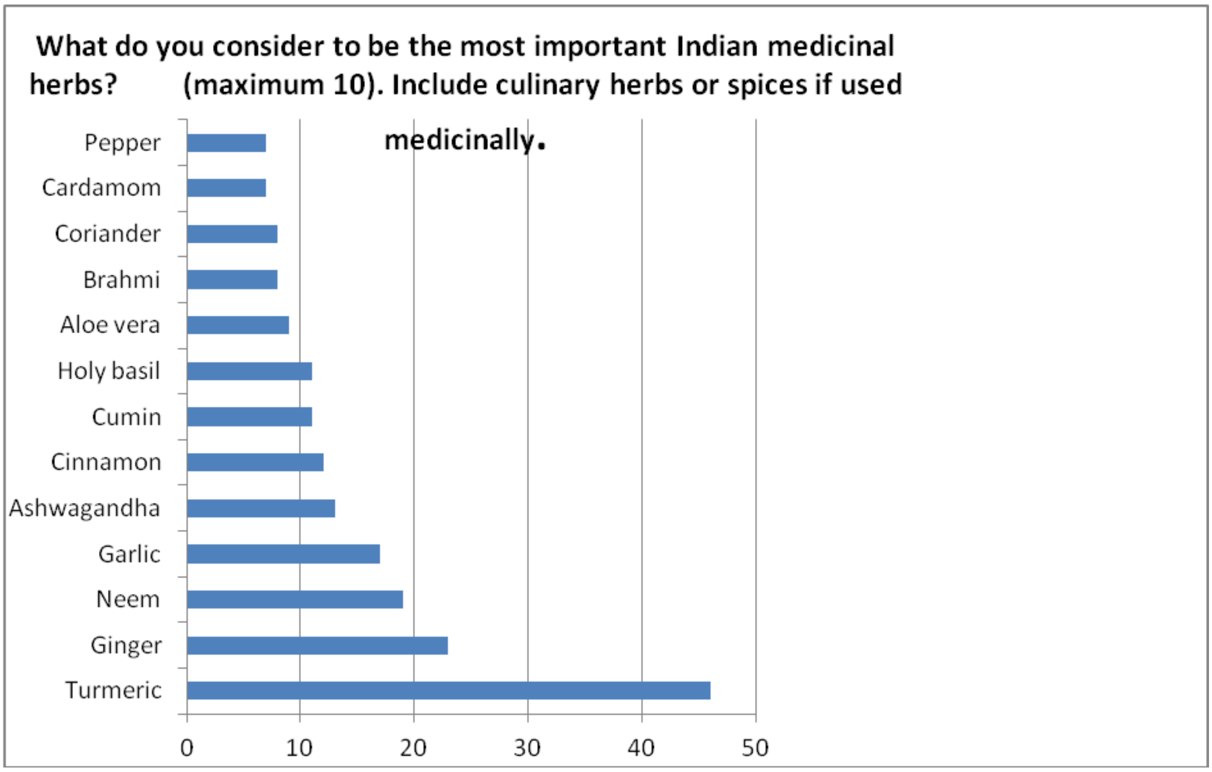


Figure 6, The most important Indian medicinal herbs, n = 191

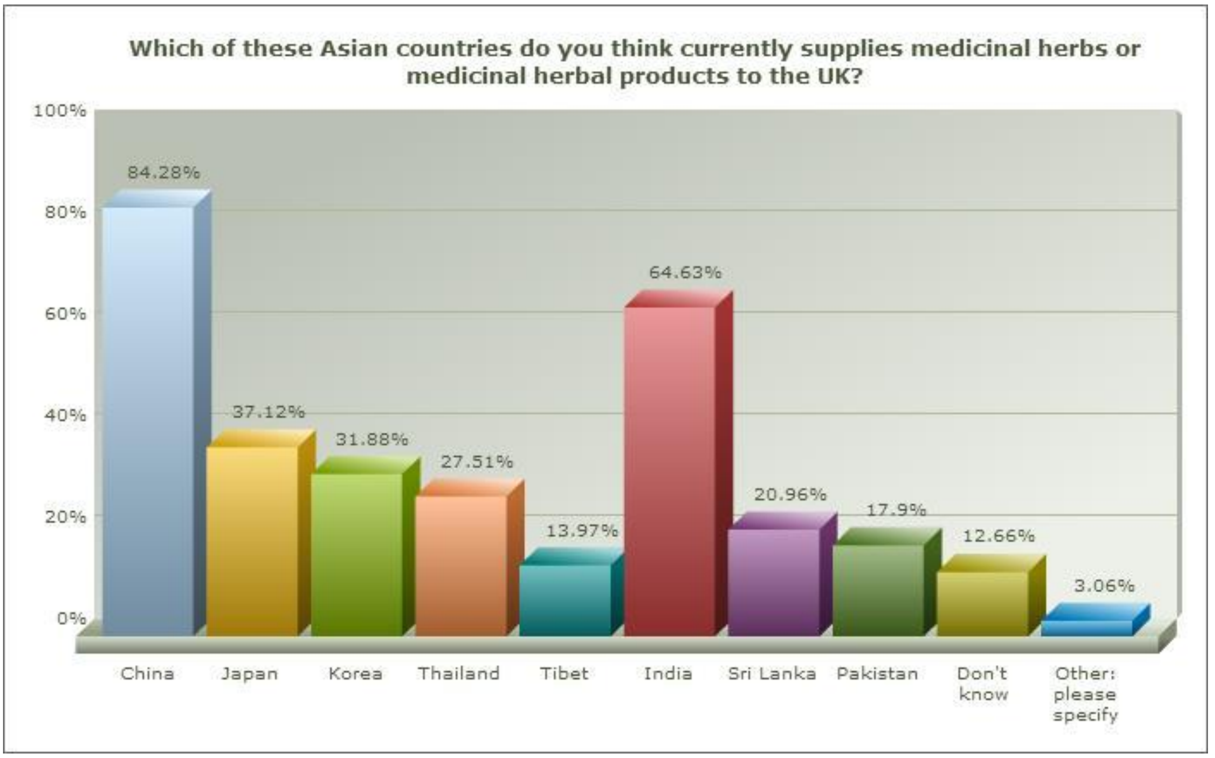


Figure 7, Asian country suppliers of HMPs, n = 229

China was the most well-known about Asian country for supplying HMPs to the UK (Fig. 7) with almost 85 per cent (of 229 respondents) recognising it. India was second choice with approximately 65 per cent. This information helped me to decide on India and China as sites for fieldwork and pre-fieldwork for the study.

Out of 209 respondents, 20 per cent said they obtained their Indian herbal medicines or medicinal spices from a supermarket (Fig. 8). This was followed by health food shop (18 per cent) and then friends and family bringing products back from India (nine per cent). It is likely that the supermarket is used for culinary herbs that can also be used medicinally, e.g. ginger, garlic, turmeric, and the health food shop is used for more medicinal products e.g. ashwagandha, neem, holy basil. Less than four per cent of respondents indicated that they used the internet as a source of supply which is in some ways surprising. However, the internet is mainly used for HMPs rather than fresh or dried herbs and spices and moreover there are sometimes concerns over the quality of products obtained from this source, which may be some of the reasons for the relatively low figure.

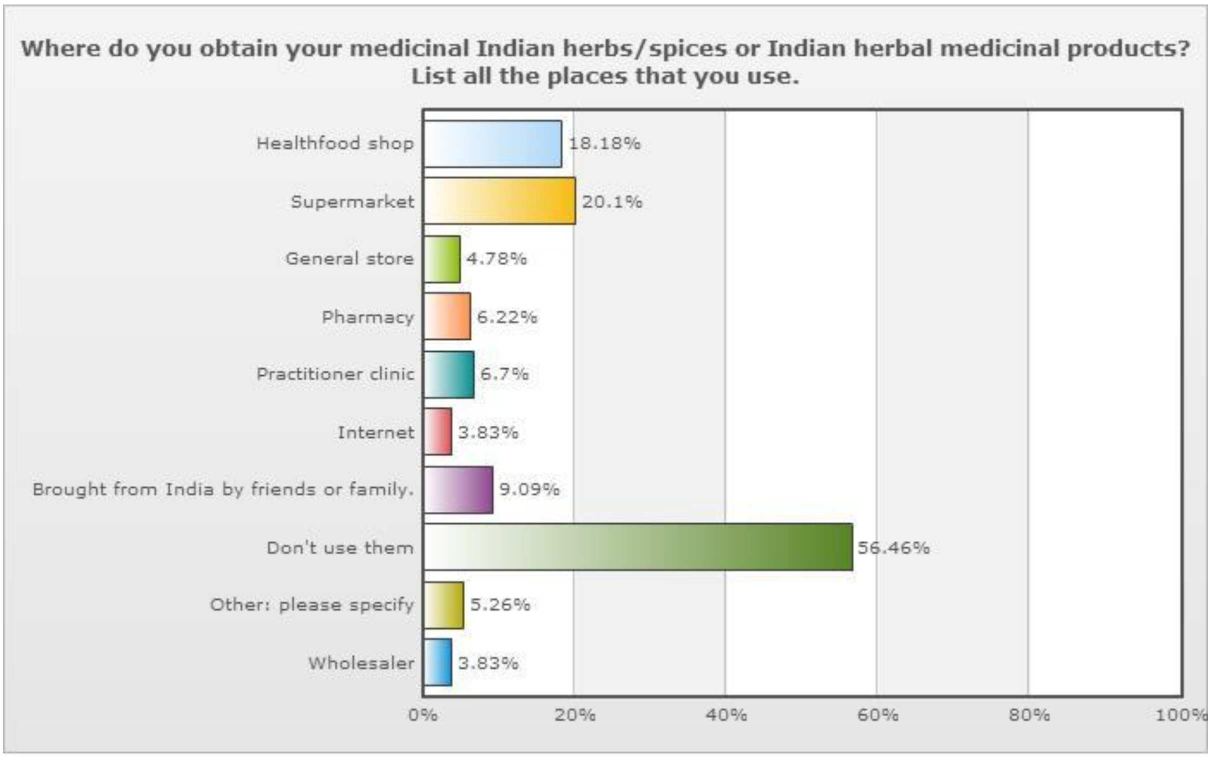


Figure 8, Sources for the supply of herbs, spices and HMPs, n = 209

Powders, fresh herbs and dried herbs are the most popular forms of consumption, whereas capsules and tablets are used slightly less (Fig. 9), indicating that the preference may be to use these products within cooking rather than having to take a daily dose of a HMP. This correlates to some local and traditional practices for the use of the fresh and dried herbs and spices, e.g. turmeric is taken with milk for a sore throat, or is mixed with other spices to form curry powder to promote general health and well-being, garlic is mixed with honey for a sore throat or used raw for its circulatory effects, and fresh ginger is used to treat common cold and it is used in its dried form to alleviate feelings of nausea.

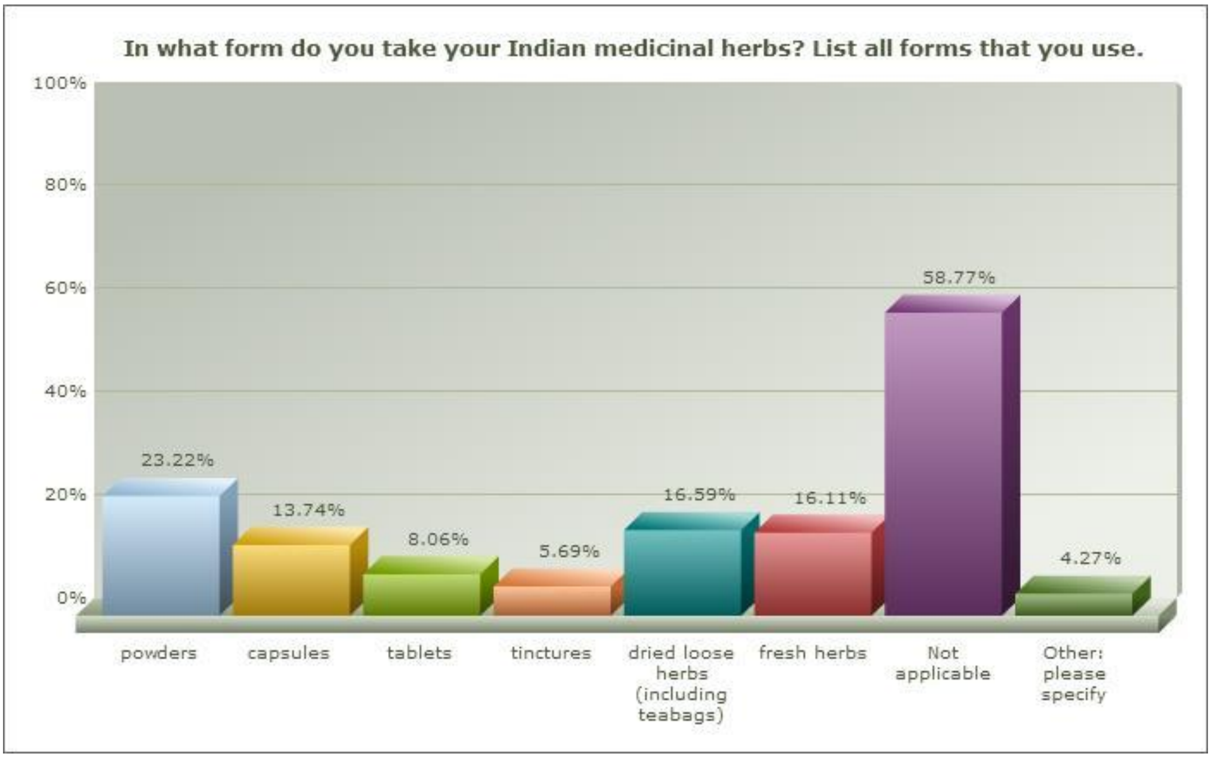


Figure 9, Dosage form for Indian HMPs, n = 211

Some of the most telling information regarded issues of quality and safety. When asked whether they had any concerns over quality and safety of Indian herbs or HMPs, only 19 per cent (of 76 respondents) indicated that they had no concerns (Fig. 10), with 50 per cent having concerns regarding quality and safety. Interestingly, only 12 per cent of responders were concerned about efficacy and when asked for their own comments regarding Indian herbal medicine, 50 per cent (of 49 respondents) regarded it as being very effective (Fig. 11).

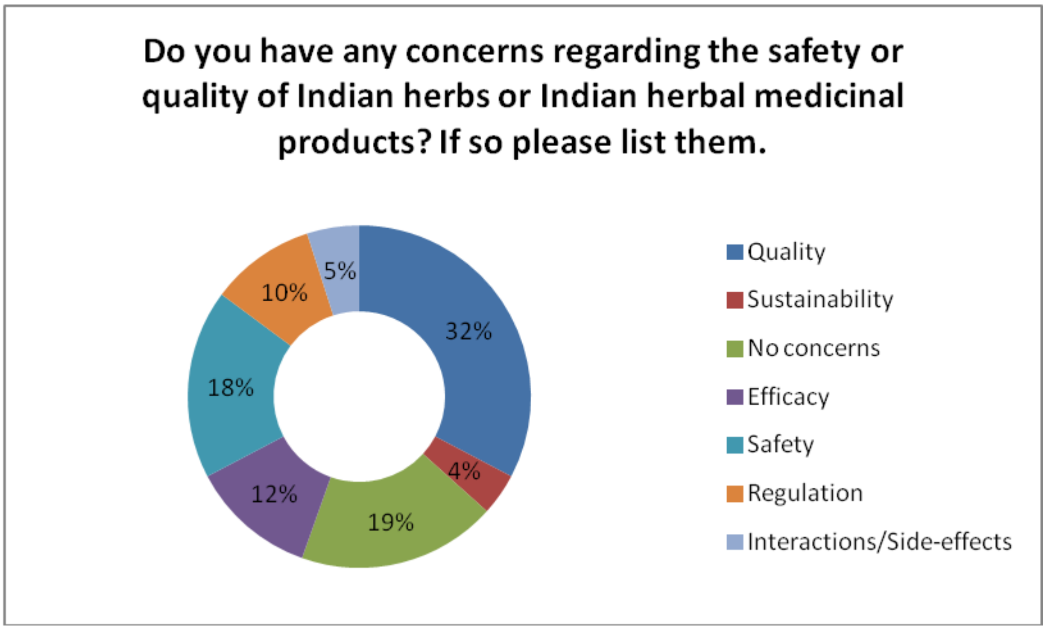


Figure 10, Quality and safety concerns regarding Indian HMPs, n = 76

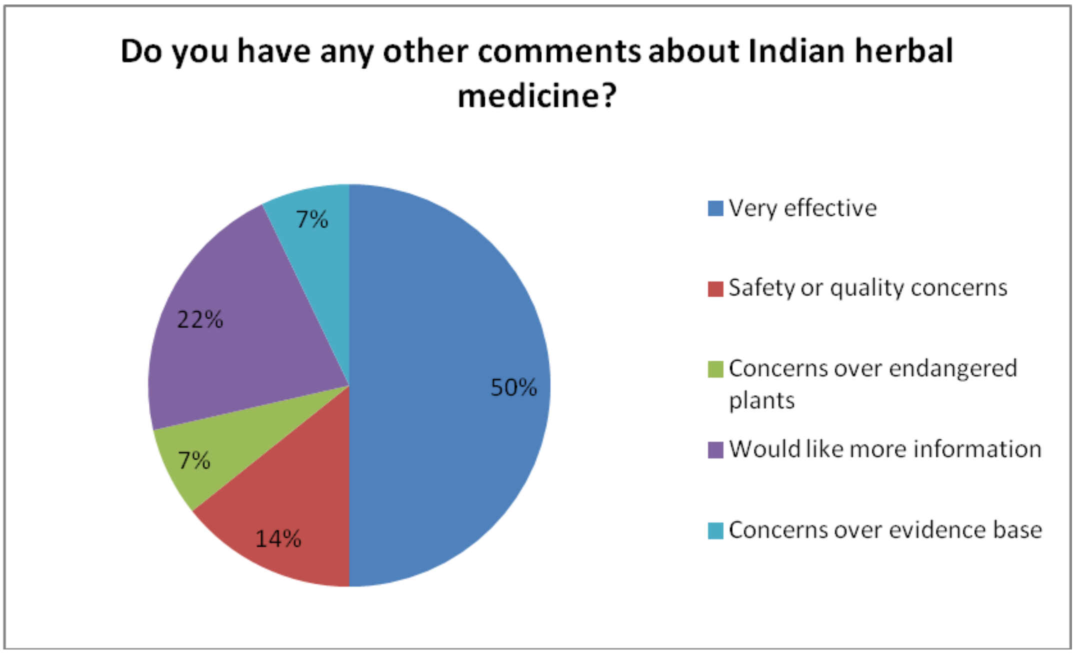


Figure 11, Comments on Indian herbal medicine, n = 49

The online survey helped me to establish turmeric as my case study. Moreover the results of the survey helped in the development of the aims and objectives of the study.

The survey demonstrated that the belief in TIM effectiveness was high and a high percentage of people indicated they would consider using TIM for a range of medical conditions.

However, there is a lack of knowledge about using these products and there are concerns over the safety and quality of the products supplied to the UK.

7.1.1 Limitations of the survey

The on-line survey recruited 230 respondents. However, certain questions, mainly relating to safety and quality, had a relatively low response rate.

The survey design allowed for self-selection convenience sample of participants which could potentially lead to a voluntary response bias in the results.

Selection bias was apparent and there was under-coverage and over-coverage of certain groups. Because the survey was on-line, the percentage of older respondents was relatively low with over 90 per cent being less than fifty four years, whereas the percentage of student respondents was relatively high (45 per cent).

There was a good ethnic mix in the survey, with 58 per cent of respondents describing themselves as 'white', and the rest being made up from different ethnic groups.

For the full survey and a more detailed account of the demographic information, see appendix 4

The online survey was an effective and rapid method for determining suitable plant candidates for the case study.

Turmeric was chosen as the case study based on the survey results.

7.2 Preliminary Investigation in Anhui province, China

Although the main fieldwork connected with this project was in India. I decided to carry out some preliminary investigations in China prior to visiting India in order to be able to assess what the current trends were within the market, particularly in the area of integrated value chains. China would make a good 'benchmark' as it has a more developed herbal medicine industry than most Asian countries, particularly if Taiwan is included. I was especially interested in the links between these two locations, separated by both geography and ideology, but in many ways similar and emanating from the same cultural roots. I wanted to discover what formal and informal links had been established between a Taiwanese company, who trade internationally, and the provincial farms, primary processors and herbal markets in China. To what degree any vertical integration had been established between the company and primary producers and whether this had an impact on local livelihoods?

I wanted to get a general background as to what plants were grown and how government and academic institutions were involved (if at all), and if any GAP standards were being implemented. Through this preliminary fieldwork I would be able to make better informed comparisons during my fieldwork in India.

7.2.1 Botanical diversity and cultivation of Anhui

As of 2005, there were 3,482 species of plants and fungi listed for Anhui province giving it a ranking of sixth most populated for China as a whole. Cultivated herbs are prominent in the north, whereas wild harvesting is more prevalent in the central mountainous regions, together with some cultivation. Wild harvesting is mainly found in the south particularly around the area of the Yellow Mountain (Chang, 2011). To support wild harvesting, seeds are sometimes collected from the wild and propagated in the laboratory (see fig. 12). Seedling plants are then returned to the wild to grow.

Selected medicinal plants and fungi of Anhui Province:

Atractylodes macrocephala Koidz. Asteraceae, is endemic to China. It is found in the areas of Bozhou, Huoshan, Ninguo, Shexian and Chimen. It is cultivated or grown using wild-simulated cultivation. *Atractylodes macrocephala* has become extinct in the wild in Anhui province due to over-collection.

Chaenomeles speciosa (Sweet) Nakai, Rosaceae, is a native plant and is found in Shuanchen

Cornus officinalis Siebold et Zucc., Cornaceae, is a native plant, found in Jinzhai, Huoshan, Yuexi and Shitai

Crataegus cuneata Siebold et Zucc., Rosaceae, is native to China and is found growing in Northern Anhui

Dendranthema grandiflorum (Ramat.) Kitam., Asteraceae, is a Di Da herb of Bozhou. (Di Da herbs are regarded as the highest quality) There are 4 types and it is found in Bozhou, Chuzhou and Shexian.

Dendrobium catenatum Lindl., Orchidaceae, is endemic and grows on stone. It can be cultivated. Wild varieties are found in the Huoshan area, growing at 800 metres, but it is very rare to find. (CITES [10]controlled). Wild species are collected for their seed. The seed is propagated in the laboratory and then the plant is returned to the wild (see Fig. 12). In TCM it is used as a 'yin tonic' and is used to treat febrile diseases.

Eucommia ulmoides Oliv., Eucommiaceae, is endemic to China and is cultivated in Anhui and Beijing.

The fungus, *Ganoderma lucidum* (Leyss. Ex Fr.) Karst, Ganodermataceae, is cultivated and the fruiting body and spores are used in medicine.

Gastrodia elata Blume, Orchidaceae, is a native plant and is cultivated in the Jinzhai and Huoshan regions. It has a symbiotic relationship with bacteria and the mycelia surrounding the maple tree. It is pollinated by hand and can be harvested within one year.

Isatis tinctoria L., Brassicaceae, is a native plant and is naturalised elsewhere and widely distributed throughout the northern hemisphere. It is cultivated in the Bozhou area. The price of this herb has increased dramatically due to outbreaks of Influenza that have significantly increased demand.

Magnolia biondii Pamp., Magnoliaceae, is cultivated in Huaining

Magnolia officinalis ssp. *biloba* (Rehder & E.H. Wilson) Cheng & Law in W. C. Cheng, Magnoliaceae, is found in Qianshan

Morus alba L., Moraceae, is a native tree with many of its parts being used in Chinese medicine. It is found widely in Anhui province.

Paeonia lactiflora Pall., Paeoniaceae, is a native species and is cultivated widely in China. The 'shaoyao' (peony) of Bozhou is known as 'boshao'. It is harvested after four years of growth.

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10 CITES Appendix II - Trade controlled to avoid use incompatible with species survival

Its quality standard is measured in terms of its paeanoflorin content which is set at a minimum of 1.6 per cent. The levels of paeanoflorin can deteriorate due to improper storage or processing.

Paeonia ostii T.Hong et J.X. Zhang, Paeoniaceae, is endemic. It is native to Henan province and cultivated in other provinces. It is cultivated in Bozhou and wild-simulated in the mountains of Tongling. Cultivation is strictly controlled. The colour of the medicinal plant is white and the coloured varieties are used for exhibition purposes. It flowers in mid-April and is harvested after 4 years. It is known as mudanpi used in TCM and used as a regional alternative to *Paeonia suffructicosa*.

Peucedanum praeruptorum Dunn, Apiaceae, is endemic and is found in the mountainous areas of Anhui.

*Platycodon grandiflorus (*Jacq.*)* A.DC., Campanulaceae is a native plant found in several areas of Anhui province and it is cultivated in the Bozhou area. It is a medicinal herb that can also be grown as a food crop, although these two practices are normally separated.

Wolfiporia extensa (Peck) Ginns Polyporaceae is found in the south-west of Anhui. This fungus is cultivated by burying pine tree bark. The bark is cut into pieces and inoculated with the poria fungus and is then buried in sand. The fungus then grows through and out of the bark and is ready for collection after six months.

Pseudostellaria heterophylla (Miq,) Pax, Caryophyllaceae, is a type of ginseng, native to China and is found growing in the mountains of Anhui.

Trichosanthes kirilowii Maxim., Curcubitaceae, is a native plant and is widely cultivated. It is grown in the Bozhou area of Anhui province.

Ziziphus jujuba Mill., Rhamnaceae, is native to China and cultivated in many parts of the world.

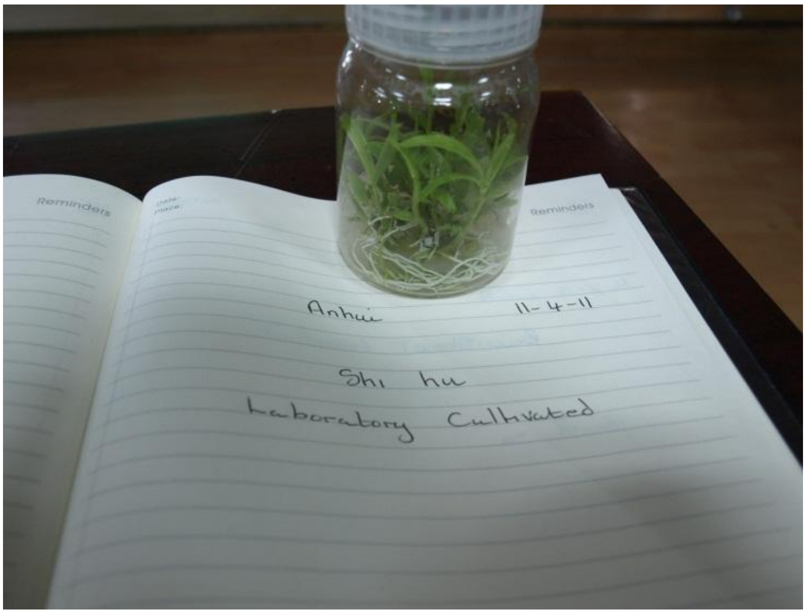

Figure 12, Laboratory cultivated *Dendrobium catenatum Lindl. (Seeds are collected from wild specimens)*

7.2.2 Trade in Chinese medicinal herbs

In Bozhou, the land is flat and fertile. One million people in the Bozhou area are involved in the production of traditional Chinese medicines. In the Chinese Pharmacopoeia, four medicinal plants are named after the city of Bozhou; boshao (peony root) boju (chrysanthemum flower) bosanpi (mulberry bark) and bohuafen (trichosanthes root), about 75 per cent of China's baishaoyao is produced in Bozhou. The city has the largest specialised TCM market and trading centre in China (Fig. 13). It occupies 80 hectares, with building areas of over 10,000 square meters (Brion, 2011).

Figure 13, The main trading building at Bozhou Herbal Market

Farmers bring their dried herbs to Bozhou from all over Anhui province and beyond. The market traders are most commonly the farmers themselves who are each allowed to produce one tonne of dried herbs per year (Fig. 14).

Figure 14, A local farmer trading his herbs at Bozhou market

Information on market trading trends is distributed by Bozhou market to help farmers make the best choice as to what to plant for the following year:

e.g. Baizhi **(***Angelica dahurica* (Hoffm.) Benth. & Hook.f. ex Franch. & Sav., Apiaceae

> "It is not only used as a medicinal herb but also can be used as an ingredient for cooking so the demand is increasing in large amounts. Its seeds can be planted in spring but the quality of the plant will not be that good. Planting in August and September is much better. Use 3 kg of seed per metric unit (MU) and it takes one year to produce; output is about 500 kg per MU. At present this herb's price is 15 Yuan per kg and income is about 7,500 Yuan" (Guangqian, 2011).

Detailed information is also provided concerning the planting growing and harvesting conditions for selected herbs together with projected figures of income,

e.g. Analysis of chaihu cultivating technique, effect and profit,

> "Chaihu (lit. kindling of the barbarians[11]) has the alternative names of zhuyechaihu, beichaihu (northern chaihu), nanchaihu (southern chaihu), hongchaihu (red chaihu) and xiaochaihu (small chaihu). This herb is of the umbelliferae family.
>
> It is used in TCM to expel pathogenic factors in order to reduce fever, sooth the depressed liver and invigorate the Spleen-yang. Indications: common cold, irregular periods, stagnation of Liver-qi. It is mainly distributed in Hebei, Henan, Shanxi, Gansu, Hubei and Dongbei.
>
> It is a perennial plant and grows up to 45 to 70 cm in height. Its root is straight and some of the root has branches. Bunches of canes grow straight up and branches are on the top in a Z shape.
>
> It likes a warm and damp environment. It is cold and draught resistant but does thrive in waterlogged places. Deep loose and rich soil is better for production; organic sandy soil is the best.

[11] In ancient China, 'barbarians' were considered anybody who originated outside of 'the middle kingdom' (China) HUANG, Y. (2013) Perceptions of the Barbarian in Early Greece and China *CHS Research Bulletin,* **2** (1)..

However, saline and low-lying land is not suitable. It requires a high altitude area, with well drained, deep loose and rich organic soil. It needs intensive cultivation. Put in a lot of base fertiliser while turning over the soil. Complex fertiliser 3,000 to 5,000 kg, mixed carbon fertiliser, potash fertiliser 50 kg per MU and urea 20 kg per MU. Make a high bed whilst waiting for cultivation.

Seeds should be planted in spring or autumn. Seeding in spring will produce results around early April and in autumn before frost arises. Seeding in autumn is better. Seed at 3 kg per MU. Water it when you put the seeds in which will allow the seeds to sprout easily.

As the baby plants are growing up, pay attention to weeding. To avoid weeds growing you can use herbicide before putting the seeds in if cultivating over a large area. During the rainy season keep good drainage. If there is drought, keep watered. During next spring you should fertilise once again using urea 10 kg and potash fertiliser 10kg per MU). In the winter clean the field to get rid of dead branches and leaves. Also add some more homemade compost.

The main disease for chaihu is root rot. This can be prevented by applying 65 per cent *daishengmengxin* spray. In the early stages you can use duojunlung spray as prevention. The main pest is aphid, which can be treated by using *tachongjin* (aphid clear away). With underground pests you can use *xinliuling* together with poison bait.

Usually after one to two years growing, the above ground part will wither away in the autumn. That means it is the time to harvest. Firstly cut the above ground part, and dig up the roots, remove earth from the root and dry it in the sun.

Income per MU:

150 kg x 40 = 6,000 Yuan, stem and leaves 300 x 2 = 600 Yuan,

Total Income 660 Yuan

Costs per MU:

Seeds: 3 kg x 70 = 210 Yuan; fertilisers: 50 x 4 = 200 Yuan;

machine: 30 Yuan; labour: 100 Yuan; pesticides: 10 Yuan

Total cost: 550 Yuan

Net benefit: = 6600 - 550 = 6050 Yuan per MU"

(Guangqian, 2011).

For a full account of prices and market trends for herbs sold in Bozhou herb market (2011), see appendix 5.

7.2.3 Anhui University of TCM

"Anhui University of TCM is the main TCM University in Anhui. It has produced 7,000 pharmacy graduates and currently has 2,000 enrolled students, 180 staff and 18 professors. It has five undergraduate programmes in pharmacy and four post graduate programmes including a PhD programme. The university has generated over 3,000 papers and has a focus on Chinese pharmacy development. It has an extensive herbarium containing more than 90,000 specimens of approximately 3,000 different species" (Chang, 2011).

Pharmacognosy is a speciality of the university and a variety of modern and traditional techniques are used. Voucher specimens are kept within the university for many of the herbarium species (Fig. 15)

"There are 50 pharmaceutical companies in Anhui province and the university has associations with some of these companies. The university is involved in the modernisation and development of TCM including research into active plant ingredients. They work closely with the sourcing companies and local pharmaceutical companies, providing technical knowledge and expertise. In return the university is supported through some industry funding" (Chang, 2011).

Figure 15, Herbarium voucher specimen at Anhui University

> "Although China has been trading medicinal herbs with the outside world for hundreds and probably thousands of years, much of this business came to an end during the latter part of the 20th Century while China was under a stricter communist regime. Although trading probably continued during more informal channels during this time, trade in Chinese exports of medicinal herbs began again officially in 1984, through the establishment of government sponsored Chinese export companies. Joint venture companies; often being collaborations between Chinese and Japanese partners, have been emerging in the arena of medicinal herbs since the 1990's. For Taiwanese companies, trade has had its difficulties and during the 1980's when trade restrictions were stringently enforced between the Island and mainland China, the Taiwanese were forced to source herbs through intermediary suppliers, chiefly located in Hong Kong. It has only been since 2000 that it has been possible for Taiwan to import herbal raw materials directly from China. For hundreds of years, buyers have obtained their herbs chiefly from the herbal markets" (Interview with WCC, 2011).

There are 17 major herb markets in China, the largest of these can be found in the city of Bozhou, Anhui province. Farmers, wild-pickers and market traders gather here from all over Anhui province and beyond to sell their herbs. There are 6,000 market stalls, trading 5,000 tonnes of Chinese herbs, consisting of approximately 2,000 species to the 50,000 people who visit the market each day. The daily turnover is estimated to exceed US$1.2 million, and annual turnover US$735 million (Brion, 2011).

This centralised market approach is the traditional way of buying herbs throughout China. Prices are fixed and advertised and bargaining is not allowed under Chinese agricultural law (PRC, 1993). (Although bargaining was observed during the visit)

The quality of the herbs is determined by traditional organoleptic methods such as size, shape, aroma and taste, and little attention is paid to the active constituents, marker compounds, or chemical impurities. Although it is often the farmers themselves that are also the market traders, little attention is paid to documenting the source of the herbs or documenting any processes that may have been applied to them. Apart from the usual drying stage, Chinese medicinal herbs may be subjected to a variety of pre-processing requirements including cutting into precise shapes, sieving, washing, stir-frying, charring, steaming, boiling and baking. Traditionally much of this work takes place on site and it is a common occurrence to see herbs laid out over the pavement or highway to dry in the sun after being washed in the local water supply. The pre-processing stages such as stir frying, boiling, baking, may take place in the farmer’s home or in roughly converted production areas.

Comment on the current market trends in Bozhou,

> “I have checked the price trend of forty herbs during the years 2008 to 2009. Their price wandered in low valleys for around two years. With other agricultural products increasing their price and with increasing labour costs, a lot of farmers gave up or reduced cultivating medicinal herbs. In 2009, crop outputs were not large amounts. Additionally, drought, floods and freezing temperatures caused havoc resulting in even lower output. In 2010, all herb prices rose” (Zhen, 2011).

7.2.4 Developing an international quality strategy

In order to satisfy the requirements of an international market, some companies have found it necessary to put in place systems that help address the quality concerns of foreign customers. Taiwanese herbal product manufacturers, which supply herbs to distributors in many parts of the world have had to find an alternative strategy from buying herbs at local or provincial herbal markets in order to better assure their customers that they can source good quality herbal ingredients that can be traced back to the areas of cultivation. The belief is that by having direct links to the farms it is easier and less costly to assure the quality and traceability of the herbs in comparison to using the herbal markets that tend to dominate herbal medicinal trade. In China it is difficult for non-Chinese organisations to make direct links with individual farmers and so herbal sourcing companies have emerged to provide this missing link in the export market supply chain. Anhui Tienho Herb Sourcing Company (ATHSC) is a company such as this. ATHSC has been exporting herbs from China for the last 20 years. Firstly to herbal manufacturers based in Japan and for the last 5 years to a company in Taiwan. They supply processed and un-processed medicinal herbs, plant extracts, essential oils and some functional foods. Their main focus is on herbs from Anhui province but they also gather herbs from all over China subject to customer demand. ATHSC appear to have built good relationships with local farmers and local people are employed to work on the land (Fig. 16).

Figure 16, Field worker in Bozhou harvesting mature plants

Figure 17, an employee of ATHSC in the warehouse

The production workers (see Fig. 17) are employed to work seven hours per day for six days of the week. Much of the work involves manual sorting of herbs (Fig. 18). Industrial equipment is used for washing herbs, drying, cutting, sieving and pre-processing.

Figure 18, ATHSC factory employees sorting Ziziphus, suan zao ren

The management at ATHSC attempts to draws a clear distinction between the quality of their herbs and the herbs that can be obtained through the market place (see Figure 20).

Company staff together with academic staff from Anhui University, pay regular visits to the herb markets to take samples of herbs for comparison.

The company claim to pay above the market price for the herbs that they source and in return they require farmers to pay close attention to quality requirements. They require that herbs are sourced at particular times of the year and sometimes in conjunction with chemical test data. For example, *Paeonia lactiflora* is harvested once the customer's requirement, of not less than 3.0 per cent paeoniflorin, is achieved (the national requirement being not less than 1.6 per cent). The company believes that the increased requirement helps to ensure that quality is preserved through storage and pre-processing. This scientific measurement of quality is a new concept for many of those involved at the early stages of the supply chain.

Some quality control testing is performed in-house, including authenticity, loss on drying, sulphated ash, essential oil, sulphur dioxide, total heavy metals and assay. Whereas more complicated tests are contracted to specialist laboratories, including microbial analysis, aflatoxins, residual pesticides and specific heavy metals.

The crop suppliers are audited by ATHSC annually and the factory is required to comply with Chinese standards of GMP as laid down by the CFDA.

Approximately 95 per cent of the herbs sourced by ATHSC are destined for the export market, mainly Japan and Taiwan, and a few other Asian countries. However, 70 per cent of these exports are destined for a Taiwanese company, making them by far the biggest customer. The Taiwanese company, Sun Ten Pharmaceutical Co. Ltd (STPCL) has built up a relationship with ATHSC over a number of years and now invests in the company's infra-structure and training programme. Even though there is a mutually advantageous collaboration apparent, with the STPCL owning about 70 per cent shareholding, there are still problems to overcome.

> “Taiwanese board members can only have involvement if they are US residents as in the strained political climate, government policy does not allow for Taiwanese citizens to be board members of companies in China even in joint partnerships. STPCL has been developing a working partnership with ATHSC and Anhui University of TCM for over 5 years.” (WCC, 2011).

ATHSC’s strategy is to develop a strong link between STPCL and the Chinese mainland suppliers, a strategy that appears to be providing mutual benefits.

Fig. 19 shows the supply chain for the herbal medicinal products and the links between the different parties involved. It can be seen that STPCL is selling some of its products on the Chinese market as functional foods which is seen as a major step forward for the future development of herbal medicinal trade between Taiwan and the mainland.

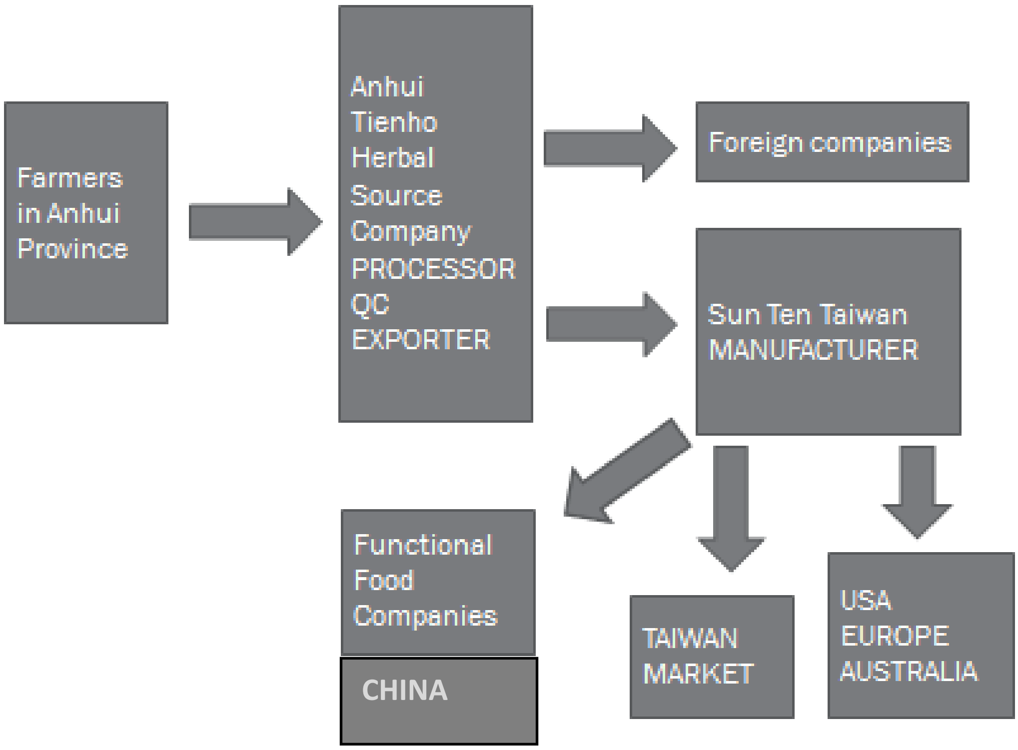

Figure 19, The Taiwan-Anhui supply chain

The herbal medicinal supply chain for STPCL involves fewer outsider businesses than the traditional route (Fig. 20). This strategy helps to promote inter-participatory cohesion and helps keep the total costs to a minimum through exclusion of the market and wholesaler stages. Importantly, it allows for better defined and transparent traceability for the herbs used in the manufacture of HMPs. The flow diagram highlights how food manufacturers are placed within the supply chain.

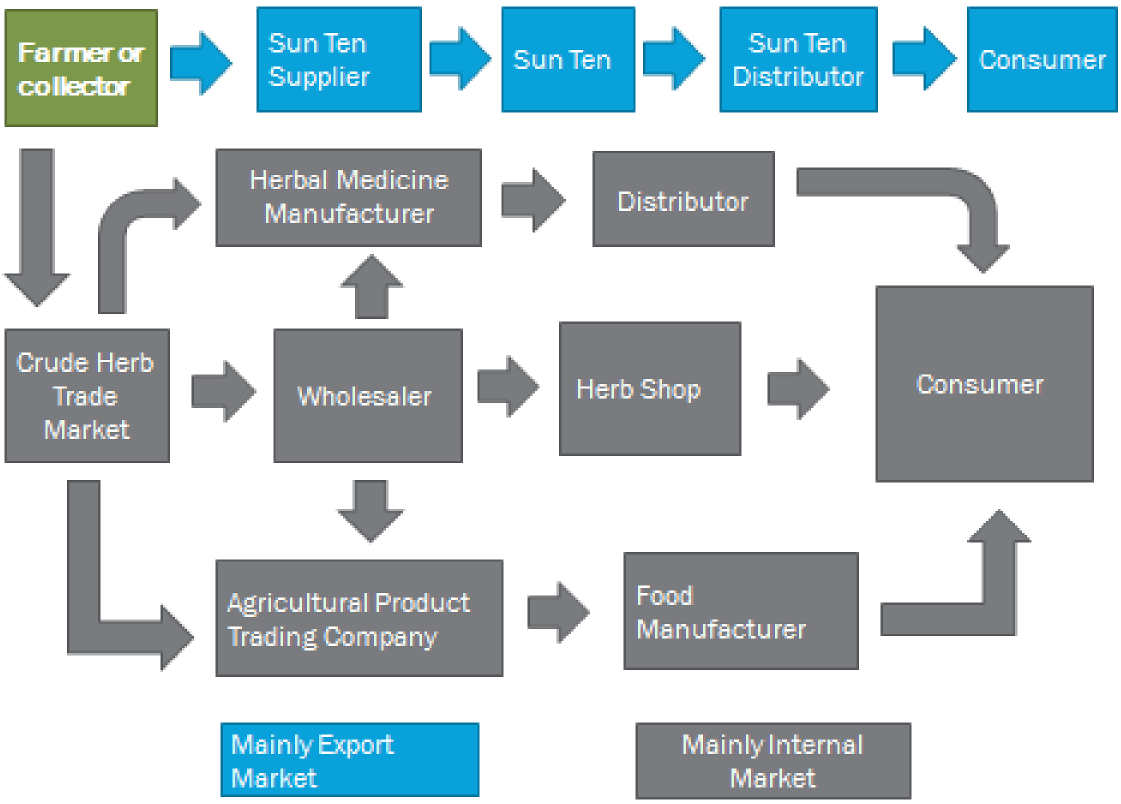

Figure 20, Different routes of supply to the consumer

Economic considerations

The price of a herb obtained from ATHSC is dependent on several factors:

1. The quality of the herb
2. The season and subsequent yield
3. Pre-processing requirements
4. Quality control costs
5. Increased demand (influence of viral epidemics / pandemics)
6. Competition from food companies (super foods)

Quality requirements are determined by STPCL, and the supplier will aim to source herbs that meet these requirements. ATHSC has some input on which fertilisers, pesticides and herbicides should not be used but it is the local government authority that normally advises on which products should be used preferentially.

The Brion Research Company, Taiwan (BRCT) has had some difficulty ascertaining the precise details regarding pesticide type and usage and this is an area that merits further investigation. Over the last five years, the price of crude herbs at the start of the supply chain has risen dramatically partly due to the emergence of sourcing companies who are contracted by food manufacturers. The quantities of herbs required are often very large compared to the medicinal herb market and it appears less likely that the buyers will require the producers to adhere to the detailed specifications that are mandatory for many medicinal plants.

Herb prices are also affected by market shocks. It is difficult to plan for many of the market shocks that have an effect on supply e.g. Influenza outbreaks, the transient popularity of ‘super foods’, droughts, tsunamis etc. These shocks can impact the market in variable ways. The so-called super foods easily go out of fashion and flu epidemics are unpredictable. Therefore, planning a cultivation strategy can be a risky business (Canada, 2012).

Some of these risks are unavoidable and the suppliers can develop strategies for minimising the impact of sudden changes in the market such as to source a wide range of herbs from several different areas. Some sourcing companies deliberately buy the same herb from different areas, when available, in order to protect supply when a poor season in one region of China produces poor yields.

It is probably the farmer who only cultivates one or two types of crop, who is most at risk from shocks and market fluctuations. Herb companies that have managed to establish direct relationships with the farmers or specialist sourcing companies are able to offer an added benefit in this arena as the sourcing company is committed to delivering a certain quantity of herbs to a required specification and so this allows the crude herb supplier to plan more effectively for future cultivation or gathering.

7.3 Fieldwork in India

Table 5, Coding for respondents and sites

Coding	Name and/or title	Site (Site coding)
BM	Biolab Manager	Phalada Agro, Bangalore, India (PA)
BH	Ben Heron, Operations manager	Pukka Herbs, Bristol, UK (PH)
CD	Company Director	Erode, Tamil Nadu Company (ETNC)
CMN	CMN Shastry, Managing Director	Phalada Agro, Bangalore, India (PA)
DMPF	Director of Medicinal plant farm	Medicinal plant farm (Dodabetta) (MPFD)
GK	Girindhar Kinhal	Indian Forest Service (IFS), Bhopal
HH	Himalaya Herbs	Trivandrum Ayurvedic Festival (TAF)
MD	Mr. Danesh, Farm Manager	Hosagunda Farm, Karnataka, India (KF)
PD	Professor Dhanabal	Tamil Nadu Farm, Tamil Nadu, India (TNF)
PLW	Professor Liz Williamson	Reading School of Pharmacy
PPM	Production manager	Phalada Agro, Bangalore, India (PA)
PRM	Retail Manager	Phalada Agro, Bangalore, India (PA)
RS	Rambir Singh University lecturer	University of Bundelkhand, Jhansi, India
SGP	SG Phytopharma	Trivandrum Ayurvedic Festival (TAF)
SK	Accounts Manager	Phalada Agro, Bangalore, India (PA)
SP	Sebastian Pole, Herbal Director	Pukka Herbs, Bristol, UK (PH)
TW	Tim Westwell, Managing Director	Pukka Herbs, Bristol, UK (PH)
VO	Vanya Orr Director	The Earth Trust

Case Study 1, The Traditional Chain (Tamil Nadu)

Case Study 2, The VIVC, Karnataka

Case Study 3, The Jhansi Chain

Introduction

The central theme of my fieldwork was to understand in detail how the participation in different value chains may impact on livelihoods and how the quality of starting materials and HMPs may vary in these chains. This enabled me to investigate and document the cultivation of medicinal plants, including turmeric, primary processing and storage procedures and (for some value chains) secondary processing of plants into finished HMPs. Undertaking this exercise enabled me to compare and contrast different value chains of turmeric and obtain a deep understanding of the processes involved that have an impact on livelihoods and product quality.

Through networking and by developing a range of contacts within the UK, with people who have interests in, or knowledge of the HMP industry in India, I was able to gain access to several study sites. It was important to compare a VIVC (case study 2) against a traditional chain (case study 1) these chains represent industrial scale operations that either produce HMPs for the domestic market or produce products for export. The third case history provides an example of smaller, non-industrial chains, providing fresh turmeric to the local market. The farmers interviewed in this chain provide an alternative scenario to the first two case histories, which describes a situation where farmers would like to add value to their products but lack the necessary inputs, skills and contacts that would be needed to make this possible and sustainable.

Professor Liz Williamson (PLW), School of Pharmacy, Reading, introduced me to a Professor in Udhagamandalam (PD) (see Table 5) who part-owned a turmeric farm. PD and his two brothers were able to provide a detailed account of how the supply chain was organised in Tamil Nadu. Moreover, they introduced me to other actors in the chain, including the manager of auction house, the owner of a storage facility and the managing director of a secondary manufacturing unit. The managing director of PH, (SP), provided a valuable source of information and facilitated introductions to key personnel in India. PH retains an employee in India (BH) who was able to arrange my visits to the VIVC farm and manufacturing site.

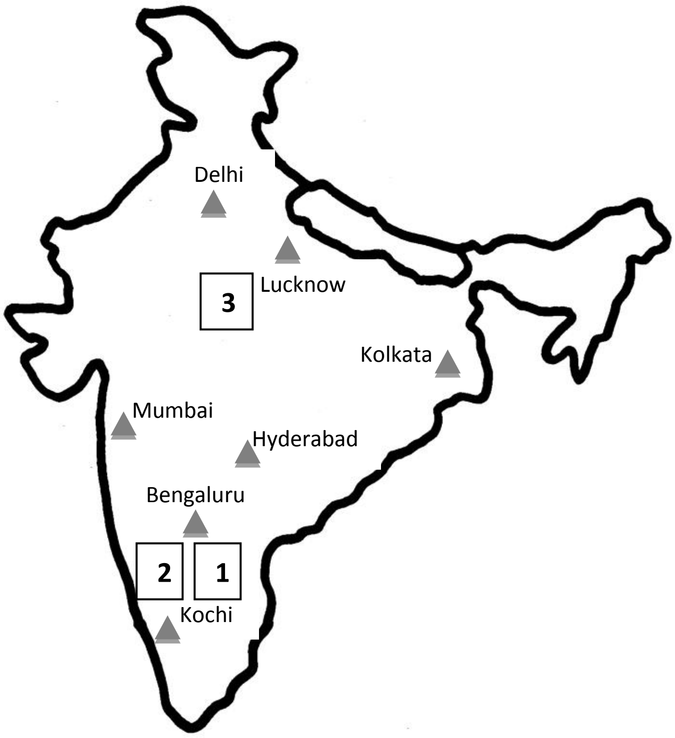

Figure 21, Location of fieldwork study sites

Key

1. Tamil Nadu site

2. Karnataka site

3. Jhansi site

Research was carried out on the Indian sites (Fig. 21) over a period of approximately four months during 2012. This generally entailed travelling to different sites by road, rail or by air and staying within farm dwellings or in accommodation in close proximity to the manufacturing sites. Whilst on the farms, I was able to spend time interviewing the farmers and / or farm managers. Although the farm workers spoke little, or often no English, I was able to get a general impression of their daily routine through observation, much of which I recorded through photographic images. Within the manufacturing units, the level of English spoken was much better than encountered on the farms and I was able to conduct interviews with many of the senior and middle management.

7.3.1 Case study 1: The Tamil Nadu Chain

Erode and the PD Farm, January 29th to January 31st 2012

Professor of Phytomedicine, (PD), grew up on the family farm where his two brothers still work and reside (see Fig. 22). PD's father died in 1996 and the brothers took over the running of the farm, which has been in the family for three generations. The farm is 12 hectares (30 acres) in size, each brother owning four hectares and the two resident brothers manage PD's plot.

Figure 22, The PD family at the Tamil Nadu farm

Each brother has his own house on the farm, which is comfortable and furnished, with modern appliances including TV, computer and broad band internet. Cows and chickens are kept on the farm for domestic purposes.

Most of the farms in the area tend to grow the same crops. These tend to be those crops that can be grown relatively quickly, that are relatively disease resistant and that have a potential for selling on. There is a sugar processing centre close to Erode which provides an avenue for the sale of sugar cane (see Fig. 23).

> "The main crops are sugar cane and turmeric. The sugar cane is harvested after 10 months and local labourers are employed to gather the crop.

Figure 23, Gathering the sugar cane (the leaves are removed before the cane is cut)

> Afterwards, the harvested crop is passed to a local sugar factory for processing. Sugar cane is the main crop in the area of Erode. This is due to it is being quite resilient and largely resistant to disease; it represents a low risk crop with good yields." (PD)

These are not the only crops grown and market forces determine which others are grown. There is a strategy for planting, chiefly based on which crops have done well the previous year.

> "Other crops that grow in this area are tapioca, coconut, rice, bananas, papaya, maize and okra. The dominant crops tend to reflect market prices - so if the price is good for one year, more of these are planned for the next." (PD)

However, this often has the effect of over supplying the market, resulting in a decrease in value. Some crops have a fast turnaround, e.g. okra is ready for harvest after three months, so that four harvests per year are possible. The farm itself does not engage directly in cultivation of medicinal plants (although the turmeric, cultivated primarily as a food crop, has the potential to be used in medicines further along the chain). The reason for the reluctance to cultivate medicinal plants is partly because of the brothers' view that the market is subject to many variations, and therefore the risks are too high.

They were not informed about any buy back or voucher schemes such as those implemented in the Karnataka state. PD had never heard about the possibility of taking out insurance for failed crops. The government in India pays little attention to helping farmers financially but there are some benefits available.

> "The involvement of the government is very low, but they provide free electricity for the irrigation of the fields." (PD)

The cultivation of turmeric on this farm requires different inputs at certain stages. Although the farm is not a vertically integrated farm, it is necessary for the farmers to make horizontal linkages with different actors. Theses linkages provide sales revenue and income for the goods and services providers.

"Turmeric can suffer from leaf rot and thin rhizomes, so different proprietary herbicides, fungicides and pesticides are used alongside fertilisers, including potash, urea and manure. After harvesting, the turmeric is boiled using a mobile steam generator (Fig. 24), which is hired from a third party. Manure is added to give a good colour. The boiling decreases the microbial load and helps to remove water from the roots and rhizomes. After the turmeric is boiled, it is dried in the sun for twenty days before it is polished (Fig. 25). The polishing gives the rhizome a more attractive colour and makes it more attractive to buyers." (PD) (Fig. 26)

Figure 24, A farm labourer boiling the turmeric root crop

The products that result from turmeric cultivation are the root tuber and the rhizome. Both of these parts are valued commercially although it is the finger-shaped rhizome that is mostly identified with as being authentic turmeric and it is this rhizome that is typically subjected to further processing.

> “Both the root and the rhizome are used and both can be re-planted but the root is more commonly used for seed stock. The rhizome is mainly ground to produce turmeric. The root tends to be used for paints and dyes but also for cosmetic purposes.” (PD)

Figure 25, A farm labourer processing turmeric

Farm labour is notoriously under-paid, with many farm workers throughout India living on or below the recognised poverty line. The introduction of mechanised horizontal inputs can significantly boost employment and the wages of labourers.

> "For the boiling process 45 rupees are charged to the farmer for each barrow load - of which, 30 rupees are shared between the five operators and 15 rupees are given to the equipment hirer. The total output is approximately two hundred barrow loads per day and so each operator earns approximately 1,200 rupees (US$20) per day during the season." (PD)
>
> A boiler of this type would be cost 2.5 lakhs (US$4,000). The polishing process also requires hired machinery. Approximately 80 bags, each weighing 90 to 100 kg, are polished every day. The farmer pays 100 rupees per bag – of which 60 rupees goes to the farm labourers and 40 rupees to the owner of the equipment. Therefore the processors earn 4,800 rupees (US$80) or 1,000 rupees each (US$16) per day.

Figure 26, Farm labourers polishing turmeric rhizomes

The usual local wage for farm labourers is 200 to 300 rupees (US$3-5) per day (depending on the season) and 100 to 150 rupees (US$1-3) per day for women workers.

In 2010, the auction price of turmeric reached up to 18,000 rupees per quintal (100 kg), but in 2011, it fell to 4,000 rupees per quintal. At this price it is difficult for farmers to realise any profit and so they may choose to store the crop until the market price rises. The brothers would not consider cultivating medicinal plants at the current time but would consider distributing un-polished turmeric to a herbal medicine manufacturer, if requested.

Most of PDs relatives, who still live in the area, are farmers. I visited some cousins who also grow sugar cane, turmeric and other crops but also have diversified with a clothing manufacturing unit on the farm site.

They buy cotton from Gujarat and use this to produce shirts and other garments, which they sell all over India. One of the cousins works in Hyderabad in information technology (IT).

PD also has a friend who was originally a pharmacist – but is now a full time farmer. He grows sugar cane, turmeric, coconuts and well as organic bananas. He doesn't grow organic turmeric, and explained,

> "That would not be profitable, because the yields are too low. I would like to produce for export, because at the moment the domestic price for turmeric is so low that the costs for production are disproportional to the profit. Even on the contrary, they would exceed this."

Moreover, he described the problematic situation regarding the middlemen, who are auctioneers and storers' of turmeric, as well as the attitude of the government:

> "On the one hand there are the middlemen, who take the whole profit and on the other hand the government, which do nothing to stabilise the price.
>
> There is some potential to distribute directly to medicinal plant companies but they are currently over supplied."

At the government regulated market (Fig. 27), each farmer sells about 2,000 bags of turmeric per day, for about 4,000 rupees per bag, depending on quality. The auction market takes two per cent of the sale price as commission.

Samples are displayed for buyers, prior to the auction, for organoleptic inspection and subsequently they will bid for each lot.

> "But as a buyer you are aware of which farm the lot comes from but have no knowledge about how it was grown." (PD)

Figure 27, The state regulated auction house in Erode, Tamil Nadu

Farmers, who do not want to sell immediately, send their harvest to a storage unit. The storage unit is leased for two lakhs (US$3,200) per annum and an additional 15,000 rupees per month (US$240) are paid to the landlord owner of the property.

In Erode there are about 350 storage facilities of this type.

The turmeric can be stored in this type of facility for up to five years (Booker, 2012, fieldwork interviews). When the crop is sold, the storage unit receives two per cent of the sale price as commission.

The turmeric is stored in jute sacks (Fig. 28) and there is evidence of weevil infestation and fungal moulds and so there are some risks involved in storing crops in this kind of facility particularly as the owner accepts no responsibility for any spoilage.

Figure 28, Turmeric stored in jute sacks and treated with pesticides to minimise infestation and microbial growth.

I visited the largest manufacturer of herbal medicinal products in Erode, Tamil Nadu (ETNC) and I interviewed the company director (CD). The parent company is well established in the cattle, poultry feed and dairy sectors. There is a powdered egg facility, producing 15 lakhs (1.5 million) eggs daily that are exported to Europe. This company is not connected to Case study 1, but is an example of a company involved in a traditional chain. The company preferred to remain anonymous.

ETNC produces HMPs and retains 250 employees. It produces Ayurvedic, Siddha and Unani medicines – medicated oils, liquid formulations as well as tablets, capsules and *bhasmas*[12] (Fig. 29). All products are produced from raw herbs and powders. This manufacturing unit does not produce plant extracts.

Figure 29, Ayurvedic medicine manufacture

> "80 per cent of the raw materials are wild-collected, another 20 per cent is cultivated, of which ten per cent is organic but not certified." (CD)

[12] Bhasmas are Ayurvedic medicinal products that contain a calcined mixture of plants, gems and metals (some of which are known to be toxic).

The company produces, what the director describes as ‘classical generic formulations’, which make up 80 per cent of products and branded proprietary medicines 20 per cent.

> “The focus is on producing old formulations with modern quality assurance. The company also has a clinical side and owns an Ayurvedic / Siddha hospital in Erode dealing with both out-patients and in-patients. It has one hundred patients being treated exclusively with traditional medicines including *bhasmas.”* (CD)

The company tests for liver toxicity and, according to the director,

> “There have been no reported cases of abnormal liver enzymes.” (CD)

The company was started as a charity using 15 crore rupees (US$2.4 million) funds from the parent (farming) business and 5 years ago the turnover was three crore rupees (US$490,000). Now it is breaking even with a turnover of 13 crore rupees (US$2.1 million) and has its main sales area in South India in the states of Tamil Nadu, Karnataka and Kerala.

There is currently no export of HMPs because it was difficult for the company to find an organised supply chain that would satisfy the needs of exportation. It would need the same kind of traceability as they have for their egg powder production.

At the moment the plants are bought from traders who supply 250 different herbs. Samples are identified and approved for quality using the services of the company’s in-house QA and pharmacognosy laboratories. Incoming raw material is cleaned to remove foreign matter and then placed into drums. It is more problematic for external testing as the director states that:

> “There is no transparency within the industry and testing for heavy metals, pesticides etc., can be very expensive, and so these tests are not carried out routinely.” (CD)

7.3.2 Case study 2: The vertically integrated value chain

January 19th to January 25th 2012 and October 9th to October 14th 2012

This case study represents the VIVC that is operated between a farm in the state of Karnataka, India (KF), a primary manufacturing company in Bangalore, India (PA) and a retail company in the UK who undertakes the secondary manufacture of HMPs (PH).

My main interviewee on the farm was MD who was able to provide me with more detailed information on employment structures, procedures and practices and how the farm linked in to other actors within the value chain.

a) The Farm (KF)

KF is a 12 hectare farm, set in 180 hectares of forest that is managed by the Sri Umamaheshwara Trust.[13] The farm is owned by CMN and is managed on a day to day basis by MD, the farm workers vary in number depending on the season.

The farm workers

Farm work is the biggest area of employment for the state of Karnataka. The work force comprises both residents of the state and migrant workers from other nearby states. The 2001 census accounts for about 56 per cent of employment as farmers and agricultural labourers (HDR, 2005).

On 20th January 2012, there were about ten farm workers on the KF site, five women were involved in weeding the gotu cola (*Centella asiatica* (L.) Urb. Apiaceae) field (Fig. 30) and three male workers were involved in harvesting and processing of *Areca catechu L*. Arecaceae (Fig. 31). Other workers divided their time between weeding, harvesting, sorting, cleaning and drying although only the male workers were involved with the harvesting of the areca catechu (which often requires the ability to climb trees) and its processing, where it is cooked in a pot for several hours.

[13] 12 hectares is large by Indian standards where an average farm is normally less than 0.4 hectare.

Figure 30, Workers at KF weeding the Gotu Kola field

*Figure 31, A farm worker undertaking processing of betel nut (*Areca catechu L*. Arecaceae)*

The farm labourers begin work at eight o' clock in the morning and work through until lunch. They are managed on a day to day basis by MD, the farm manager. MD lives and works on the farm and it is his full time occupation. He is currently single, but plans to get married later in 2012 and hopes that his wife will come to stay with him on the farm.

The other farm workers either live on the farm or in close proximity (up to 1km away) and also work on other farms as demand dictates. The farm register recorded between six and fourteen farm workers attending the farm each day. The length of time that workers had been on the farm varied and some were relatively new to the farm, other workers, however, have been employed on the farm for many years and have children who also work on the farm.

> "They either stay for a half day or full day, depending on what work is required, and are paid on a daily rate. I haves no plans to move away from the farm and when I get married later this year, my wife will come to live with me on the farm. The longest serving employee has been on the farm for 15 years and has a son and daughter who also work on the farm.
>
> I have been on the site for six years and two of the male workers have been on the site between six and eight years." (MD).

MD, the farm manager appeared well and healthy. His attire was clean and smart. He has a number of material possessions that could be interpreted as wealth indicators. There are other farm workers who also have been able to save some of their wages in order to accumulate some possessions.

> "I have a mobile phone, a motorbike and a car. One of the young farm labourers has a second hand motor bike and another labourer also has a motorbike" (MD)

The farm work is varied and cultivating crops organically can be more labour intensive than conventional farming. The work carried out on the farm is divided up between male and female labourers. The men and women at KF are usually segregated in the workplace. This practice is typical throughout India for many types of employment, although I observed that the army and police force were noteworthy exceptions. At KF it appeared that the men and women had quite well-defined roles and this was confirmed by MD.

Most of the farm labourers work permanently on the farm. Occasionally, short-term contractors are employed during periods of high productivity.

There is some variation between how males and females will find employment, with men tending to travel further to find work. Sometimes, when there are particularly busy periods, extra labour is recruited off-site, e.g. the Areca crop, which is a particularly labour intensive, is loaded onto a lorry and taken to the nearby village where women sit and take off the husks (Fig. 32).

This work is physically demanding as the husks are tough and must be cut with a metal implement before shelling can take place. The women work under a shaded area outside of a large house. They sit and chat to each other while working, which helps to pass the time.

> "The women and the men share the work but the type of work that they do is often different, the men do more climbing and heavy work and also take care of the animals (cows and buffalo).
>
> When the seasonal work comes to an end, the women will find other agricultural work in the local area. The men may travel further afield to find work. When the Areca is harvested, extra processing is required off-site. This mainly involves the shelling of the raw fruit. It is then returned to the farm for processing." (MD)

Figure 32, Women from a nearby village help to process the Areca crop

The cook and her husband work on the farm and they have one son. When he finishes school, around four o' clock, he comes to the farm to meet his parents. He speaks little English. The husband is a habitual betel nut user and the son likes to eat raw sugar cane and fresh coconut. The ten year old boy helps out with the farm work on occasion.

> "Both the cook and her husband work on the farm. They have one child, ten years old, who is in school. They live about one kilometre from the farm but often stay on the farm during harvest time." (MD)

By the time of my second visit the cook and her family had moved to the city. MD explained that the husband had found better paid employment. The cooking responsibilities were taken over by the wife of one of the Brahmin priests (SK). As well as taking care of feeding the priests, and some of the farm workers, she also manages the farm accounts.

At the time of the interview (October, 2012) SK had one, three year old daughter, who was about to start school. SK lives with her husband in a house next to the main farmhouse. SK has knowledge of some medicinal plants and their uses. This knowledge had been orally handed down to her through a family relative, her aunt, and is based on the Ayurvedic system. She uses this knowledge to treat herself and her family when they are unwell.

> "My husband used to live in the farmhouse with another three priests but when we were married, a new house was built for us.
>
> I gained my knowledge of Ayurvedic medicine from an auntie who was an expert in their use. I use various plants from the forest for medicine. I mainly use the Ayurvedic medicines to treat my daughter when she is unwell." (SK)

Infrastructure, wages and working conditions

The buildings are mainly brick built and sturdy looking in their construction. The accommodation is basic but clean and practical. My own accommodation, which was located about fifty metres from the main farmhouse, consisted of a large room with a bathroom attached, there was another room of a similar size next door occupied by some Italian volunteers. The accommodation is used regularly by volunteer workers, mainly from Europe, who typically stay on the farm for a few months. They can choose to do farm work or to help with a temple restoration project that is taking place in the forest. In return they receive meals for the day and a place to sleep.

For all of the domiciliary buildings, there is hot water provided by log (or coconut) burners located on the outside of the building. The electricity comes from the mains supply but can be disrupted by power cuts and so a generator is kept on site as a back-up. The ovens and hobs that are used for cooking are powered by gas. This is either bought in pre-filled cylinders, or is obtained as a by-product from the cows.

In keeping with Hindu belief, all of the three meals served per day are vegetarian. There is a strong connection between the farm and the nearby Hindu temple, of which CMN (the Managing Director of PA), is a benefactor. The local Brahmin priests regularly come to the farm to eat at the communal meal times. On other days, particularly at the time of religious festivals, meals are provided at the temple, and the farm workers will join the priests and other members of the local community at these gatherings.

The majority of workers are paid by MD on a daily basis and he receives his wages monthly. It is a long working week with few holidays. The men earn 150 rupees (US$2.4) per day and the women 100 rupees (US$1.6) per day. This is lower than the usual local rate of 250 rupees for men and one 150 for women but the farm workers at KF are hired under contract, which is atypical for farm labourers in India who would normally move from farm to farm as the work dictates. At KF, the workers are employed on a yearly basis for six days per week and so although the daily wages are lower, they have a guaranteed yearly income, without having to travel. The farm (and the factory further along the chain) benefit from this arrangement through having workers who are trained in GAP and have knowledge of crop cultivation that has been built up over a period of time.

> "If the workers stay until the afternoon, they eat in the farmhouse, otherwise they eat at home.
>
> The farm workers work six days per week and have four unpaid days per month off plus festivals.

The men earn 150 rupees (US$2.5) per day and the women 100 rupees (US$1.6) per day. My wages are 7,500 rupees (US$120) per month. I manage the farm workers and also help out with the harvesting. During the Areca harvest time, two weeks in January, I sleep outside with the crop as there have been cases where the crop has been stolen during the night." (MD)

"The farm workers on the estate are contracted for the entire year and paid for six days per week. Typically for the area farm work is seasonal and workers are only paid for days they have worked harvesting, spraying or planting. Organic and bio-dynamic farming, particularly in the forest setting needs constant attention and management and so there is always work to be done throughout the year." (SK)

The farm is contracted to supply medicinal plants and spices to one company in Bangalore who in return offer some services to the farm.[14]

"PA buys all the medicinal plants. They provide seeds and seedlings, training in cultivation, advice on good agricultural practice (GAP), good collection practice (GCP), and best use of organic inputs." (MD)

The farm has a computer where all accounts and records are kept, a 24 inch colour TV and digital box and internet access through Wi-Fi.

The crops

It is common for farms in India to produce more than one crop. This multi-cropping helps to ensure that there is employment for much of the year and also helps to protect against the impact that climatic shocks or diseases may have on individual crops. Moreover by having a selection of differing crops, it helps to even out fluctuations in market prices.

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[14] The owner of the farm CMN, is also the owner and managing director of the company in Bangalore.

“As well as Areca and medicinal herbs the farm grows food crops. Chili, all spice, cinnamon, nutmeg, pepper, bananas, coconut and ginger, which are sold at local markets, small mangoes are grown on the farm to make pickle and also to sell at the market. The main farm crop is *Areca catechu*, then rice, coconut, spices, medicinal herbs. All of the rice is consumed on the farm. The Areca, coconut, bananas and pepper are all sold at markets in Sagar.” (MD) (Figs. 33 and 34)

Figure 33, Pepper vines are grown amongst the Areca forest

Figure 34, Bananas are grown on the farm and sold in a nearby town

In keeping with the organic and sustainable ethos that CMN encourages, there is much interest in finding ways to grow crops under the Areca forest canopy. Crops that are cultivated in this way are termed ‘woods-cultivated’ or ‘wild-simulated’ and can often be sold at a higher premium than other cultivated products. In this way it is seen as a form of value addition within the chain. These methods of semi-wild cultivation that can lead to value-addition of the product were highlighted in the literature review in relation to ginseng cultivation in North America.

Some of these experiments are still at an early stage and not all of the seeds planted are expected to survive. Some of the experiments are more successful than others. One experiment with haritaki (*Terminalia chebula* Retz., Combretaceae), which took place in 2010, did not yield as many plants as hoped.

> “Some crops, such as haritaki, may take up to five years to harvest, whereas turmeric is ready in nine months. 20,000 haritaki plants have been seeded in the woods. The haritaki planting had mixed success with many seeds not producing plants.” (MD)

In another experiment with *Centella asiatica (gotu kola),* shading is used with palm leaves to try and force it to grow quicker (Fig. 35). The shaded crops appeared to be growing better than the un-shaded.

Figure 35, An experiment using shading techniques to promote plant growth

After harvesting the crops are cleaned by hand, washed using a tiered system and then drained and dried. Initially in a drying room, before being laid out in the sun for further drying (Fig. 36). The turmeric rhizomes will be sent for further processing but the root tuber is mainly replanted for next season's crop.

The chosen plant of interest, *Curcuma longa* (Turmeric) is a major crop grown on the farm. It is also cultivated on neighbouring farms that are contracted to the VIVC. It is dried, as is typical for root crops, by being laid out in the sun (see fig 36).

Figure 36, Turmeric after harvesting and being laid out in the sun

Or sometimes, in the case of Areca, the drying takes place on the roof (Fig. 37).

It is then processed on the farm before being shipped to the next actor in the chain.

Figure 37, Areca catechu drying on the farm house roof

> "Areca is pre-processed using a boiling method and dried in the drying huts before sending to the main processing unit in Bangalore." (MD) (Fig. 38)

Figure 38, *Processing Areca catechu*

On the 21st January 2012, I observed harvesting of the *Bacopa monnieri* (L.) Wettst. Plantaginaceae (*jala brahmi*). The harvest was undertaken by the women workers; six local Indian women and one Italian volunteer. The process consists of harvesting the plants by cutting them close to the ground, removing foreign matter, sequential washing, draining and drying. The process steps are recorded on a GAP tag that is attached to the batch (Fig. 39).

According to the batch record, this crop of jala brahmi was planted on 21/8/2010 and harvested on 21/1/2012. The harvest takes place over several days and the women often spend the whole day in the sun and heat in order to reach their target yield.

> “The seven women harvest 25 kg of wet plants per day.” (MD)

Figure 39, Different stages of crop processing; collecting, sorting, sequential washing, drying and batch record attachment.

Livestock

On the farm, as in much of India, cows are regarded as an essential possession. Particularly on an organic farm, where chemical fertilisers are prohibited, cow manure becomes an essential requirement for healthy plant growth.

There were six cows and two buffalo kept on KF. These were used both to provide essential food items used in daily meals, for agricultural use and as a source of energy.

> “The cows provide milk and curds and the cow manure is collected for fertiliser, it is mixed with water before irrigating the fields, and to make (methane) gas for cooking.” (MD)

Organic farming

Figure 40, Organic farm certification for KF

The farm has been certified organic since 2004 (Fig. 40).

Waste vegetable matter is composted and leaves are collected to produce leaf mulch fertiliser.

Many crops are planted in the forest in a random fashion, the crops in the fields are manually weeded and those that grow in water do not require weeding. Organic farming encourages natural pest management and a resident wild bird population helps to keep the insects down as well as providing another source of fertiliser (Fig. 41)

> "All of the farms are certified by an International certification body similar to the soil association in the UK. There is a nursery where organic plants are propagated. These are given to the farmers for growing on and then the crop is bought from the farmer after harvesting." (CMN)

> "There are no chemical pesticides or herbicides used on the farm." (MD)

Figure 41, Fields are weeded by hand and birds help to fertilise the land and reduce the insect population

b) The primary manufacturing site (PA)

PA began trading in 1999 and in January 2012 employed 150 people.

> "We are currently making a modest profit but not enough to provide a margin of safety in a fairly high risk area. However, the company continues to grow by 20 to 30 per cent each year."

The factory workers

The pay for factory workers is similar to that of farm workers (Fig. 42) although factory work is generally preferred as the working conditions within the factory are considered better than on a farm where temperatures can get very hot or it is very wet during the monsoon season. Moreover, within the factory hierarchy there are more positions of middle and senior management that attract a higher salary.

Figure 42, Factory staff at PA, sorting dried herbs

> "The staff at PA normally work a six day week, however, they can work seven days if they choose to. The work consists of sorting, cleaning, processing and packaging depending on customer requirements." (CMN)

> "The workforce at PA, work a six day week (48 hours). The employees receive free healthcare, a company pension and free education for their children. Salaries range from 6,000 rupees (US$95) per month for a junior clerk to 16,000 rupees (US$255) per month for a manager." (PPM)

The products

The company produces a range of products, all connected with the sustainable cultivation of organic herbs and spices. Apart from the medicinal herbs the company also produces a range of organic culinary herbs and spices (Fig. 43).

Almost all of the spices and medicinal herbs are exported but since 2010 the company has been experimenting with a spice range for the growing domestic market.

“Medicinal herbs are produce exclusively for PH.

Culinary herbs and spices are sourced locally but also farther afield e.g. saffron from Kashmir, mint, fennel, holy basil and mustard from Uttar Pradesh.” (CMN)

Figure 43, Organic food products packed at PA

Another important product for the company is organic compost. This is a mycorrhizal compost that is suitable for use with organic farming.

Fertilisers are a major cost for farmers and most farmers produce their own through the use of decayed vegetable matter and through animal manures.

“There are 2 sites for this, one in Shimoga, Karnataka and another in Mumbai. These two sites produce 3,000 to 4,000 tonnes of compost per annum. Some of it is destined for PAs own contracted farmers if they cannot make enough of their own but the majority is sold to the big organic farms throughout India.” (CMN).

“Farmers are not obliged to buy pesticides / fertilisers from PA and the majority (80 to 90 per cent) choose to manufacture their own.” (PPM)

Figure 44, Production of mycorrhizal fertiliser

There are also a range of (bio) - fertilisers, pesticides, fungicides and herbicides produced. These are also essential for the healthy growth of organic plants. Some can be made by the farmer but many of these products require complex bio-engineering with much of the initial development being undertaken by the Indian government.

> "Bacterial bio-fertilisers are able to symbiotically fix nitrogen in the soil. A phosphorous solubilising bacterium allows more readily uptake of phosphorus by the plants. *Pseudomonas sp*. is used to control disease. *Aspergillus sp*. aids in compost manufacture. The mother tinctures are developed by the agriculture department of the Indian government which PA purchase and then grow in the lab." (BM)

Figure 45, Laboratory production of bio-(fertilisers, pesticides and fungicides)

Turmeric

Turmeric is one of PAs top selling products and is produced on several contracted farms, including HF.

> "Turmeric ranks within the top five of products produced by PA. We export 60 tonnes of turmeric, of which about three tonnes goes to PH. The remainder goes to another UK company (OHC organics), the USA, Germany and Austria. The usual variety grown is Roma with an average curcumin content of 2.7 per cent (as determined by PA).

The company is keen to exploit new markets and has been investigating the potential of using different varieties of turmeric.

> We are now experimenting with a north-eastern variety, Kandama, which has high oil content. The domestic market is still relatively low with about 0.5 tonnes being distributed." (PPM)

Perhaps surprisingly, the more profitable business, in terms of margins, is the domestic one. This is mainly due to the extra costs involved in meeting the standards required, (a problem highlighted in the literature review). However, in this case, the export market remains most profitable in total because of the high turnover.

> "Although the domestic share is relatively low, the returns to PA are slightly higher than with the export business (Figs. 46 and 47). This is because even though PA receives a better price from the export buyer, there are additional costs to the company that reduce the net profit. These extra costs are mainly export duty and the additional testing that is required to ensure conformity to EU regulations and customer specifications. However, the majority of business lies with the export market." (CMN)

The costs of producing turmeric in this VIVC are relatively low when compared to the traditional method. One reason for this is that less processing is needed at the beginning stages (i.e. the boiling and polishing steps) as the appearance of the rhizomes, while being a major indicator of value for product sold at auction, becomes less important within a VIVC where an encapsulated or tableted HMP is the end result.

> "It costs 20 rupees per kg to cultivate turmeric, this includes labour costs. This is probably lower than at other farms as all the primary processing (boiling only) is undertaken at the Bangalore site." (MD)

However, some additional costs become apparent when trying to sell a niche product within the domestic market.

> "The organic market is very small compared to the regular market and consequently retailers want to make a higher return and so demand a higher percentage of the retail price. In the medicinal plant sector, organic is in even less demand although some of the more progressive companies are beginning to consider organics in response to changing consumer demand." (PRM)

There are also some other reasons why Ayurvedic medicinal preparations are less popular in the domestic market.

> "The majority of business for Ayurvedic products lies in the export market with only 10 to 15 per cent remaining domestic. Rural people with some knowledge of medicinal plants are unlikely to buy Ayurvedic preparations. This is partly due to the cost but also many of these plants are available in the wild. Home cultivation may also be employed, especially for food plants with medicinal qualities. In urban areas the situation is different. There is little knowledge amongst the general population concerning traditional medical uses of plants. Because of busy lifestyles, Western pharmaceuticals have become popular as they tend to act more rapidly and do not generally require that the individual modifies their lifestyle or dietary intake. Very little knowledge of Ayurveda has been passed down through the generations and my friends or I do not have a good knowledge of Ayurveda. In general, conventionally trained doctors enjoy a higher status than the Veydas who can be looked on with some suspicion." (PRM)

However, this picture is not a static one and there seems to have been some changes over the previous ten years and the impetus of this change may have come from the use of these medicines in more economically developed countries. This is coupled with a more relaxed regulatory system in India that allows for a wider interpretation of evidence of the effectiveness of HMPs.

> "Through mainly advertising and marketing campaigns, more people are becoming aware of the health benefits of certain plants. There is a view that if these plants are being used by people in Western countries then there must be some truth in the claims made for their effectiveness. Consequently there is an increasing trend for manufacturers to add these plants to food products and health drinks, including teas. The health claims that are permissible in India are more generous than what would be allowable in the EU." (PRM)

The contract with the farmer

HF has been contracted to PA for over ten years and it is necessary to build up these longer term relationships in order to build trust along the length of the value chain. One way of developing this trust is by ensuring good governance in financial obligations. However, particularly with newly contracted companies, break-downs in supply chain governance can occur. Because of this PA has had to find ways of ensuring adequate stocks are maintained.

But for the farmers who remain loyal over time there are financial rewards. Incentives are offered to the farmers in the form of price premiums. These premiums are paid in recognition of the extra work it takes to be able to farm organically and using GAP.

> “Relationships are built up with farmers over time. PA is now in a position where it can settle accounts immediately which is a good incentive for farmers to remain loyal.” (PPM)

> “One of the main problems is when the farmer sells to another company who urgently needs the crop or sells it on the open market when the price runs high.” (PRM)

> “We try to ensure that we have the crop in the warehouse before finalising the customer contract (Before final payment is made)” (PPM)

> “The farmer receives a 10 to 40 per cent premium for spices, foods and medicinal plants above the market price depending on the complexity of cultivation and the GAP processes that need to be used e.g. ginger 30 to 40 per cent, turmeric 10 per cent, coffee 10 per cent, pepper 20 per cent, white pepper 30 per cent. The premium is adjusted depending on the conventional market price”. (CMN)

Costs

Pesticide testing is one of the biggest expenses particularly as customers demand that testing take place in EU certified labs. Historically it was found that Indian and EU labs would often give different results for the same batch of product.

A bigger problem than pesticides are heavy metals and microbial contamination. As the herbs come from different farmers, often supplying 5 to 10 kg of dried herb each, which is then blended. All it takes is for one farm to have a high microbial count and it can affect the whole batch. One solution would be to test each supplier but this would be costly. If a batch fails the microbiological test, it is steam or dry sterilised, either at the Bangalore plant or at a plant located in Turkey, which is equipped to deal with larger volumes. This isn't ideal as it is costly and may change some of the herb's characteristics

The lead firm

In any VIVC there is usually one lead firm who has the ability to govern the chain. Whether this actor is placed at the beginning, middle or end of the chain is often variable and depends on complex and multi-factorial inputs, including the type of commodity supplied, where it is produced and where it is destined. In the VIVC examined it appears that the distribution and retail company (PH) may be the lead firm. This relationship between PA and PH requires that a good line of communication is implemented and maintained between the two sites. This can be in the form of electronic means but face to face meetings are considered as being of vital importance.

However, although PH may be the lead firm, a different firm may be responsible for governance of the actors at the beginning stages of the chain and so in turn PA has the power in the relationship with the farmer. This situation has to be managed carefully as taking too much of a lead role can lead to problems if things go wrong.

> "PH has the power in chain by perhaps 60:40, they dictate which crops are grown and what amount. This is similar for the domestic market where the retailer has the power. We advise on which crop should be grown and the amount. However we are now careful not to dictate how the crops are grown or insist the farmer uses our products as this can lead to recriminations if the crop does poorly. We will offer advice but stipulate that the integrity of the crop is the farmer's responsibility." (PPM)

> "PH visits two or three times per year, either for business discussions or to carry out a customer audit." (CMN)

c) The distribution and retail site (PH)

PH is the largest supplier of Ayurvedic herbs in the UK. It was founded in 2001 by SP, an Ayurvedic practitioner, and TW. In the first year, turnover was £45,000 and by 2005 it was £650,000 (Bristow, 2006). In 2011 the company's turnover reached approximately £7 million, generating profits of £150,000 (Check-Business, 2014) and by 2013 turnover reached £10 million (Bradley, 2012).

It operates with 50 staff it has a range of products that include traditional Ayurvedic medicines, a range of 24 teas and a distribution network across Europe and beyond.

Herbs and spices are obtained from 27 different countries. Most come from India where the company works directly with 500 farmers and every year, 100 tonnes of herbs pass through the warehouse (Bristol, 2009).

The company maintains that working at this grass roots level helps ensure that the farmers get the best price for the goods that they grow. All finished product manufacture is undertaken in the UK at a registered facility with a Manufacturer's Licence (S.A., 2013).

> "The herbs are sourced directly from the farming co-operatives that PH has helped to set up in India and Sri Lanka. This helps to ensure that the farmers are paid a fair wage. By employing a strategy of fairer pay to the lower end of the value chain, the company seeks to ensure that the workers are committed from the earliest stage to producing a quality product." (SP)

PH works with farmers living across the varied climates who are required to cultivate the different medicinal plants from the Ayurvedic pharmacopoeia. These include the humid tropics of Sri Lanka and South India, the dry plains of Madhya Pradesh and Gujarat and they are working with cultivation projects in the Himalayas to grow some of the rarer species (Jatamansi – *Nardostachys jatamansi* and Kutki - *Picrorhiza kurroa*). PH has been able to successfully cultivate and market *Picrorhiza kurroa* with the correct CITES certification. With respect to the VIVC, the lead company verified that it has been working with the other actors in the chain for some time.

Any differences of opinion between PH and PA appear to centre on different interpretations of what constitutes 'a good quality product and what constitutes 'GMP."

The manner, by which some of these issues have been managed, where PH has insisted on their quality requirements being met, adds weight to the view that PH is the lead company in this VIVC.

In this case study, tangible benefits for the primary producers have been realised through the chain management being delivered by the lead company (e.g. regular orders, timely payments and access to an international market).

This arrangement, where both actors in the chain benefit, provides another reason why the relationship is still intact after ten years and both companies continue to grow and prosper.

> “The product is exported to the USA where there is demand from practitioners, who are far greater in number than in Europe, but also the regulatory framework is pliable enough to allow its distribution as an OTC product.
>
> PH has been working with PA for ten years and has built up a good working relationship, although it hasn’t always been easy and there have been some differences of opinion regarding correct working practices.
>
> It has been a challenge to persuade PA to adopt good manufacturing practices that comply with EU requirements, but notwithstanding, these changes were implemented and once the Indian company experienced tangible benefits of being linked into an integrated value chain, it was more amenable to change.
>
> “The benefits are seen in terms of regular orders, high quantity orders, and stable prices. PH visits PA approximately four times per year to perform a customer audit and additionally to train staff on current EU requirements, GAP and GMP. “(SP)

7.3.3 Case study 3: The Jhansi Chain

November 5th to November 7th 2012

I visited two farms in the north of India. One of these farms represents the smallest commercial operation with fewer attached inputs than the other case studies. The second farm visited in Jhansi did not produce turmeric but it was useful to look at this site for comparison.

The first farm was less than 0.5 hectare in size and produced peanuts *(Arachis hypogaea)* and turmeric. The second was an interesting contrast as it was a very large farm by Indian standards of around 120 hectares and cultivated chiefly European herbs for use in the pharmaceutical and cosmetic industries. The farmers on these sites spoke little English and so I used the services of a translator from a local University.

Farm 1: The farmer and his family cultivate turmeric to sell in the local market. It is not boiled, polished or even dried but sold directly to market traders after harvesting. The farmers sell the crop to middlemen for 25 rupees per kg, which is less than either of the other case studies. This is the same price as you would find turmeric selling for in the local street market.

Turmeric was not the main crop, in 2012 but this was *Arachis hypogaea* (peanut). Turmeric is always grown as a 'standby' crop, in case of a sudden rise in its market value, as was seen in previous years. Using this strategy, the farmers have some turmeric ready to sell and have enough seed stock in the form of the root tubers for replanting when necessary.

A fairly small area of approximately 200 square metres can produce a yield of two tonnes of turmeric rhizomes. This high yield is due to the loose sandy soil of the area, which is ideal for growing root crops.

The farmers adhere to a planting strategy that is directed by local brokers (middlemen). These brokers advise the farmers on which crop to plant and how much, based on their market predictions.

The majority of the farm work is undertaken by family members and so there are no additional labour overheads.

The farmers expressed interest in processing crops to increase their value but had little idea on how they would go about this. There was no auction house in the area.

Farm 2: Approximately 120 hectares in size, the main crop grown was *Mentha piperita* L. (peppermint) which was sold to a local distillation company for the production of menthol. The farmers were unsure exactly what the menthol was used for but thought it was purchased mainly by the pharmaceutical and cosmetic industries.

The farm employed 35 permanent staff who are paid 150 rupees per day

7.3.4 Secondary sites

Although the farmers and primary producers were the main focus for the research interviews and observations; I additionally visited peripheral organisations and individuals in order to ensure a wide as possible representation of the research issues.

Earth Trust – 1st February 2012

VO has been working in India with The Earth Trust for the last twenty years and is currently project director. She is 78 years old and lives in Udhagamandalam, Tamil Nadu. The trust works with indigenous communities (scheduled tribes) and their strategy is focused on growing nutritious food crops and medicinal plants that can be used by these minority groups for maintenance of health and treatment of disease.

The trust currently has three nurseries between 0.4 and 1.5 hectares in size. It has developed sustainable models for managing slopes, seed collection and organic production. The tribal people are using the medicinal plants for their own medical use and several plants have unique properties for curing specific illnesses. Surplus plants are generally given away to women for planting in their home gardens. All of the participants in the scheme originate from the local area.

> "The operation is quite low-key, however, the models we have developed could potentially be replicated anywhere and so there is real potential for expansion." (VO)

The trust operates a twelve module training programme in health studies which includes the use of traditional knowledge and medicinal plants. All of the people taking part in the scheme are women and adolescent girls.

> "The men are less interested as there is little monetary gain to be had." (VO)

Twelve village health workers, with responsibility for over 50 villages, were given two year training in primary healthcare which included both western medical sciences and a respect for traditional beliefs.

> "Two years ago we helped them (the health workers) set up their own small enterprise group. They call themselves 'The Thulasi Group' and land was made available for a nursery. Developing the 'Gardens for Health' concept, we set up a herbal preparation unit where they make the medicines they need for their work. There is a monthly meeting where they present their work and discuss the advice and medicines they gave and the results of these interventions. A Siddha doctor attends these meetings as well as our health team members. A second unit is in its beginning stages with the Kurumba women at Chengalpuddur. Altogether seven units are planned around the Niligiri Ghats." (VO)

Another project is to develop forest gardens within tribal communities as part of a wider strategy to produce a sustainable model and engage young people in ethno-botanical projects and give them lessons in schools within Udhagamandalam.

> "Tribal elders are brought in to teach the children about the uses of medicinal plants. The school curriculum now includes modules on organic farming and environmental science." (VO)

The Earth Trust mainly relies on private funding and has a fund-raising centre, based in Winchester, UK. For a future project the Trust wants to acquire a piece of land in order to develop a medicinal plant garden using traditional knowledge from the Toda indigenous group.

Global Ayurvedic Festival February 8th to February 12th 2012, Trivandrum, Kerala

The suppliers at the festival were mainly based in the state of Kerala but sold their products all over India and to a lesser extent, internationally, mainly to the United States, where HMPs are mainly sold as food supplements and to Switzerland and Sweden who have sympathetic policies regarding international trade.

Sweden is easier to access than many EU countries as it has a policy of free trade and is against forms of protectionism allowing for easier access for exporters (MFA, 2011). Switzerland is not formally a part of the EU and so is not subject to the same European directives concerning HMPs and although they are well-known for producing and marketing high quality products, they are free to regulate HMPs according to their own regulatory framework.

In general conversation with company representatives attending the festival, I discovered that the suppliers often deal directly with practitioners of traditional ethnic medicine (TEC) but also have some products that are suitable for OTC trade.

These tend to be the external preparations, e.g. massage oils, hair applications and cosmetics and also functional foods, the most well-known being Chyawanprash, a mixture of up to 80 herbs and ghee (clarified butter) made into a type of jam with the main ingredient being amla, the Indian gooseberry, *Embelica officinalis*. The market size of Chyawanprash in 2010 was 4 billion rupees (about US$80 million) (Sagar, 2011).

Many of the company representatives claim to have contracts with the farms that produce the crops or collect them from the wild. Very few of the cultivated products are produced organically although the representatives agreed that this was a growing market for exported products and more recently in India. However it was felt that the main driver for the domestic market was still price and that Indian consumers were still reticent about paying a premium for organically produced products.

One company, SG Phytopharma (SGP) employs approximately 60 employees and specialises in classical Ayurvedic preparations, including *bhasmas.* Some products take up to eight months to prepare when following the original guidelines but strict adherence is important to the Ayurvedic practitioners who constitute the main market for these items. The raw materials are either cultivated or collected from the wild. The company employs the services of a plant material distribution centre, who gather plant material from different farms and wild collectors. SGP planted more than 10,000 plants on the Sahyadri Range, west of Maharashtra. The company chiefly supply to India but have plans to expand into other Asian and African countries. They currently supply one anti-malarial product to Nigeria.

Himalaya Herbs (HH) is one of the largest manufactures of HMPs in India. The company own 80 hectares of farms growing herbs mainly for the US and the EU markets. They are based in Bangalore, India and are currently building new production facilities in the USA. The company trades $60 million in herbal products across 56 countries. They produce 10 million tablets each day.

The company was founded in 1935 with 10 employees. Their first product was Serpina® *Rauwolfia sepentina.* It was used to treat hypertension and in 1954 the drug Reserpine was isolated from the plant. Now the company has 136 products in total, 60 per cent of which are herbal medicines.

15th October to 17th October 2012 Convention on Biodiversity, Hyderabad

I attended the Convention on Biodiversity in Hyderabad in October 2012. This convention brought together interest groups from all over India and Internationally. The convention gave me an opportunity to interview another secondary sample group in addition to the primary responders and provided a good comparison of wages and conditions for other types of workers in different states of India.

15th October 2012

The Uttarakhand Bamboo project

In Uttarakhand, there is currently a local government project to develop the Bamboo industry. Local government helps to provide loans to farmers and craftsmen and offer tax incentives. The average earnings for a skilled bamboo craftsmen/ house builder are 500 rupees (US$8.0) per day.

The Chenchus of Andhra Pradesh

This indigenous group, undertake work to conserve the land and protect bio-diversity. Each group member earns 200 rupees (US$3.2) per day plus 20 kg of rice per month. In addition they receive free education for their children. The Chenchus are considered experts in their knowledge of medicinal plants and wild foods. They belong to a religious class of ancient Hindus.

16th October 2012

Sushil Bajpur WOTR

In the state of Maharashtra, indigenous groups are known to collect wild food but only in the region of 10 per cent is wild collected. In comparison, indigenous groups in Madhya Pradesh collect up to 40 per cent of their food from the wild. The Maharashtran groups grow rice, vegetables, and lentils for protein. Regarding livestock, there has been a problem with hybrid cows (Western varieties bred with older Indian stock) in that, although high yielding, they are also more susceptible to disease and consequently there is a drive back towards rearing traditional varieties of livestock.

This demonstrates how in the drive for higher productivity, exogenous variables can be introduced that can exert serious negative consequences on the value chain.

This move back towards traditional food sources can also be observed with crop cultivars, including rice, of which there are approximately 95,000 varieties.

Only about ten cultivars are produced on a large scale by a few companies which dominate and control the market. The less well known cultivars can be produced on a smaller scale and sold as special niche products of higher value, as seen with *Navara, '* the medicinal rice of Kerala' (Swaminathan, 2011).

SP, managing director at PH

SP has been leading a project to cultivate and market *Picrorhiza kurroa* in the Himalayan region (with the correct CITES certification).

> "The product is exported to the USA where there is demand from practitioners, who are far greater in number than in Europe, but also the regulatory framework is pliable enough to allow its distribution as an OTC product. It is likely that Picrorhiza products originating in the USA are available worldwide via internet sales. Practitioners of Ayurveda differ from TCM practitioners in that they mainly prescribe manufactured products and so have been more negatively affected by the implementation of the THMPD. One of PH's criticisms of the THMPD is that it pays little attention to GAP and has no requirement for manufacturers to regularly audit their supply chain to farm level."
> (SP)

17th October 2012, GK, IFS, Bhopal

Application of Fairwild® standards, national, regional and local policy

There are 68 million hectares of forest in India. Standards for forest management are working on a local level but not nationally on any meaningful scale. The state of Madhya Pradesh is well developed with regard to the government's involvement in the Fairwild® initiative.

In India, there are 1,000 companies sourcing from the wild. Over the last ten years companies have diverted their practices towards the collection of medicinal plants. Manufacturers are recognising the importance to their businesses of conservation. This is a new development to tie business in with conservation. The main difficulty is in the implementation.

A representative from the Darbur Company (RDC), one of India's largest HMP companies explained some of the company's sustainability objectives,

> "Darbur owns the world's largest greenhouse. We produce 5,000 saplings each year which are distributed free of charge to farmers with a buy back clause. We take these steps towards sustainability for the survival of the industry rather than through any regulatory pressure."

But it appears that consumers are largely unaware of the Fairwild® initiative.

> "Consumers know nothing about Fairwild® and need to be educated about how much of what they eat or use as medicine comes from the wild and the effects this may have. More investment is needed and more dialogue with ministers. A ten year impact study should be performed following the example of Costa Rica where they have hard evidence that forest sustainability is possible." (RDC)

31st October 2012

Interview with the DMPF, Doddabeta (MPFD)

The farm grows both European and Indian herbs and produce aromatic oils, which are sold throughout their five retail outlets in India; medicinal plants, which are sold as dried herbs to Indian distributors and some culinary herbs which are sold locally.

> "We tried exporting some herbs to Europe but had some problems. A whole shipload of herbs was rejected as it was discovered that one per cent was not organic."

The farm comprises approximately 12 hectares of certified organic fields and some further hectares, which cultivates non-organic herbs for the medicinal plant extract industry. The MPFD acts as an intermediary between tribal partners and industry buyers. The farm acts as an 'incubator' project with the aim that farmers will eventually acquire their own land.

The farmers, 90 per cent of whom are women, take home 5,000 rupees (US$80) per month (approximately US$3.30 per day assuming working a six day week). The men tend to work away, earning money as agricultural workers or building labourers.

The project has had some positive impact within the community resulting in fewer social problems. Children are for the first time, starting to receive some formal education.

A total of 85 people work on the farm, and are made up of different tribal groups.

> "I have seen a change in attitude from the tribal members; there are less disputes and a better work ethic."

The farm was originally a *cinchona* farm used in the production of quinine. Due to the world wide problems of malarial resistance to quinine, the farm went out of business. However, there is once again an interest in cinchona as a source of quinine as it is believed that the malaria parasite cannot develop resistance so easily.

7.4 Analysis of the value chain

The data obtained from the fieldwork study demonstrates that there are many different value chains surrounding a single product (turmeric). It is widely grown in India and is often treated as a commodity product and sold on to middlemen once the price is right. There is some reluctance to grow the product organically by some of our sample as it is seen as too high risk and would be a change from normal farming practice. However, the farms involved in the VIVC have deviated from normal practice and are no longer driven by the same market forces. This can mean that they may fail to make large profits should the price of turmeric suddenly rise but they benefit from having an agreed price paid with associated premiums.

Although, in the VIVC case study, it cannot be shown that farm workers are better off financially in terms of their actual wage, they benefit through having constant employment and relatively good working conditions. Overall this means that throughout the year their gross salary can be higher than farm workers who have to seek out seasonal employment on different farms.

It can be observed that the quality of turmeric on small farms could suffer due to lack of inputs such as proprietary fungicides. The larger farms are able to grow better quality turmeric by using chemical treatments. Turmeric can be stored for long periods using these chemical treatments.

The VIVC turmeric is grown organically, treatments are used to keep the crop in good health but these must be approved for use in organic farming. The farmers are taught organic farming methods and GAP. Through this training a better quality crop can be produced and because the crop is not sold at auction, it can be quickly exported, minimising potential problems of growth of micro-organisms and the loss of volatile compounds.

The export market versus the domestic market

From the analysis of the turmeric chain it is evident that the profits that can be made in the domestic market can be higher than for the export market but the demand is much lower. This observation appears particularly relevant to the organic market which is a relatively new emerging market in India. However there appear to be differences in demand for these niche products in rural compared to urban areas.

Moreover, the popularity and trust in pharmaceutical medication alongside a decline in the use of Ayurveda and other traditional medical systems is likely to affect the domestic market for HMPs. At the time of this study PA was exporting 95 per cent of its organic spices and medicinal herbs.

In the domestic chain (Fig. 46), the farm worker receives 7.5p per kg of turmeric harvested[15]. The farmer receives 70p from the PA. The farmer has paid the farm worker 7.5p and has additional overheads of 12.5p per kilo to cover the cost of seed and the inputs needed for successful cultivation. This leaves the farmer with a profit of 50p per kg. Indian retailers pay PA £2.80 per kg. PA has paid the farmer 70p per kg and has additional overheads of £1.40 per kg.

The overheads are mainly staffing and associated costs. This leaves PA with 70p per kg profit. The customer pays the retailer £4.00 per kg. The retailer has paid PA £2.80 and has relatively small overheads of approximately 10p per kg. This leaves the retailer with a profit of £1.10p per kg of turmeric.

For 1kg of turmeric

Farm worker	←	Farmer	←	PA	←	Retailer	←	Customer
	7.5p		70p		£2.80		£4.00	Cost
7.5p		62.5p		£2.10p		£1.20p		Earnings
		12.5p		£1.40p		10p*		Expenses
		50p		70p		£1.10p		Profit

Figure 46, Amount per kg paid for turmeric along the PA domestic value chain

In the export chain (Fig. 47), the farm worker and the farmer receive the same amounts and any overheads are identical to the domestic chain. However PA is now selling the product to the buyer in the UK as part of the VIVC. PA receives £3.00 per kg from PH, they have paid the farmer 70p per kilo but in this case the overheads are higher to the amount of £1.70 per kilo.

[15] In relation to the VIVC, I have converted Indian rupees to pounds sterling rather than US$ for clarity and ease of reference. 100 rupees is approximately equivalent to £1.

This higher amount is with respect to the additional testing that is needed for products to be accepted into European countries. This leaves PA with a profit of 60p per kg. The retailer pays PH £238 per kg. PH has paid PA £3 per kg but operating within the UK has a high level of overheads in order to place the finish product on the market of £223 per kg (including staffing costs).

This leaves PH with a profit of £12 per kg. The retailer is paid £340 per kg by the customer. The retailer has paid PH £238 per kg and has modest overheads of £5.00 per kg, leaving the retailer with a profit of £97.00 per kg.

Farm worker ←	Farmer ←	PA ←	PH(UK) ←	Retailer ←	Customer	
	7.5p	70p	£3.00p	£238	£ 340	Cost
7.5p	62.5p	£2.30p	£235	£102		Earnings
	12.5p	£1.70p	£223	£5.00p*		Expenses
	50p	60p	£12.00p	£97.00p		Profit

Figure 47, Amount per kg paid for turmeric along the PA export VIVC

These figures have been produced primarily from fieldwork data but I have also used an estimated figure* (based on the cost of shelf-space) concerning the overheads for retailers as these can vary depending on size of premises, number of staff and running costs.

Using the information gathered from the visit to the Chinese herb market in Bozhou, on turmeric cultivation and the using information gleaned from the turmeric products sampled, I have highlighted two separate value chains. One follows the practitioner route of supply[16] and the other concerns the production and delivery over the counter (OTC) products. The herbal practitioner value chain (Fig 48) begins with the herb grower in Asia and finishes with the consumer in the Europe, As the herb material moves along the chain value is added in terms of costs to the producer and it is the consumer who will eventually pay for these costs along with any profits added. (Prices based on average values, November 2011, for 20 randomly selected commonly used

[16] Practitioners of herbal medicine are prevalent in the UK and are able to dispense herbal ingredients to patients following a consultation.

East Asian herbs) Estimates based on informal interviews with herb sourcing companies, suppliers and practitioners. The value of the herbs increases as the product moves away from the farmer and towards the consumer. The farmers are often the same individuals who are selling the herbs in the market. In this example there is no 'value addition' due to processing as the final product is still in the same form as when it started i.e. a crude dried herb. Therefore the price increments are due to costs incurred through externalities, price increases through middlemen and value added in terms of professional knowledge. This is in contrast to when the OTC product has value added additionally through different cultivation and processing methods (Fig. 49). Notably there is a tenfold increase for simply encapsulating the powder for convenience and to give the appearance of a medicinal product.

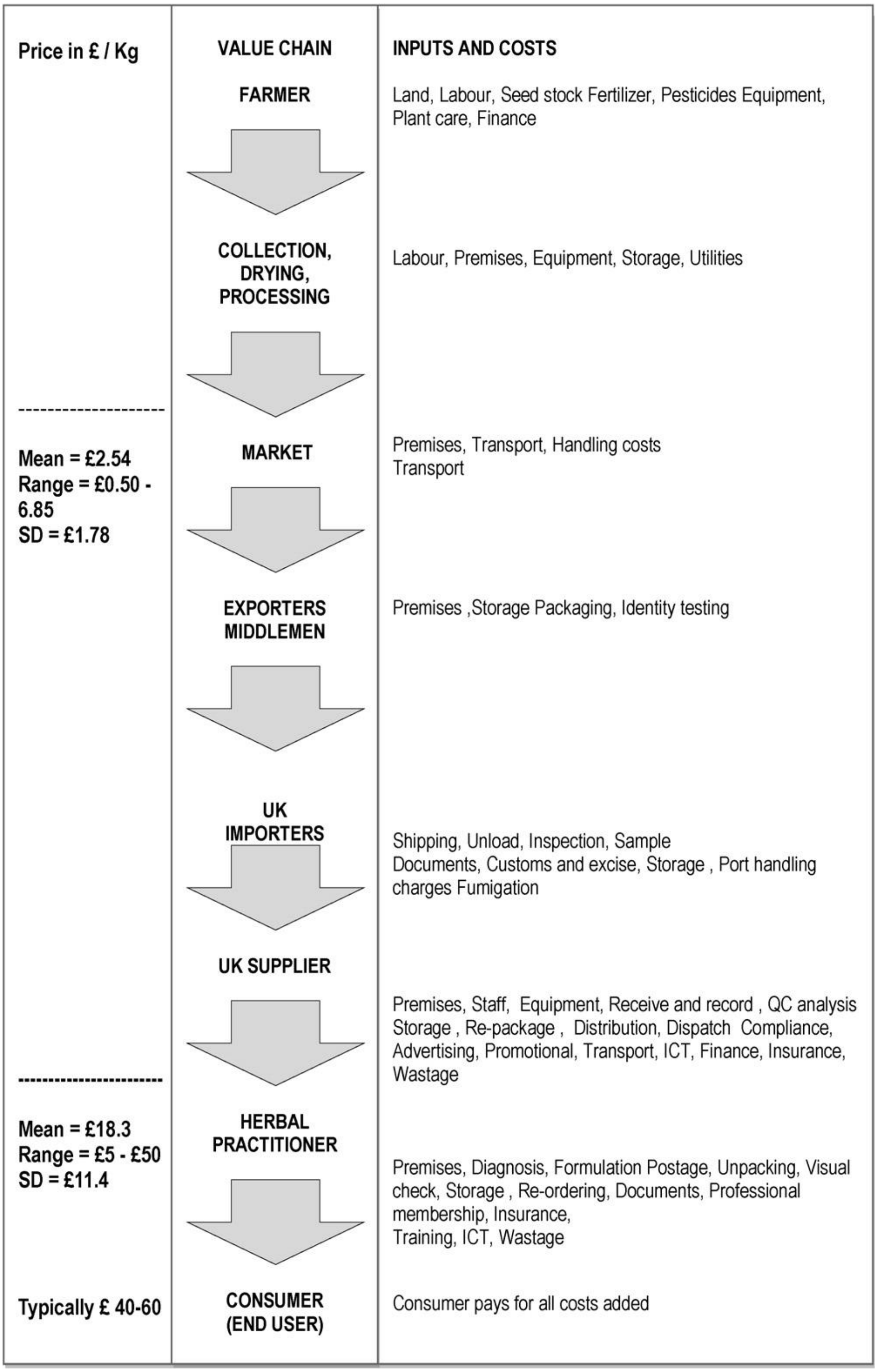
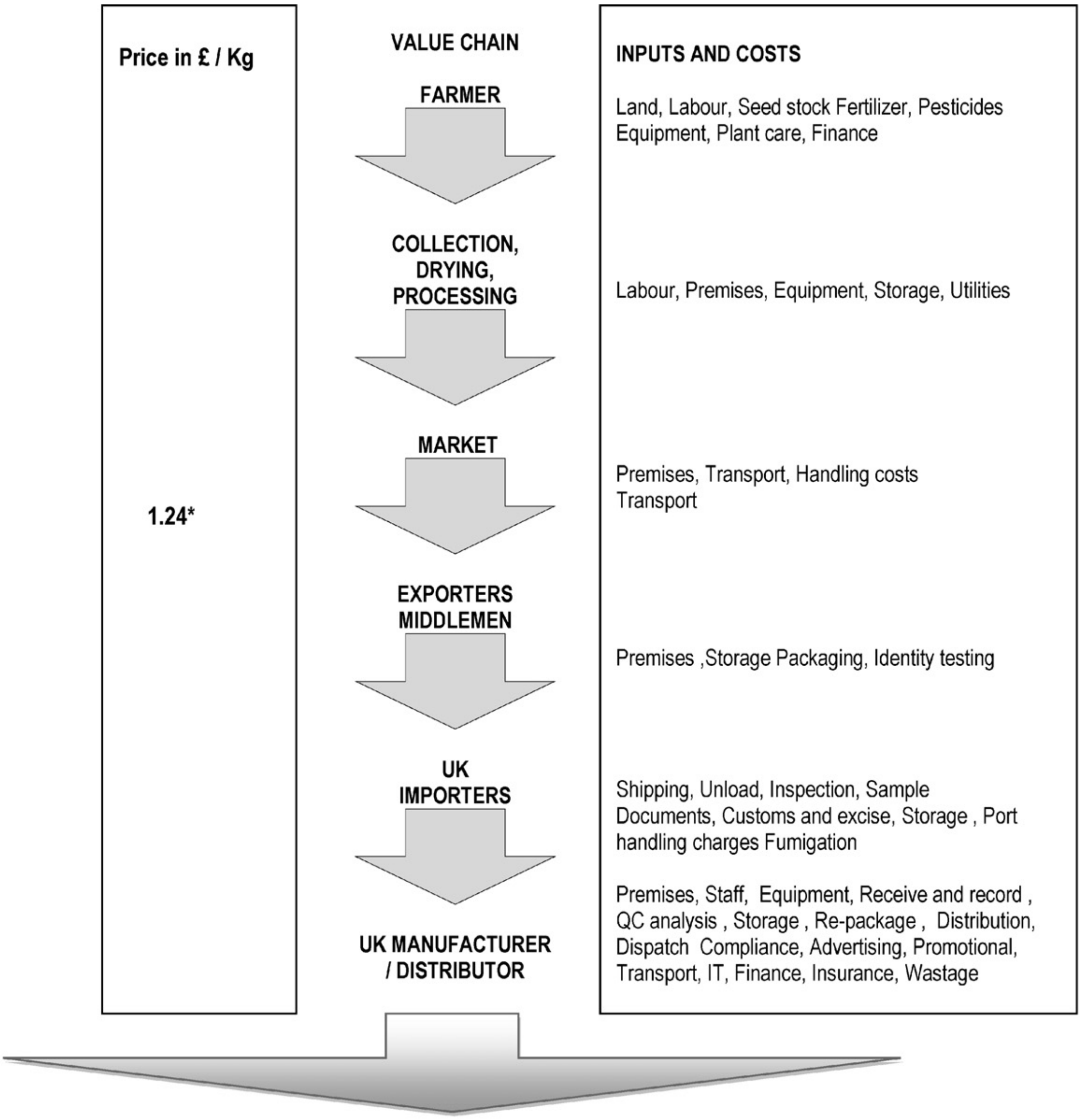


Figure 48, The herbal practitioner value chain.



Product description	Turmeric Powder food grade	Turmeric powder capsules	Turmeric high potency tablets	Turmeric rhizome capsules	Turmeric aqueous extract granules	Turmeric SCF extraction softgel capsule	Turmeric organic tincture
Value added	Grinding, packaging	Grinding, encapsulate packaging	Extraction, tableting, packaging	Grinding, encapsulate Complies with BP standard	Extraction freeze drying granulation packaging	SCF extraction, soft gel, packaging	Organic certified, extraction, packaging
Price per kilo	£14.90	£214.75	£665.00	£246.67	£78.00	£1715.83	£179.80 / Litre
Price per daily dose	£0.015	£0.17	£0.33	£0.37	£0.62	£0.69	£1.08

Figure 49, The value chain for OTC turmeric products found in UK retail outlets.

7.5 Analysis of farmer and farm / factory worker perspectives

The majority of farms in India are small and food crops are grown primarily to provide food for the family. Any surplus food can be sold at local markets. A decision to replace food crops with medicinal plants presents the farmers with a dilemma. On one hand the income received from medicinal plants can be greater but on the other, the market has historically been unstable with prices fluctuating. This has not been so much of a problem for wild collection where little investment is needed but in cultivation land must be put aside and inputs must be bought. For some plants, the time before harvest can be many years. This scenario presents a substantial amount of risk for the farmer, and more so for the farmer with only a small farm and little capital.

Turmeric appears to be one of the few medicinal plants commonly grown by farmers in India. Of course, this must partly be due to its use as a food and a cosmetic making it less of a risk than plants that are solely used as medicines.

In case study 1, the Tamil Nadu chain, the farmers were aware of turmeric's use in medicine but chose to sell their crop at the state-run auction house. This gave them the possibility of selling when the price was high and also they could take advantage of the storage facilities provided in the town of Erode when the market price was low. They expressed interest in selling directly to HMP manufacturers and especially those outside of India but at present did not have the necessary linkages in place. They accepted that there was a market for organically produced turmeric but lacked expertise in this area and were not prepared to undertake any changes that, in their view, could easily result in a loss of income. Paradoxically, they were unhappy with the low market value of the domestic market and their necessary but uncomfortable reliance on middlemen.

Their views towards medicinal plants generally were skeptical and they considered them to be high-risk products. There general strategy was to watch the market carefully and have a cultivation strategy that would return the highest income, plant crops that could be harvested in the shortest period of time and use whatever external inputs necessary to produce the best quality, highest yielding crops.

In case study 2, (The VIVC), the risks for the farmers have been minimised through the establishment of contracts that guarantee an order size and a price for the crop. The farmers in the integrated chain are directed through the buyer as to which plant to grow and how much. If market prices should fall, the loss becomes the buyers rather than the farmers although if market prices substantially rise, then it is the farmer who will lose out and so there is still some level of risk with this system in place.

The cultivation of medicinal plants in India (as in many other regions of the world) is relatively new, with wild-collection being the main source of supply. Through belonging to the chain, the farmers are able to access important information from the lead company on the optimum cultivation parameters for individual plants. The farmers are also engaging in their own research on how best to grow the plants organically.

Apart from the premiums paid for different crops, the farmers (and farm workers) benefit from the stability and regularity of belonging to an integrated chain although for this to continue the manufacturers further down the chain must succeed and prosper.

Case study 3, the Jhansi chain

The two farms examined provided a stark contrast. The farmers on the small farm were the less affluent of all the chains studied. They had no means to engage with any outside markets and relied on selling their unprocessed turmeric for the minimal price at local markets. Farm workers were generally part of the family and rather than receive wages they worked on the farm in order to eat and have somewhere to live.

In contrast the other Jhansi farm was the largest investigated in this study and the farmers (or more accurately farm managers) appeared relatively wealthy. The farm was a source of employment for local and sometimes migrant labourers. This farm did not grow food crops but focused mainly on *Mentha piperita* from which menthol can be extracted. It was not integrated into a value chain but sold its crops to a local distillation company who act as middlemen for pharmaceutical and cosmetic industries.

7.6 Analysis of manufacturer perspectives

For the manufacturer, the quality and traceability of the raw materials used to manufacture HMPs is a major concern, and especially when those products are required to be licensed e.g. the European THR.

In India, it was observed that companies that produce HMPs for the domestic market often obtain their supplies through middlemen. In the case of turmeric they may buy it from one of the state-run auction houses. Some companies have started to invest in cultivating their own crops but for others wild collection is still the main source.

With the VIVC investigated, the primary processing company (PA) is a vital part of the chain. Being located in India, they are able to make contracts with farmers in order to fulfill the order requirements of the lead firm (PH). PA has become a major supplier of PH and the majority of medicinal plants processed are destined for secondary manufacture by PH.

PA can plan their contracts with farmers in advance and in accordance with market predictions from the lead firm.

PH do not only deal in India but have contracts with over one hundred farmers in many parts of the world, including Sri Lanka, China, Vietnam and Eastern Europe. Through making these contracts and paying a premium for organically produced crops. PH are able to use this to full market advantage, apart from the organic nature of their products, they are able to claim full traceability – down to the field the crop was grown in. Moreover they are able to exploit the relationships they have built with farmers and use their 'fair trade' ethic as a marketing tool.

This represents a considerable investment for PH in terms of time and money. The relationships that are forged with the farmers need to be constantly attended to. In practice this means that the lead firm must send employees to visit the farms on a regular basis. Training needs to be delivered to the farmers and farm workers and the farms and primary processing facilities need to be audited to ensure compliance with the manufacturer's product specification.

Using the terminology of Shahidullah and Haque (2010), described in chapter 3.4, the relationship can be presented as an example of quasi-vertical, tapered, cost plus integration (an especially close and long term relationship, where a company (PA) sources inputs externally from independent suppliers as well as internally within the same company and where the contractor is paid a negotiated amount regardless of incurred expenses).

7.7 Analysis of livelihoods

If livelihoods are examined purely from a monetary perspective, the fieldwork investigations revealed that the wages earned by farm workers is approximately equitable throughout the different cases examined (Fig. 50). In fact the male workers in Tamil Nadu earn slightly more than the other two case studies.

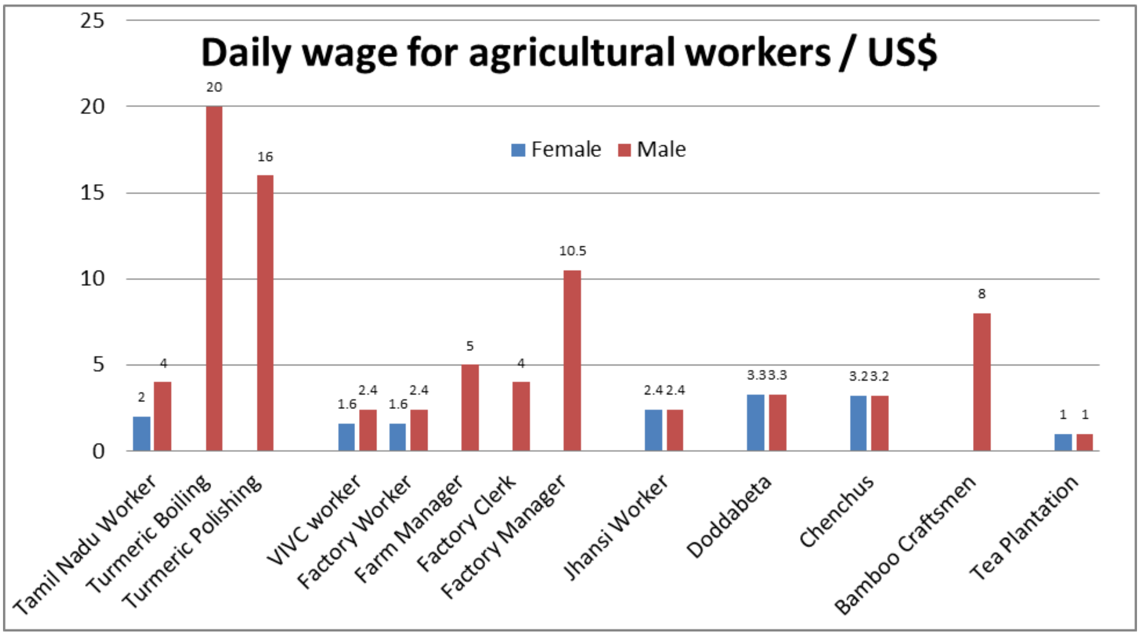


Figure 50, Comparison of wages for agricultural and factory workers

There is evidence that the pay rates between men and women is sometimes different, with the male workers in Tamil Nadu (case study 1) and the VIVC (case study 2) earning more than their female counterparts. The pay between sexes for the Jhansi workers on the large farm (Case study 3), the ‘tribal’ workers at the medicinal plant farm at Doddabeta and the Chenchus of Andhra Pradesh is the same. (The average poverty line is regarded as US$2 per day in developing countries) (World-Bank, 2014).

It can be seen that by moving from farm labouring to factory work, there are more opportunities for promotion in the factory and the pay for a manager is more than double that of a farm manager.

For workers that develop their own skills in relation to forest products, there are further opportunities, a skilled craftsmen can earn up to US$8 dollars per day. However, the workers that stand out for their earning ability are those involved in the secondary processing of turmeric.

The agricultural workers who invested in renting machinery and provided a service to other farmers (boiling and polishing) are able to earn US$16 to US$20 per day during the harvest season, (approximately 3 months).

The tea plantation wages are included to give a comparison to the lowest paid agricultural workers who work on the large tea plantations and where crop prices are driven down through pressures from multinational companies (see 3.8)

Although the workers in the VIVC are generally paid less than other groups, they benefit from being employed on long term contracts for a year at a time and there are some opportunities for working in the factory (PA).

7.8 Discussion of socio-economic findings

Comparable to China, companies in India are also involved in forming direct contractual relationships with farmers although there is a greater emphasis in sourcing organically cultivated crops in India. In addition to sourcing herbs for export, it has been suggested that it is also possible to diversify and develop a product range for newly emerging domestic markets (Commission, 2007).

The fieldwork investigations corroborate this view and the evidence suggests that consumers are willing to pay a premium for goods that are ethically sourced and that are produced organically (see Fig. 49). This was mainly evident in the VIVC providing HMPs to an international market but additional information provided by PA suggested that there is a new domestic Indian market emerging for these commodities.

During the fieldwork in China and India, I discovered examples of sourcing companies, or individuals employed to source herbs. These were integrated into a VIVC either as employees within the chain, as was the case for the UK company (PH), where a sourcing manager and sourcing staff are sent out to different countries to find potential suppliers, or the sourcing company (ATHSC) who were contracted by a manufacturer in Taiwan to source herbs in China.

Local companies, NGOs and government institutions are able to provide advice and support to farmers on market trends, planting strategies and growing techniques, including the correct and safe use of fertilisers and pesticides.

This was observed particularly in China, where there is government involvement in the setting up of GAP initiatives and where provincial universities (e.g. Anhui University) work closely with farmers on the ground (see 7.2.3).

The fieldwork suggested that the farmers involved in the VIVC benefited from having regular orders and price stability with the associated premiums for individual crops. Other companies and primary producers investigated have shown an eagerness for linking into a VIVC but so far have lacked the inputs and industry connections necessary to make this happen (case study 1 and 3).

My own investigation of a VIVC suggested that farm workers are not exploited but the benefits of belonging to a VIVC may not be immediately apparent. It initially appeared that the farm workers employed on the more traditional farms are better off financially (see Fig. 50). However, I discovered that the farm workers on the VIVC are employed on year-long contracts, which provides a regular income and greater job security. The benefits for the farmers and primary producers are greater through belonging to the VIVC except for those times when the market price for turmeric increases significantly, in which case, having access to the free market can produce higher returns. However, this needs to be balanced by the times that the price of turmeric drops to a low point and the farmer has to store the crop and incur the associated expense and inevitable product deterioration.

While conducting preliminary fieldwork in Bozhou, China, I was able to witness first-hand how Chinese herbs are traded on the open market. In China it was apparent that herbs were traded as commodities in a similar way to gold, silver or other items that are subject to price volatility (see 7.2.2). There is little evidence of GAP or GMP and once the herbs are dried and presented within the market, there is little opportunity to discover the age of the herbal material or how it has been processed.

The supply of turmeric in India presents a similar picture and one that is unlikely to be appreciated by consumers in Europe. I have shown how turmeric is traded as a commodity and how over-planting leads to a drop in its market value, forcing farmers to store the dried material for sometimes long periods (see 7.3.1).

During this storage period the product is heavily treated to prevent the growth of spoilage organisms (see Fig. 28).

Even without this spoilage, the gradual degradation of compounds in the product due to prolonged exposure to high climatic temperature may result in a sub-standard product.

My fieldwork investigations reveal how it is possible for an industry to move away from wild collection and invest in cultivation. This is immediately apparent in the VIVC where the majority of herbal raw materials are cultivated but there is also evidence to support that this is part of a wider trend. The interviews with many of the respondents at secondary sites (see 7.3.4) reveal that indigenous groups, who are often regarded as being responsible for much of the wild collection, are engaged in projects involving the cultivation of medicinal plants. These projects could provide whole communities with a more structured and long term work outlook and their governance through NGO's appears to elevate their wages to above the norm for agricultural workers (see Fig. 50).

The fieldwork data suggests that in the case of the VIVC examined, the contractual obligations were honoured on both sides. In order to achieve this, the lead firm (PH) has to maintain regular contact with the farmers and primary producers and ensure through regular audits that processes and procedures were complied with. My fieldwork has provided evidence to show that an Indian company producing HMPs (PA) is capable of linking into an international value chain and this chain has shown to be both profitable and sustainable.

8.0 Analytical analysis methods

8.1 ^{1}H-NMR spectroscopy methods

Solvents, reagents and chemicals

DMSO-D6

Curcumin reference standard (mixture of three curcuminoids) Sigma Chemicals Lot 69H3457

Tumerone reference standard Sigma Chemicals Lot 1129150

Apparatus and instrumentation

Bruker Avance NMR Spectrophotometer (500 MHz) with Topspin software version 1.3

AMIX Bruker Biospin multivariate analysis software version 3.0

SIMCA multivariate analysis software Version 13.0

Ependorff Minispin plus centrifuge, model 5453, Serial no. 0031564

Fisher brand ultrasound bath, model D-78224, serial no. 004472044

Rotamixer, rotary mixer, serial no. 8011

Gilson micro-pipettes 200ul, serial no.AC55298 and 1000ul, serial no. AD63010

Reaction tubes, 1.5ml eppendorf supplied by Griener Bio-One, Germany

Wilmad LabGlass NMR sample tubes, 5mm economy, 7"Length, 100MHz

Sample preparations for ^{1}H-NMR spectroscopy analysis

The method for the extraction of plant samples was developed from a method described by Kim et al 2010. Initial experiments were carried out using chloroform-D, and DMSO-D6 and methanol-D4 but it was found that DMSO-D6 was a better extracting solvent because the ^{1}H-NMR spectra showed more peaks in the 0 to 10 ppm range than with the other solvents tried. Approximately 20 mg of all the samples were weighed into a 1.5 ml reaction tube and 1.0 ml of deuterated DMSO containing 0.05% TMS was added. The mixture was mixed on a rotary mixer for 60 seconds and sonicated in an ultrasound bath for 15 minutes, and allowed to stand for 1 hour. The solutions were centrifuged for 10 minutes at 14,000 rpm. 800 µl of the supernatant was added to a 5 mm diameter NMR spectroscopy tube and the samples were submitted for ^{1}H-NMR spectroscopy analysis.

^{1}H-NMR spectroscopy metabolomic analysis

The ^{1}H-NMR spectra spectra were acquired using 500 MHz NMR Bruker Avance spectrometer (Bruker BioSpin GmbH, Rheinstetten, Germany) equipped with a 5 mm cryoprobe head and operating at a proton frequency of 500.13 MHz. The acquisition parameters were: size of the spectra 64 k data points, line broadening factor = 0.16 Hz, pulse width (PW) = 30 degrees and the relaxation delay d1 = 1 s. The acquisition temperature was 298 K. TOPSPIN version 1.3 software was used for spectra acquisition and processing. The NMR was set up for the analysis applying diffusion-edited ^{1}H-NMRspectroscopy with suppression of the water signal. The scans were locked at zero on the TMS peak. 256 scans was the number of scans chosen for optimum resolution of peaks, requiring approximately 10 minutes acquisition time.

Statistical analysis

TOPSPIN version 1.3 software was used for spectra acquisition and processing of the ^{1}H-NMR spectra which were manually corrected for phase and baseline distortions. The spectra were exported to Topspin Plot editor, version 3.5, Bruker and thoroughly examined visually for appropriate reference peaks for the identification of curcuminoids in the sample. The ^{1}H-NMR spectra of all the samples were imported to the AMIX software, version 3.5 and simplified by using the bucketing function. The spectra in the range 0 to 12 ppm were divided into 301 buckets of 0.04 ppm. The residual solvent signals for DMSO (2.65 to 2.45 ppm) and water (3.60 to 3.10) were excluded. This data were imported to Microsoft EXCEL where the samples were re-labelled S1 to S 52. The data were then imported to SIMCA, version 13.0 software for PCA analysis.

8.2 HPTLC methods

Solvents, reagents and chemicals

Reference standard no.363 Curcuminoids USP B070268

Methanol Acros p.a. 0958514

Ethyl acetate Acros p.a. 0963023

Acetic acid Acros p.a. A0278887

Toluene, Dichloromethane, 2-Propanol, Acetonitrile, Propanone

Water In-house

HPTLC glass 20x10 cm, Si 60 F254 Merck HX258909

Apparatus and instrumentation

Automatic TLC Sampler 4 CAMAG

Twin Trough Chamber 20x10 cm CAMAG

Chromatogram Immersion Device III CAMAG

TLC Plate Heater III CAMAG

Automatic Development Chamber ADC 2 CAMAG

Visualizer CAMAG

Filter paper for chamber saturation CAMAG

Ultra Centrifugal Mill ZM200 Retsch

Analytical Balance AG245 Mettler-Toledo

Balance DC4400 Mettler-Toledo

Sample preparations for HPTLC analysis

The method for the extraction of plant samples was developed from a standardised method used at CAMAG laboratories. Approximately 200 mg of all the samples were weighed into a 10 ml reaction tube and 4.0 ml of solvent was added (methanol for curcuminoid and dye adulterant determination, toluene for the determination of essential oils and water for the determination of sugars). The mixture was mixed on a rotary mixer for 60 seconds and shaken for 20 minutes. The solutions were centrifuged for 10 minutes at 14,000 rpm. The supernatant solution was transferred to a vial and the samples were submitted for HPTLC analysis.

HPTLC was carried out using Merck HPTLC glass plates 20x10 cm, Si 60 F254

HPTLC Plates. Samples were applied (4.0 µl) using the CAMAG Automatic TLC Sampler 4. Four developing systems were used, for curcuminoid determination (Toluene: acetic acid, 4:1), for essential oils (Dichloromethane) for dye adulteration (toluene: methanol: acetic acid, 32: 8: 10) and for sugars (acetonitrile, acetone: water, 40:40:20). The Lab Temperature was 23°C and tank humidity within the developing tank was controlled at 33% using a magnesium chloride solution. The developed plates were derivatised by dipping with anisaldehyde reagent for the curcuminoid and essential oil systems and aniline-diphenylamine-phosphoric acid reagent for the sugar system. The plates were coated with reagent using a CAMAG chromatogram immersion device III and heated to 100 degrees C on a plate heater. (The adulterant dye plates were not derivatised). The plates were inspected using a CAMAG visualiser under white light and at UV, 254nm and 366nm, photographed and uploaded into the computer software (WinCats).

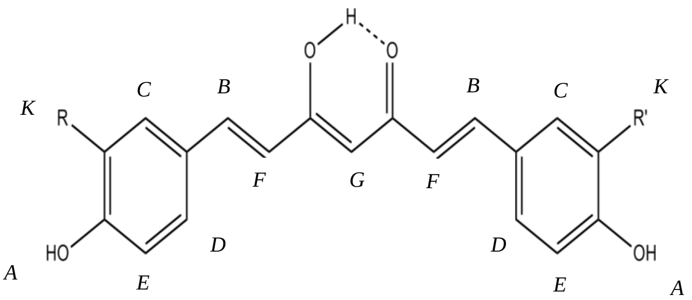
9.0 Analytical analysis results

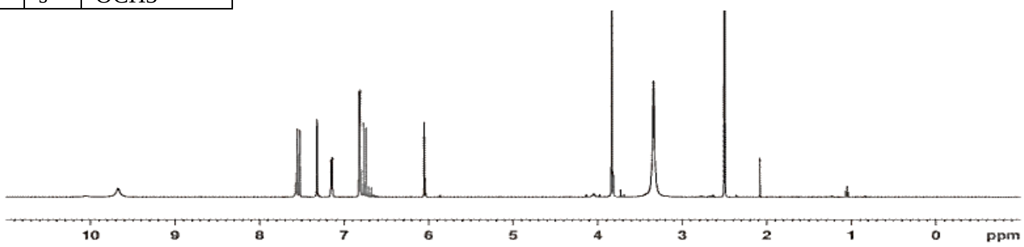
9.1 ^{1}H-NMR spectroscopy and multivariate analysis

Curcumin reference standard Lot 69H3457 (mixture of 3 curcuminoids) minimum 80% curcumin, minimum 94% curcuminoids

Curcumin (C): R, R^1 = OCH3, Demethoxycurcumin (DMC): R=OCH3, R^1=H, Bisdemethoxycurcumin (BDMC): R, R^1=H

P	δ	M	CG
A	10.052	s	OH (BDMC)
A	9.659	s	OH
B	7.545	d	H
C	7.324	d	H
D	7.152	dd	H
E	6.823	d	H
F	6.758	d	H (C)
F	6.712	d	H (DMC)
F	6.681	d	H (BDMC)
G	6.060	s	H
K	3.840	s	OCH3





***P* = Position, δ = Chemical shift, *M* = Multiplicity, *CG* = Chemical group**

Figure 51 ^{1}H-NMR spectroscopy Curcumin reference standard (mixture of three curcuminoids)

The spectra information was compared with that for pure samples of the compounds published in literature. The assignments of the protons responsible for these signals were further verified from the ^{1}H-NMR spectra of Curcumin from the SDBS NMR database SDBS-^{1}H-NMR spectroscopy Curcumin SDBSNo.2056HSP-45772 [17] and Chemical book Curcumin reference number 458-37-7[18].

[17] http://riodb01.ibase.aist.go.jp/sdbs/cgi-bin/direct_frame_top.cgi

[18] http://www.chemicalbook.com/SpectrumEN_458-37-7_1HNMR.htm

Table 6: Product description, NMR spectroscopy reference, usage and preparation information

Simca No	Details of product	NMR spectra no / sample	Species	Use /Preparation
1	Tablets. 10,000mg (as 500mg of extract) providing 95% curcumins. Manufactured in UK. Supplied via internet. Dosage: 1 tablet daily. Ingredients: Turmeric root extract, calcium carbonate, dicalcium phosphate, microcrystalline cellulose. Tablet coating: (hydroxypropyl methylcellulose (HPMC), glycerine. Colours: Iron oxides and titanium dioxide), hydroxypropyl methylcellulose, carboxymethylcellulose, silicon dioxide, stearic acid, magnesium stearate.	JUL-20-12-10 s1	**CL**	**M/EE**
2	500mg capsules manufactured in UK and supplied via internet. Dosage: 1 capsule, 3 times daily. Complies with British Pharmacopoeia. Ingredients: Turmeric rhizome, hypromellose.	JUL-20-12-20 s3	**CZ**	**M/PW**
3	400mg gelatine capsules, manufactured in USA and supplied via retail health food shop in UK. Dosage: 1 capsule, twice daily. Ingredients: Turmeric powder (*C. longa* L.) microcrystalline cellulose, silicon dioxide, magnesium stearate, stearic acid.	JUL-20-12-30 s4	**CL**	**M/PW**
4	500mg capsules provided by Ayurvedic company in Tamil Nadu, India. Dosage 1 capsule, 3 times daily. Ingredients: Curcumin extract (*C. longa*)	JUL-20-12-40 s5	**CL**	**M/EE**
5	Combination product with *C. amada Roxb* and *Frangula purshiana* Cooper Rhamnaceae *(Rhamnus purshiana synonym on label)*. Tablets manufactured in NL. Dosage: 3-4 tablets, 1 or 2 times daily. Ingredients: Curcuma rhizome extract 600mg, *C. amada* rhizome pulverized 100mg, *Frangula purshiana* Cooper cortex 30mg, sugar 75mg.	JUL-20-12-50 s6	**CZ** (mixed species)	**M/PW+M/EE.**

6	400mg capsules, manufactured in USA and supplied via retail health food shop in NL. Dosage: 1 capsule, twice daily. Ingredients: Turmeric powder (*C. longa*), microcrystalline cellulose, silicon dioxide, magnesium stearate, stearic acid.	JUL-20-12-60 s7	**CL**	**M/PW**
7	UK supermarket(UK)	JUL-20-12-70 s8	**CL**	**F/PW** (organic)
8	Standardised 500mg tablets. Manufactured in UK and supplied via internet. Dosage: 1 to 3 tablets, daily. Ingredients: Curcumin powder extract 350mg (standardised for a minimum of 95% curcuminoids), turmeric powder (*C. longa*) 150mg, Bromelain 20mg, di-calcium phosphate, microcrystalline cellulose, silicon dioxide, stearic acid. Coating: HPMC, propylene glycol.	JUL-20-12-80 s9	**CL**	**M/PW+M/EE**
9	500mg capsules. Standardised for 95% curcuminoids. Manufactured in USA and supplied via internet. Dosage: 1 capsule daily. Ingredients: Turmeric powder (. *longa* root) 450mg Turmeric extract (C. longa root) 50mg, gelatin, silica, magnesium stearate, stearic acid.	JUL-20-12-90 s10	**CL**	**M/PW+M/EE**
10	UK supermarket.	JUL-20-12-100 s12	**CL**	**F/PW**
11	UK retail shop.	JUL-20-12-110 s13	**CL**	**F/PW**
12	Integrated Chain Product	JUL-20-12-120 s14	**CL**	fine ground **M/PW(VIC)** (organic)
13	Integrated Chain Product	JUL-20-12-130 s15	**CL**	course ground **M/PW(VIC)** (organic)
14	Market in Delhi, India	JUL-20-12-140 s16	**CL**	**F/PW**
15	UK retail shop.	JUL-20-12-150 s17	**CL**	**F/PW**
16	Retail shop in South India.	JUL-20-12-160 s18	**CL**	**F/PW**
17	Retail shop in South India.	JUL-20-12-170 s19	**CL**	**F/PW**
18	UK retail shop.	JUL-20-12-180 s20	**CL**	**F/PW**

19	Sourced in Bangalore, India	JUL-20-12-190 s21	CA	C/PW (sold as food)
20	UK retail shop.	JUL-20-12-200 s22	CL	F/PW
21	*C. kwangsiensis* S.G. Lee and C.F. Liang. Manufactured as granules in China and supplied by UK TCM company	JUL-20-12-210 s23	CK	M/AE
22	*C. longa.* Full spectrum 5:1 herb extract powder. (Replenished essential oils). Manufactured in China and supplied by UK TCM company.	JUL-20-12-220 s24	CL	M/AE
23	*C. longa*. Manufactured in Taiwan and supplied by UK TCM company. Ingredients: Curcuma longa rhizome concentrated extract (66%), corn starch (34%).	JUL-20-12-230 s25	CL	M/AE+ M/PW
24	Capsules supplied by an Ayurvedic company in India.	JUL-20-12-240 s26	CL	M/PW
25	*C. aromatica*. Sourced in India	JUL-20-12-250 s27	CA	C/PW
26	Supplied by UK company	JUL-20-12-260 s28	CL	M/AE
27	*C. aromatica*. Sourced in India	JUL-20-12-270 s29	CA	C/PW
28	Supplied by retail shop in Kerala, India	JUL-20-12-280 s30	CL	DRh
29	Manufactured in China and supplied by UK TCM company.	JUL-20-12-290 s31	CL	M/PW
30	Cultivated in China and supplied by UK TCM company.	JUL-20-12-300 s32	CL	DRh
31	Farm in Erode, India	JUL-20-12-310 s33	CL	DRh
32	Farm in Erode, India	JUL-20-12-320 s34	CL	DRh (polished)
33	Farm in Erode, India	JUL-20-12-330 s35	CL	DRT
34	Cultivated in China and supplied by UK TCM company.	JUL-20-12-340 s36	CL	DRh
35	500mg gelatin capsules. Standardised for 95% curcuminoids. Manufactured in USA and supplied via internet. Dosage: 1 capsule daily. Ingredients: Turmeric concentrate 500mg (*C. longa*), cellulose, magnesium stearate, silicon dioxide.	JUL-20-12-350 s37	CL	M/EE
36	Manufactured in Austria and supplied by retail shop in Iceland.	JUL-20-12-360 s38	CL	F/PW (organic)
37	*C. zanthorrhiza* Roxb. rhizome, Tropilab	APR-08-13-10 s50	CZ	M/PW

38	Market in Delhi, India	APR-08-13-20 s51	**CL**	**FRh**
39	UK supermarket	APR-08-13-30 s52	**CL**	**FRh**
40	UK supermarket and freeze dried	APR-08-13-40 s53	**CL**	**FRh**
41	Market in Udaipur, India	APR-08-13-50 s54	**CL**	**DRh** (polished)
42	Market in Udaipur, India	APR-08-13-60 s55	**CL**	**F/PW**
43	*C. aromatica* Salisb., Kasturi Manjal from India, sourced via internet	APR-08-13-70 s56	**CA**	**C/PW**
44	*C. aromatica*, rhizome, Kasturi Manjal from India, sourced via internet	APR-08-13-80 s57	**CA**	**C/PW**
45	*C. aromatica*, Kasturi Manjal from India and sourced via internet	APR-08-13-90 s58	**CA**	**C/PW**
46	An Agmark certified food powder sourced in Hyderabad, India	APR-08-13-100 s59	**CL**	**F/PW**
47	Medicinal powder. Integrated Chain Finished Product in 425mg capsules manufactured in UK and sourced via internet. Dosage: 2 capsules, 3 times daily. Ingredients: Turmeric root (*C. longa*), HPMC.	APR-08-13-110 s60	**CL**	**M/PW(VIC)** (organic)
48	Medicinal Super Critical Fluid (SCF) extract 400mg soft gel capsules. Manufactured in USA and sourced via internet. Dosage: 1 capsule daily. Ingredients: Turmeric (*C. longa*), olive oil, gelatine, glycerine, yellow beeswax, carob.	APR-08-13-120 s2	**CL**	**M/SCF**
49	*C. zanthorrhiza* CAMAG 9765	APR-08-13-130 9765	**CZ**	**M/PW**
50	*C. zanthorrhiza* CAMAG 9767	APR-08-13-140 9767	**CZ**	**M/PW**
51	*C. zanthorrhiza* CAMAG 10565	APR-08-13-150 10565	**CZ**	**M/PW**
52	*C. zanthorrhiza* CAMAG 10567	APR-08-13-160 10567	**CZ**	**M/PW**
53	Retail shop in Greenland		**CL**	**F/PW**
54	Integrated chain product, manufactured and sourced in UK. Ingredients turmeric rhizome, ethanol.		**CL**	**M/EE** (organic)

Species:

CL – Curcuma longa

CA – Curcuma aromatica

CK – Curcuma kwangsiensis

CZ – Curcuma zanthorrhiza

Use / Preparation:

M/AE – medicine / aqueous extract

DRh – dried rhizome

DRT – dried root tuber

M/EE – medicine / ethanolic extract

FRh – fresh rhizome

C/PW – cosmetic / powdered drug

F/PW – food / powdered drug

M/PW (VIC) – medicine / powdered drug (vertically integrated chain)

M/PW – medicine / powdered drug

M/PW+M/EE – medicine powdered drug + ethanolic extract

M/SCF – medicine / super critical fluid extract

The samples (see Table 6) were analysed using ^{1}H-NMR spectroscopy coupled with SIMCA multivariate analysis software, version 13.0. Using these coupled analytical platforms and using the information gathered from the products (from labels, leaflets and packaging), it was possible to order the products into different groups. Applying the SIMCA software, the groups were separated using PCA, with reference to species (Fig. 52) and to dosage form / morphology (Fig. 53). Using this method it was possible to differentiate four separate species: *Curcuma longa* L., *Curcuma aromatica* Salisb., *Curcuma zanthorrhiza* Roxb., *Curcuma kwangsiensis* S.G. Lee and C.F. Liang and a range of different dosage forms, comprising ethanolic extracts, a super critical fluid extract, aqueous extracts, medicinal powdered drugs, powders used as foodstuffs, mixed powder and extract products, dried cut rhizomes, whole dried rhizomes and fresh turmeric rhizomes. For comparison of individual ^{1}H-NMR spectra, including curcumin and tumerone reference spectra (see appendix 6).

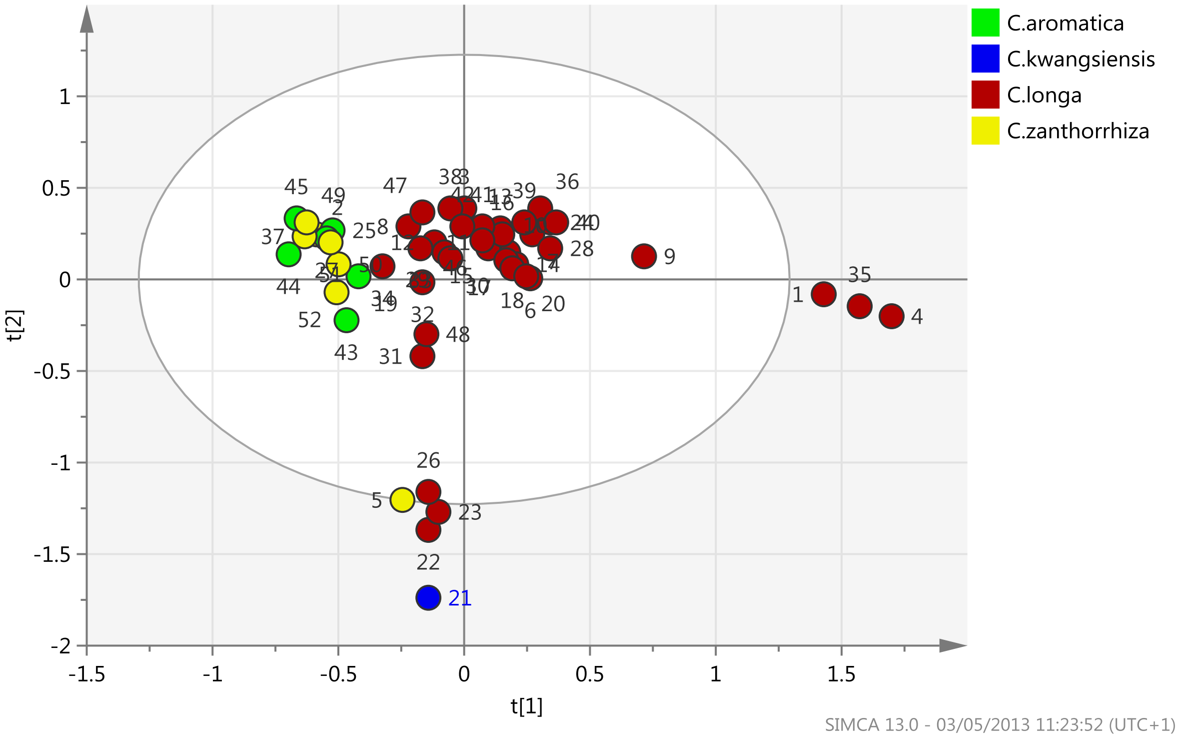


Figure 52, Scores plot showing samples grouped according to species, PC1 VS PC2 (n = 52)

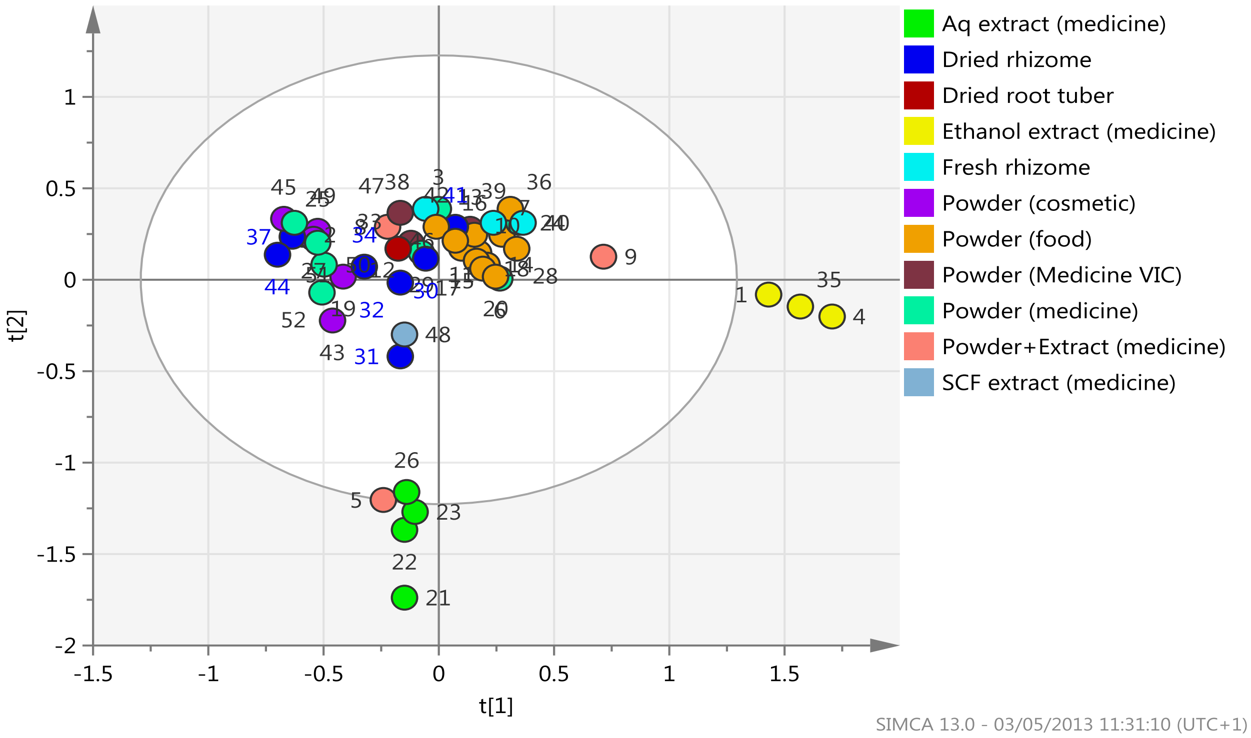


Figure 53, Scores plot showing samples grouped according to form, PC1 VS PC2 (n = 52)

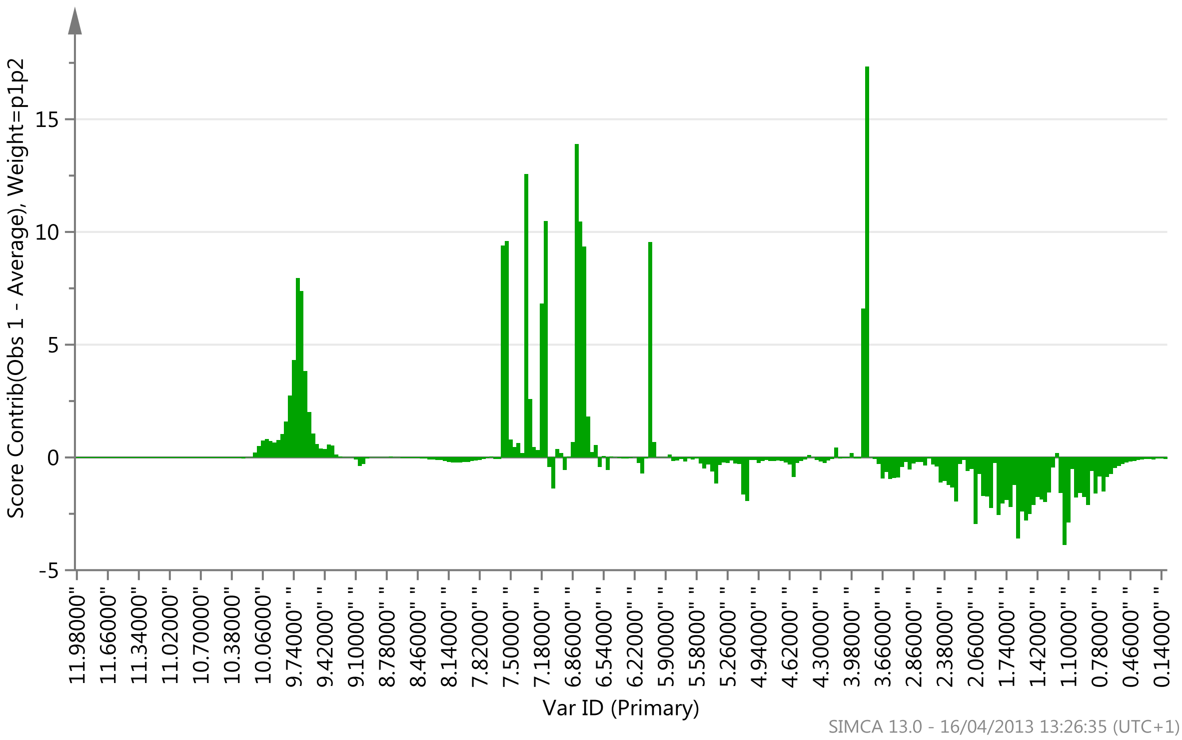


Figure 54, Contributions plot showing the metabolite differences between sample 1, an ethanol extract and the group average, n = 52

The contributions plot provides information on how the PCA separates the samples i.e. they are separated based on the presence or absence of a compound or the difference in concentration of a compound, which can be observed at the particular chemical shifts relating to that compound.

When I compared an ethanol extract (sample 1) against the average for all samples (Fig. 54), sample 1 was higher than the average in the chemical shift regions associated with curcuminoids (6-10ppm) but lower in the carbohydrate (3-5ppm) and essential oil region (1-3ppm).

The PCA was able to differentiate four different species but the initial analysis failed to differentiate *C. aromatica* and *C. zanthorrhiza* satisfactorily. However, when the powder samples were analysed without the extracts, the PCA differentiated them from *C. longa* more effectively (see Fig 55).

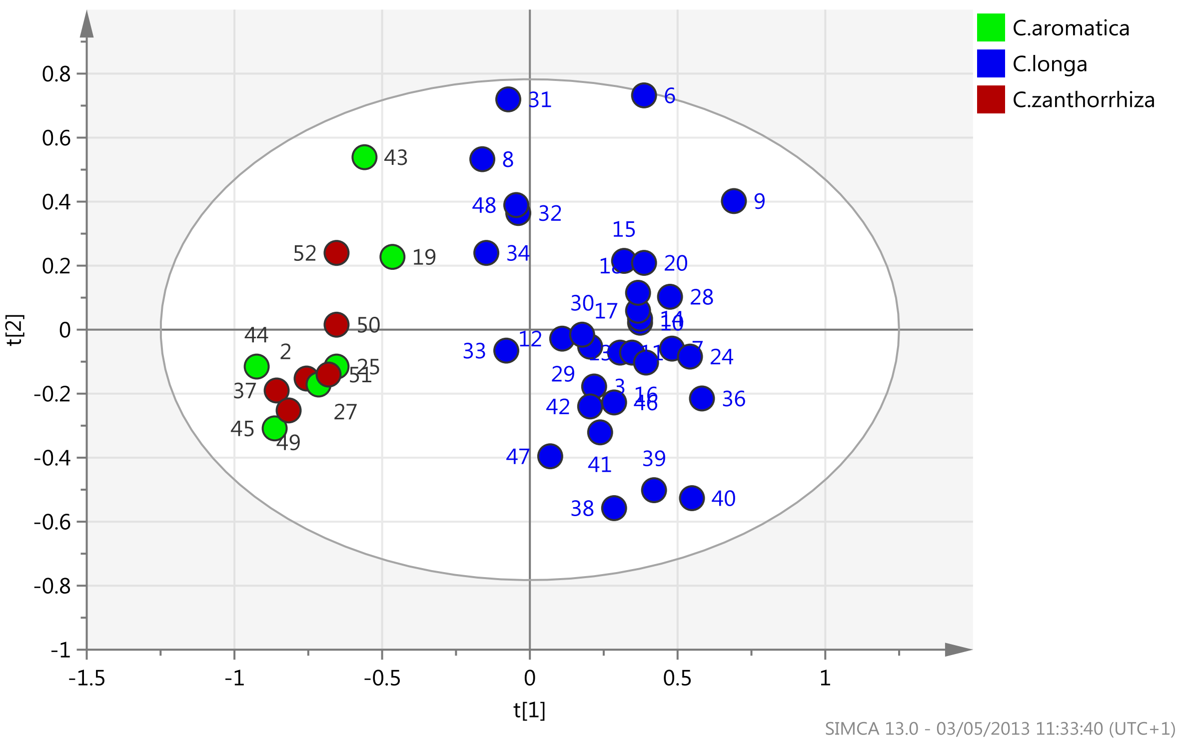


Figure 55, Scores plot comparing all powders, roots and rhizomes, grouped by species, PC1 VS PC2, n = 44

In Figure 52, sample 5 appeared to be grouped with the *C. longa* samples and in Figure 53, sample 5 was grouped with the aqueous extracts, suggesting that it was an aqueous extract of *C. longa*; however, this was not concordant with the product information that was held on this product. In the contributions plot, Fig. 56, sample 5 was high in the carbohydrate region (3-5ppm), which is consistent with high sugar content.

Subsequent HPTLC analysis confirmed that this was not an aqueous extract and was not *C. longa* as the PCA suggested (see Fig. 64) and it did contain high amounts of sugars (see Fig. 69).

Sample 9, a mixture of a standardised extract and powder appeared where expected (Fig. 53), somewhere between the powders and extracts. The other mixture of this kind (Sample 8), however, was placed firmly within the powder group indicating that the product was not high in curcuminoids as would be expected for an extract.

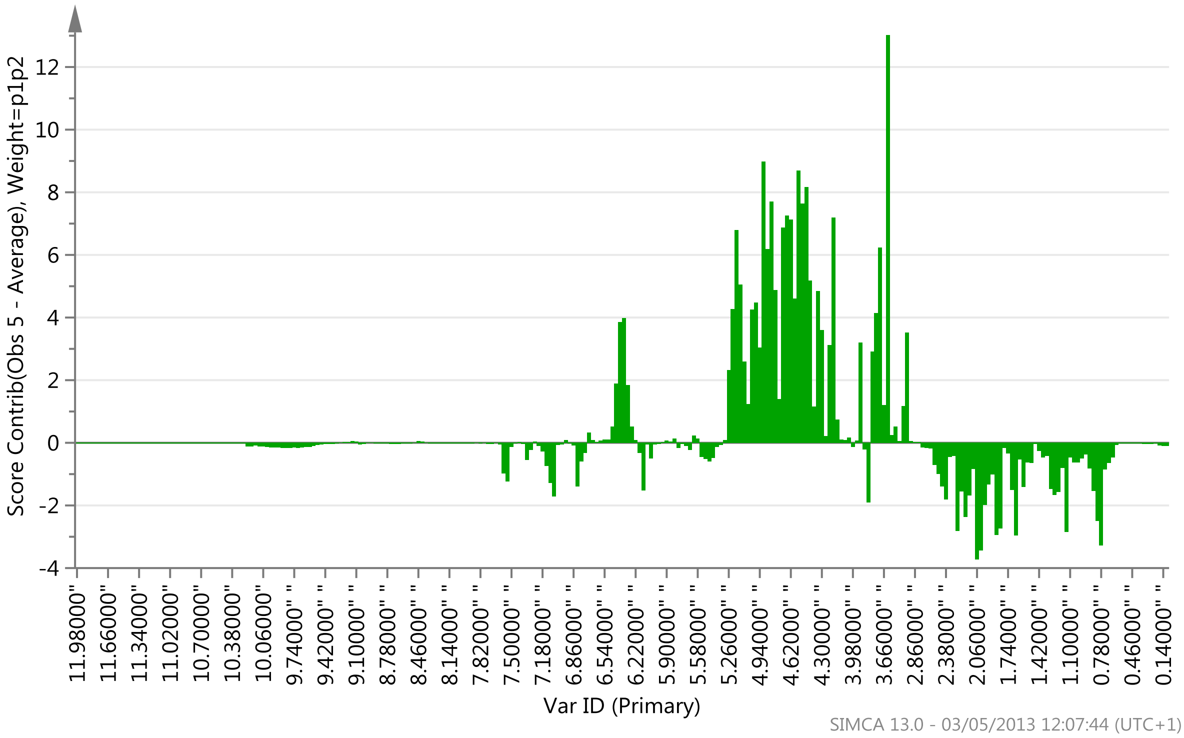


Figure 56, Contributions plot showing the metabolite differences between sample 5 and the group average peak intensities for the remainder of the samples, n = 52

The metabolite variability between species was chiefly in the curcuminoid region (in *C. aromatica* and *C. zanthorrhiza*, bis-demethoxycurcumin was absent, a phenomenon confirmed by HPTLC, see Fig. 64) and variation was also observed in the lower range of chemical shift where one would expect to see essential oils (Fig. 57). One reported difference between *C. longa* and *C. aromatica* / *C. zanthorrhiza* is that the later species do not to contain tumerone, the essential oil which gives *C. longa* its distinctive aromatic smell.

Sample 19 was interesting as although sold as C. longa it is appeared to be contaminated with *C. aromatica* or *C. zanthorrhiza.*

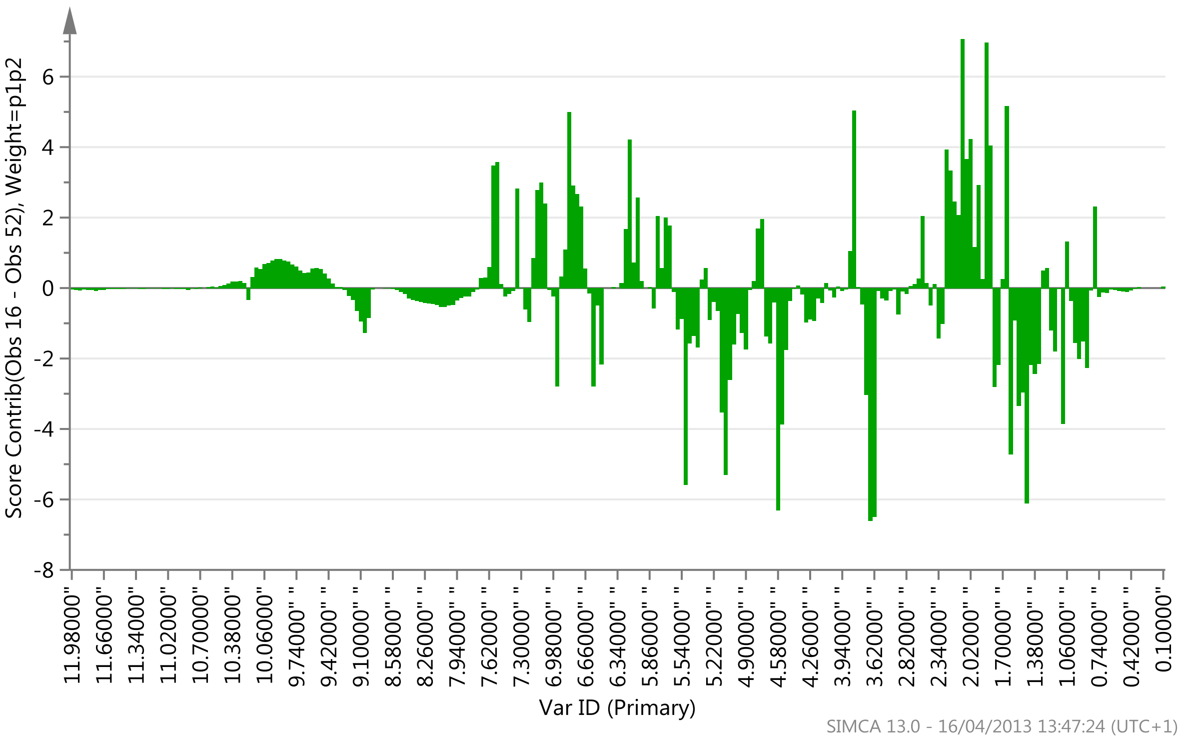


Figure 57, Contributions plot showing where the main differences in metabolite composition occur between a sample of C. longa (sample 16) and C. zanthorrhiza (sample 52)

C. aromatica samples were not well separated from *C. zanthorrhiza* samples (see *Fig. 58).* The curcuminoid composition between *C. zanthorrhiza* and *C. aromatica* is not a major variable and so in order to find differences between these two species, it was necessary to examine different principal components.

A pattern was observed between the species and samples 49 to 52 were particularly well grouped (Fig. 59). These four samples came from the same geographical location.

Although sample 2 was labelled as complying with the British Pharmacopoeia and the company claimed it was *C. zanthorrhiza*, the data suggested that it was more similar to the metabolite profile of *C. aromatica.*

Sample 37 was supplied, certificated as *C. zanthorrhiza* but had been subjected to fumigation which may have affected the ^{1}H-NMR spectra.

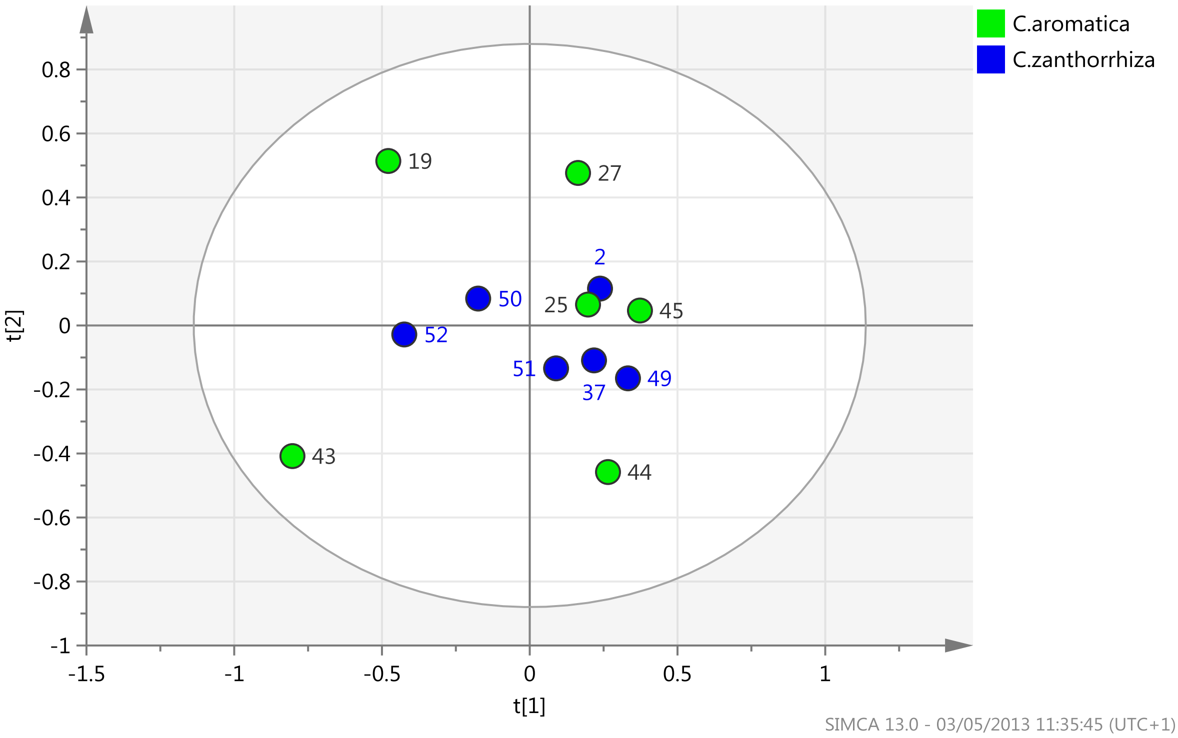


Figure 58, Scores plot showing differentiation of *C. aromatica and C. zanthorrhiza*, PC1 VS PC2 , n = 12

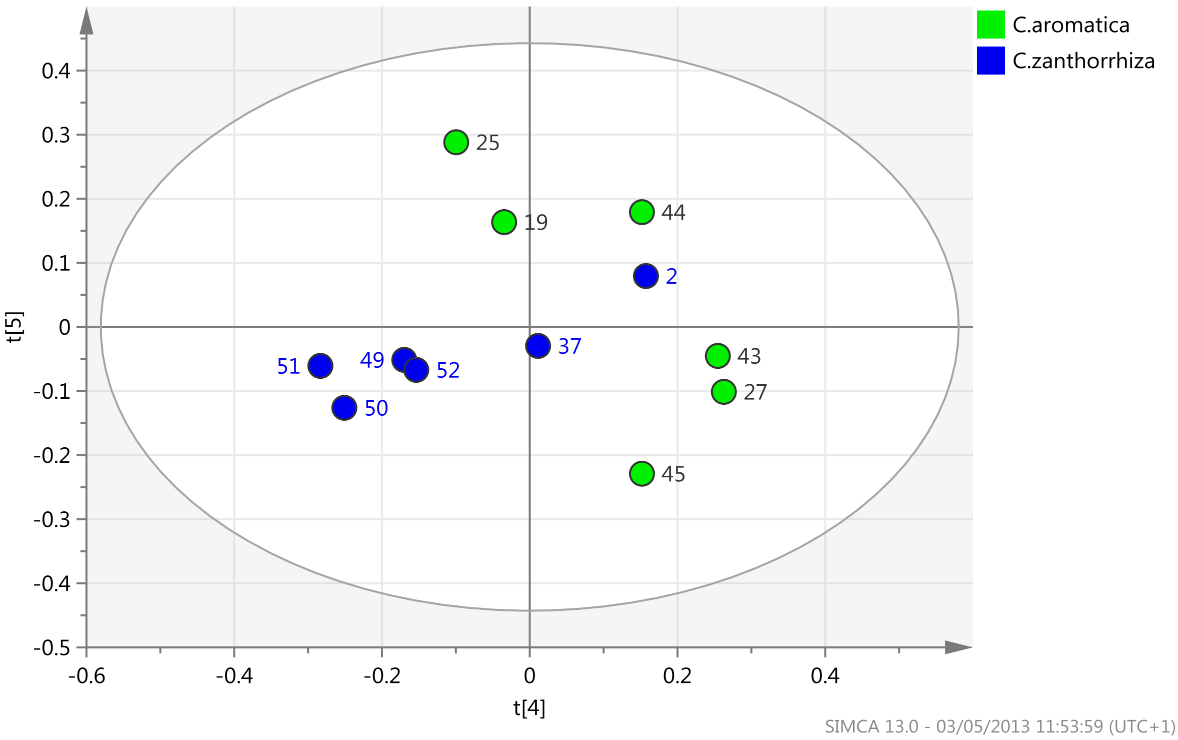


Figure 59, Scores plot showing differentiation of C. aromatica and C. zanthorrhiza, PC4 VS PC5, n = 12

Foods, medicinal powders, rhizomes and a root tuber were examined, finding that PCA differentiated these well (Fig. 60). The fresh rhizomes (38, 39 and 40) the recently dried Erode samples, (31, 32 and 33) the 3 organic samples from the integrated chain (12 and 47), and the 2 samples from a TCM supplier (29 and 30) were mainly differentiated from the food powders.

Sample 24 was interesting in that it was sold as a herbal medicinal product by a major Indian Ayurvedic company but according to the PCA was very similar in composition to the food powders.

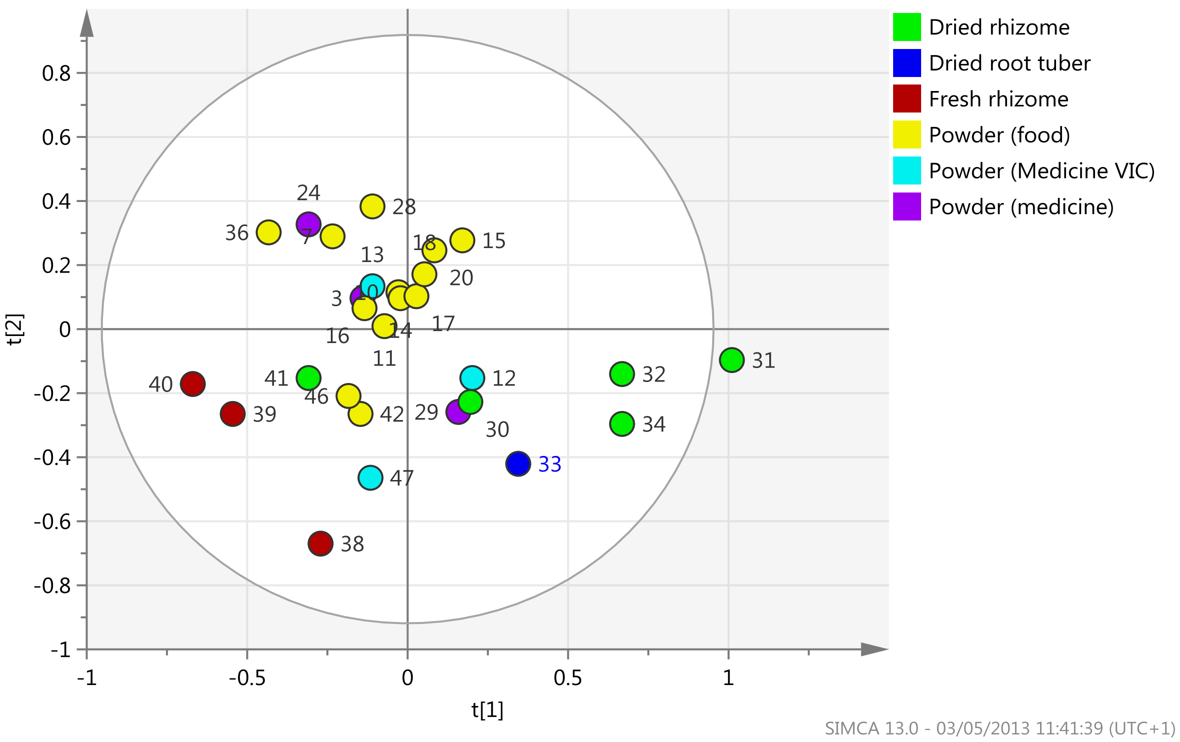


Figure 60, Comparison of all powders, dried roots, rhizomes and fresh rhizomes, PC1 VS PC2, n = 28

Fig. 61, compares sample 47, the integrated chain finished product, against the average peak intensities for the remainder of samples shown in Figure 60. This sample appeared to be lower in curcuminoid content compared to the powder food samples but higher in the low chemical shift range, indicating that it was higher in essential oil content. Sample 47, the integrated chain finished product exhibited a metabolite profile similar to that of the fresh turmeric samples.

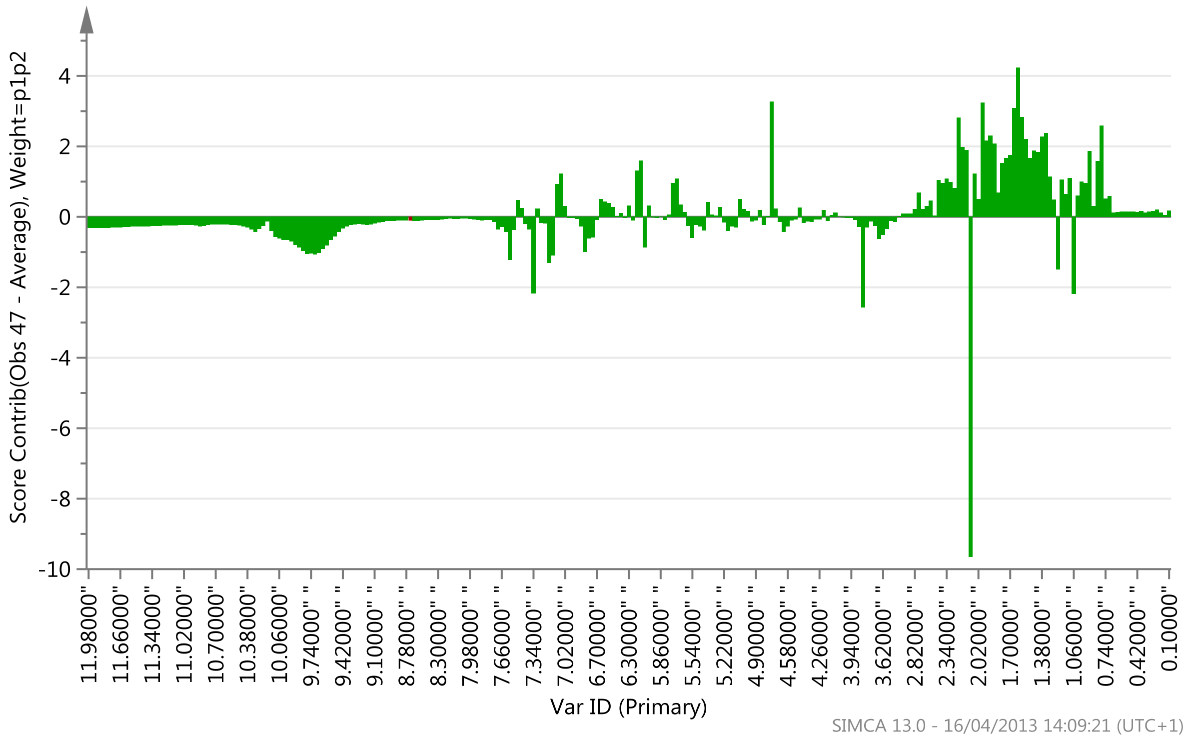


Figure 61, Contribution plot showing metabolite differences between sample 47 and the average peak intensities for the main group shown in Figure 60 (n = 28)

Sample 47 was compared to an ethanolic turmeric extract sample 1, (Fig.62) where it was observed that compounds were lower in the curcuminoid region but higher in the essential oil region compared to the ethanolic extract.

This may be a result of the high temperature processing employed in the ethanol/water extraction process, which can result in a high loss of volatile compounds, whereas sample 47 has not been subjected to prolonged high temperature processing but has only been boiled for a short time (a necessary step to prevent further plant growth and reduce microbial load) and then dried at ambient temperature.

Moreover, sample 47 may be richer in these volatile compounds (compared to sample 1), as it has been processed into a final product relatively soon after harvesting (an advantage of belonging to VIVC).

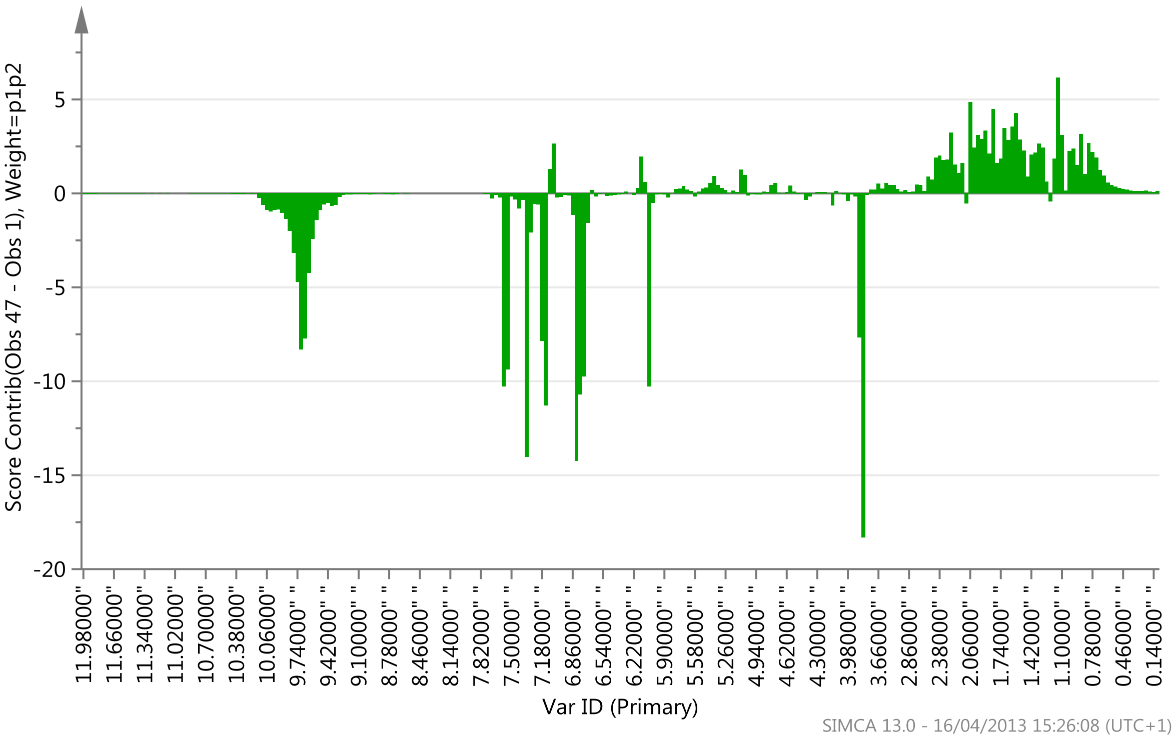


Figure 62, Contribution plot showing metabolite differences between sample 47 and an ethanol extract, sample 1, n = 52

The aqueous extract of *C. kwangsiensis*, sample 21, contained less of the curcuminoids or essential oils seen in the other products but chemical shifts in the carbohydrate region suggested it was comparatively high in sugars (Fig. 63).

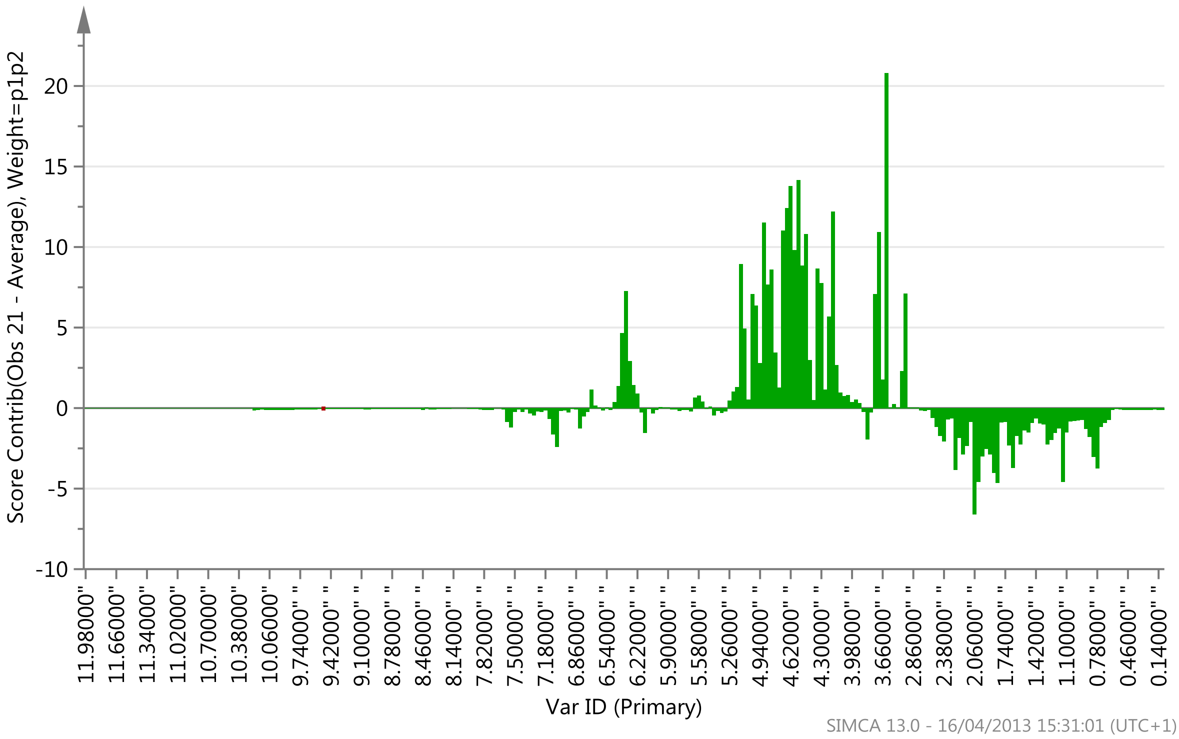


Figure 63, Contribution plot showing metabolite differences between sample 21, an aqueous extract and the main group, n = 52

9.2 HPTLC analysis

Forty samples of turmeric and turmeric products were analysed by HPTLC. A curcumin standard was run alongside the samples in order to identify the three major curcuminoids. Curcumin (Top band), demethoxycurcumin (middle band) and bis-demethoxycurcumin (bottom band).

In Fig. 64, Group1 includes *C. aromatica* and *C. zanthorrhiza* and group 2 consisted of *Curcuma longa*. Bis-demethoxycurcumin (Rf 0.18) was only present in C. longa.

Group 3 are the ethanolic / SCF extracts, (35, 1, 4, 9 and 48), aqueous extracts (21, 22 and 26) and some products (54, 34 and 8) that displayed weaker intensity zones. Group 1 samples exhibited strong zones at Rf 0.58 and at Rf 0.82. These zones were observed faintly in some of the *C. longa* samples indicating possible contamination or adulteration.

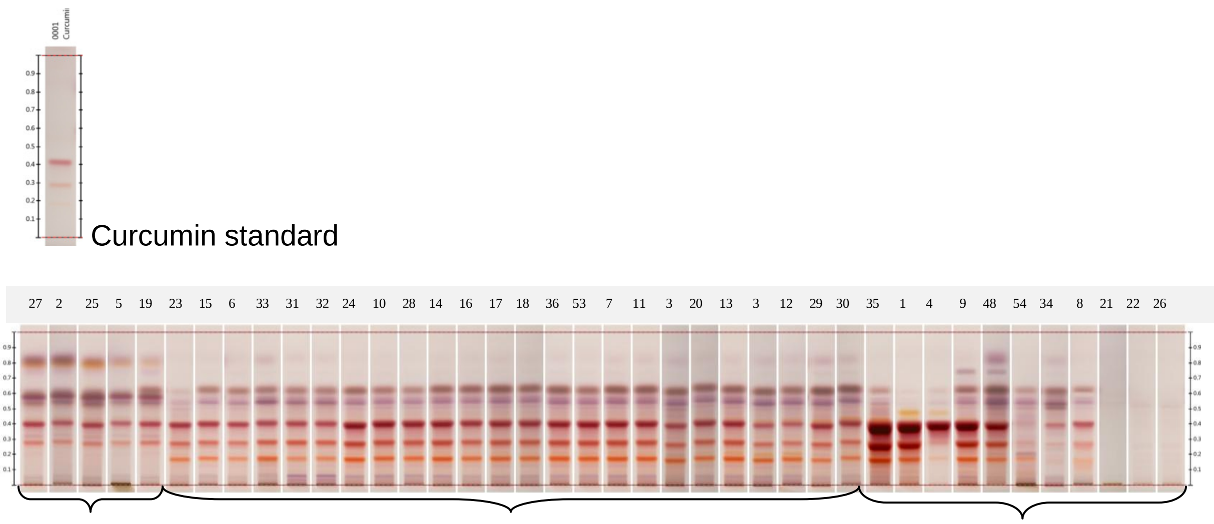


Figure 64, Derivatised plate under white light showing curcumin standard and samples separated into 3 groups. Mobile phase toluene, acetic acid 4:1(Curcuminoid system)

Group 3 divulged information on some of the most diverse and interesting samples. Sample 48, a Super Critical Fluid (SCF) extract, appeared to contain more compounds than the other extracts. The samples in the last three tracks were aqueous extracts and no curcuminoids or essential oils were detected. Sample 23 was unusual in that it was an aqueous extract but contained curcuminoids. Sample 19 was sold as turmeric but was likely to be *C. aromatica* or *C. zanthorrhiza*. Sample 34, a TCM product was different to other C. longa chromatograms and may be *C. kwangsiensis*. The two products that were mixtures of ethanolic extract and powder gave differing results. Sample 9 showed strong bands and looked similar to the SCF extract, whereas sample 8 exhibited weak intensity bands in comparison to the other samples. Sample 54 was a cold ethanolic extract and was relatively low in curcuminoids but did show a dark band close to the application point consistent with essential oils in this system. Sample 4 exhibited a strong zone for curcumin but very little for either of the other two curcuminoids. This sample was unusual in that it was the only sample that was not sampled directly but was given to me by the company after a one day interval.

HPTLC was performed to determine if there was any differences between samples that were sold as fresh rhizomes, the samples obtained through the integrated chain and those that had been boiled, dried, polished and stored (the traditional method).

My first hypothesis was that the samples obtained through the integrated chain would have a metabolite profile that was closer to that of a fresh rhizome as the boiling, sun-drying, polishing and storing steps were not used. My second hypothesis was that samples obtained through the traditional route may be adulterated with some other Curcuma species.

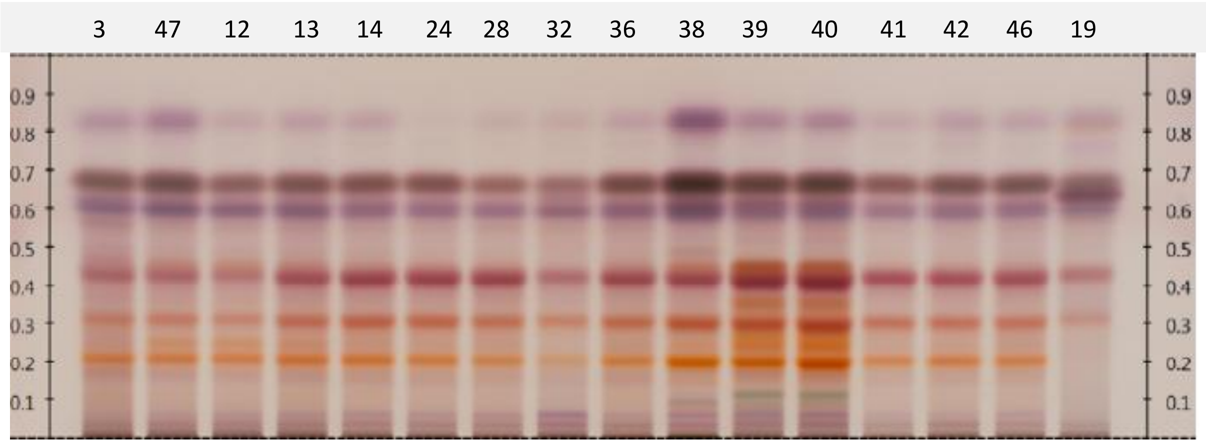


Figure 65, Derivatised plate under white light. Mobile phase toluene, acetic acid 4:1(Curcuminoid system)

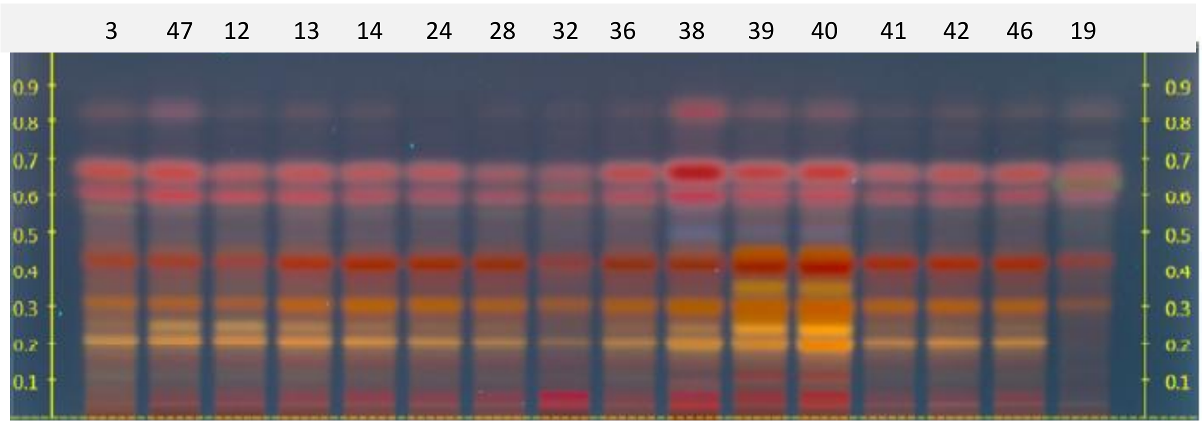


Figure 66, Derivatised plate under UV 366nm. Mobile phase toluene, acetic acid 4:1 (Curcuminoid system)

More compounds were present in the freshest samples 38, 39 and 40 (figures 65 and 66). These were fresh rhizomes that had not been boiled or dried. The integrated chain samples 47, 12 and 13, displayed a strong zone at Rf 0.25, which was also observed for 38, 39 and 40. There was also a stronger zone for the integrated chain samples and the fresh rhizomes at Rf 0.83. Sample 19 displayed a different pattern, having an extra zone at Rf 0.65 and the bis-demethoxycurcumin zone at Rf 0.2 was missing (consistent with *C. aromatica* and *C. zanthorrhiza*.) indicating that this sample was not *C. longa*.

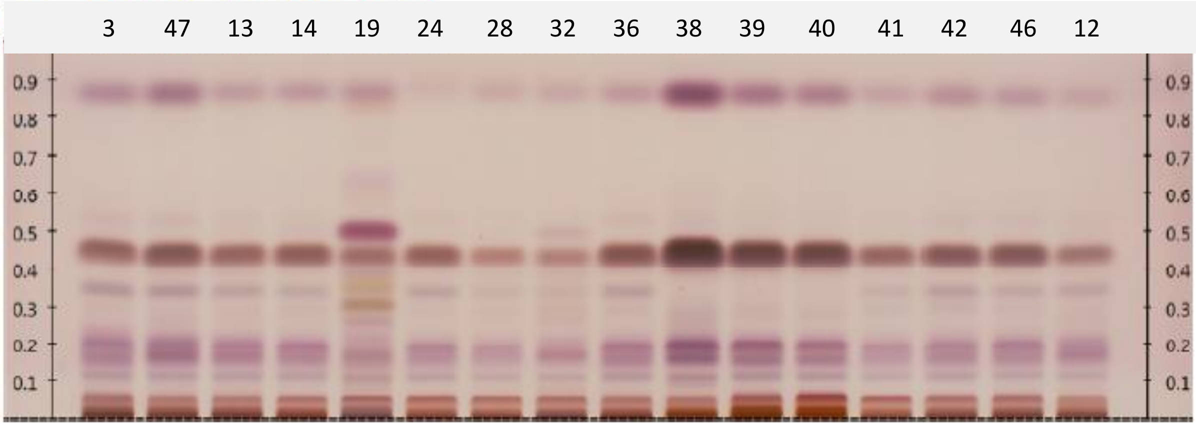


Figure 67, Derivatised plate under white light. Mobile phase Dichloromethane (essential oil system)

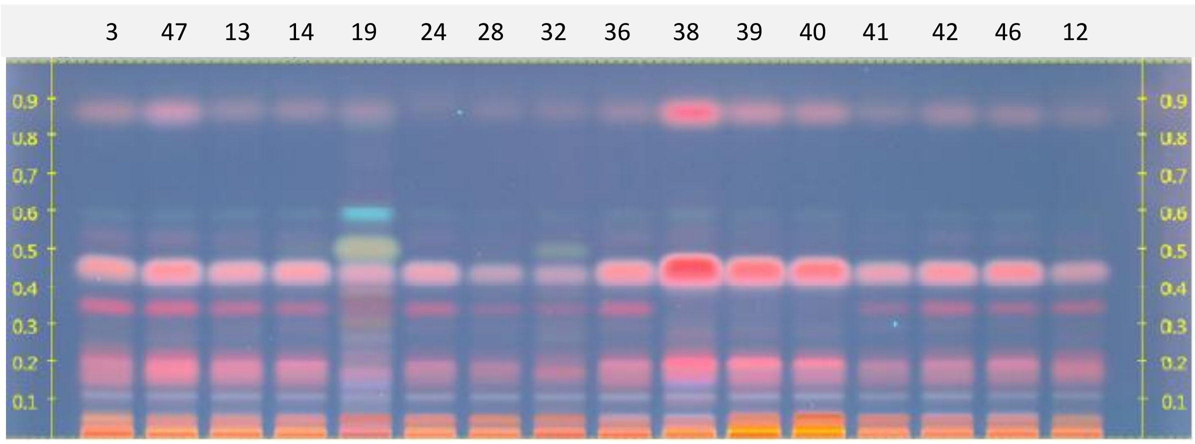


Figure 68, Derivatised plate under UV 366nm. Mobile phase Dichloromethane (essential oil system)

In the HPTLC analysis of the essential oil system sample 19 stood out as being different from the rest of the group and was likely to be *C. aromatica* (Fig. 67 and 68). Sample 32 was a polished rhizome from Erode and had a band at Rf 0.5 indicating possible adulteration with *C. aromatica*. Sample 47 (track 2) showed a strong zone at Rf 0.86 that was also observed with the fresh rhizome samples. Moreover, for the fresh rhizomes, there was a zone absent at Rf 0.35 that was present in the other samples. This could possibly be a breakdown product caused by heating or storage.

Fig. 69 shows the aqueous extract samples compared against the standards, sucrose and fructose and a turmeric food powder. It was observed that the food powder only contained compounds with similar RF's to the standard sugars whereas the aqueous extract products contained more sugars. From the position on the plate of these sugars it is likely that they are more complex polysaccharides.

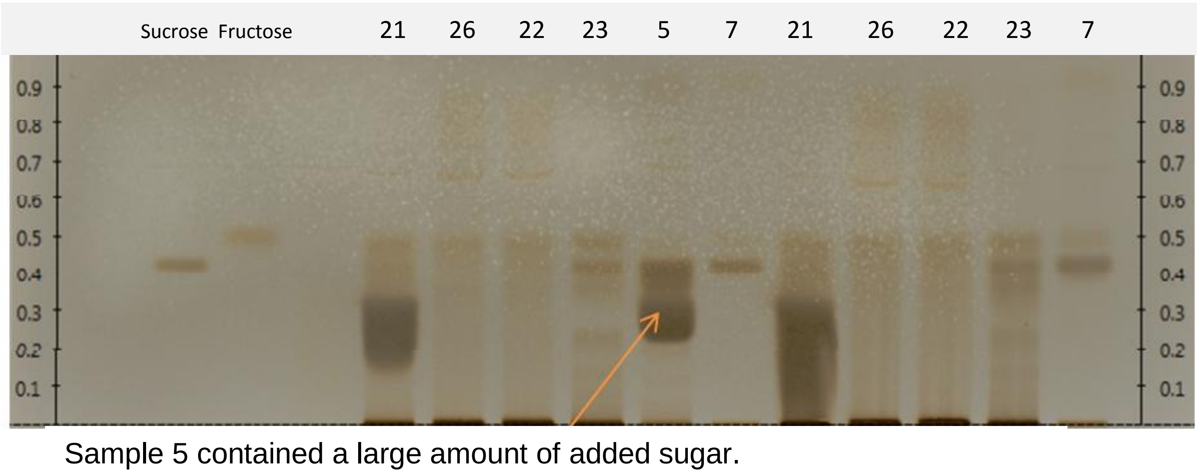
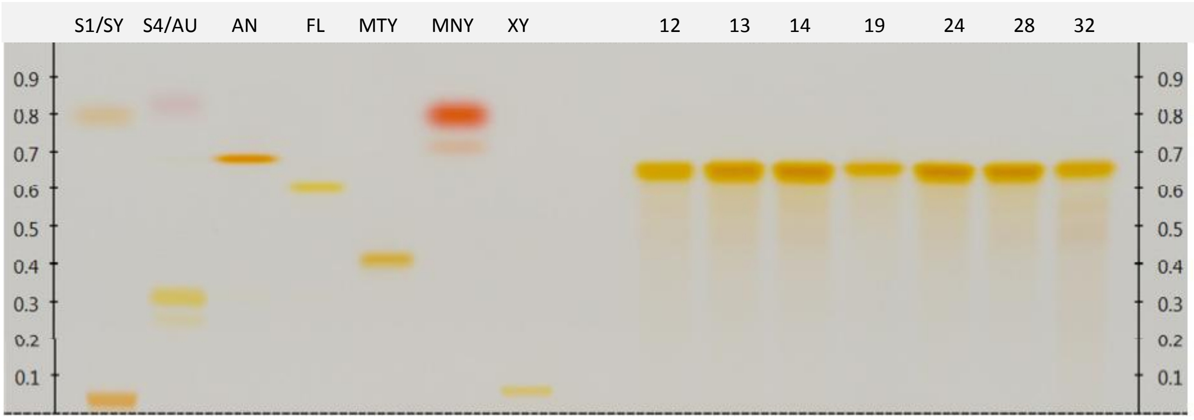


Figure 69, Derivatised plate viewed under white light. Mobile phase: Acetonitrile: acetone: water 40:40:20 (sugar system)

Figure 69 confirms that the TCM aqueous extracts contain mainly sugars. Sample 5 was not an aqueous extract but was placed with the aqueous extracts in the PCA due to the large amount of added sugar that it contained. Sample 7 appears only to contain sucrose and fructose.

Seven samples were selected that were suspected of possible adulteration with artificial dyes and run against the vertical chain samples. No artificial dyes were detected by HPTLC in any of the samples tested (Fig. 70). There was some tailing which may have obscured the zone associated with fluorescein. A modified mobile phase could be used to make this zone clearer.



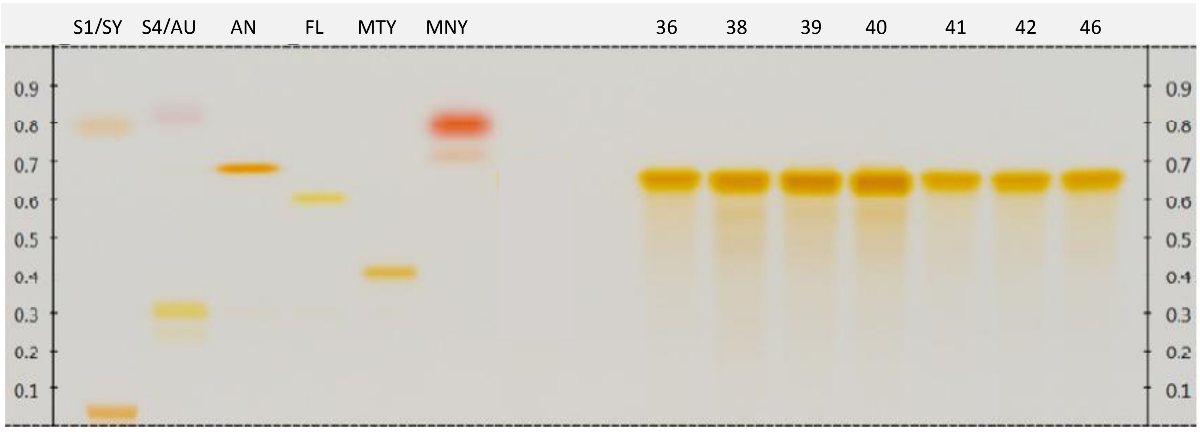


Figure 70, Plates viewed under white light[19], Mobile phase: Toluene: methanol: acetic acid 32:8:10 (Artificial dye system)

For further details of the HPTLC materials and methods and a fuller presentation of all the HPTLC analysis, see appendix 7.

[19] S1: Sudan I, SY: Sunset Yellow, S4: Sudan IV, AU: Auramine O, AN: Aniline, FL: Fluorescein, MTY: Metanil Yellow, MNY: Menthyl Yellow, XY: Xylene 2G

The HPTLC data provided some evidence that there were compounds present in the fresh root samples that were less evident in the ground powder samples. The integrated chain product showed this (see figure 66).

I hypothesised that this compound was likely to be an essential oil (I had witnessed during the fieldwork stage how turmeric can be stored for long periods in sub-optimal conditions) leading to the loss of volatile compounds.

In order to test this hypothesis, I acquired some tumerone reference standard (tumerone is reportedly the main essential oil component in turmeric) and ran an NMR analysis on the standard and compared this to the samples of interest in the HPTLC chromatogram (sample 47 from the VIVC, sample 32 from the traditional route of supply and sample 40 obtained from the fresh root of *Curcuma longa*.

Figure 71 shows the comparison between the NMR spectroscopy and HPTLC results. Tumerone was positively identified in the samples, giving unique peaks at 6.14 (singlet) and 7.08 (quadruplet). Comparing the intensity of the zones at Rf 0.25 in the HPTLC chromatogram against the intensity of peaks in the NMR-spectra, there is good visual correlation between the two techniques and it is probable that the zones at Rf 0.25 are caused by tumerone. This should be confirmed by running a tumerone standard during the HPTLC analysis.

The NMR spectroscopy data confirms that tumerone is present in the VIVC chain sample (47) and at a comparatively higher level than the sample taken from case study 1 (A polished rhizome from Erode, sample 32).

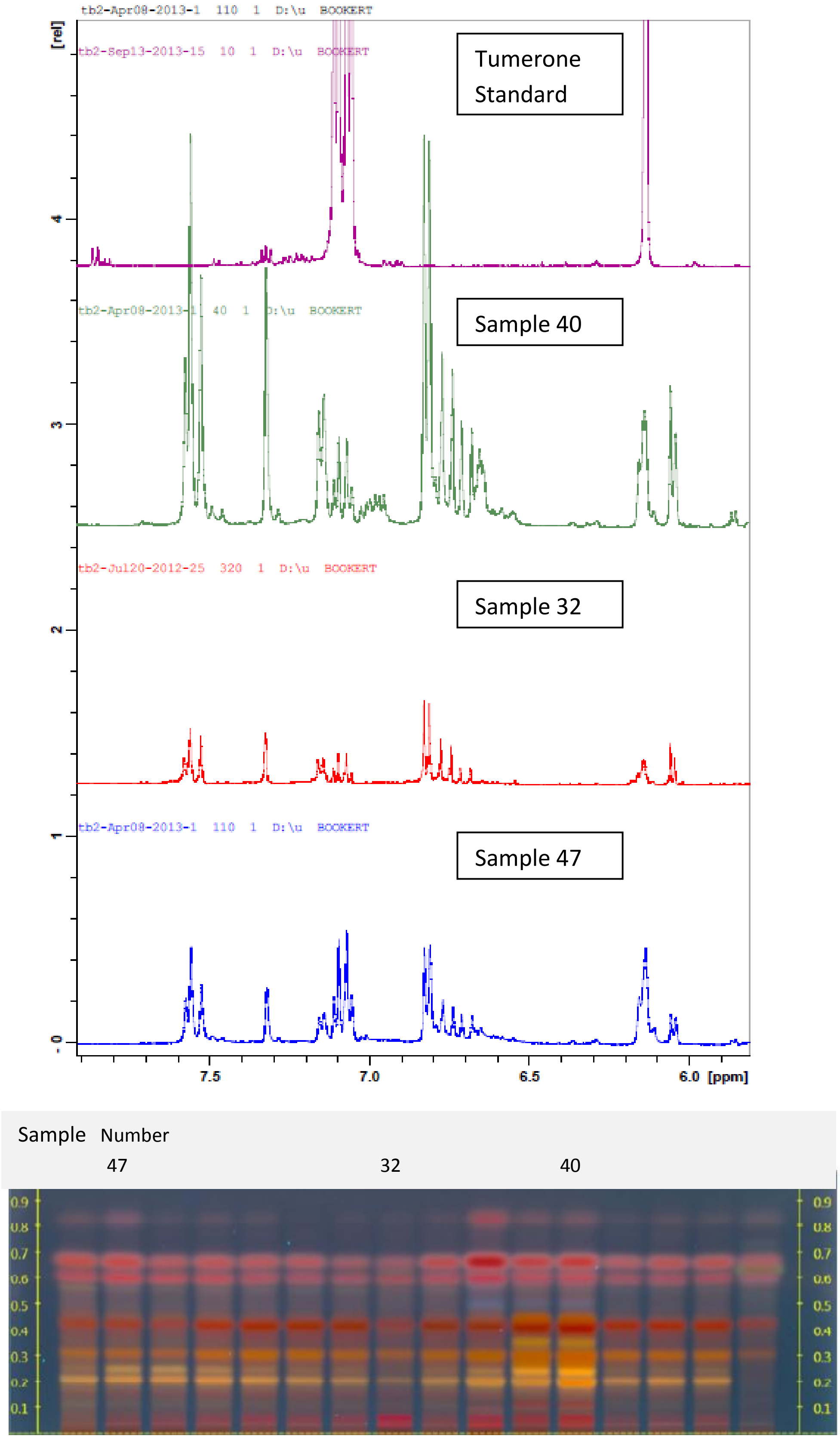


Figure 71, Comparison of NMR spectroscopy and HPTLC results with reference to the presence of tumerone.

9.3 Discussion of analytical results

I have shown that the chemical composition of raw materials is variable (see Fig. 55) and that finished products are not always of an acceptably consistent quality (e.g. samples 19 and 32 (Fig. 68), sample 7, (Fig. 69)). However, there are strategies that can be introduced that may be able to address the problems from the bottom up and one of these strategies is the implementation of a sustainable VIVC.

The fieldwork investigations and laboratory analysis has demonstrated that the chemical composition of *Curcuma longa* and the resulting turmeric products can vary greatly (see Figs. 53 and 64). It is evident that many of the quality related problems associated with the product can be traced to economic factors (e.g. long term storage when market price is low).

This study has shown that traditional methods of cultivating, storing and selling *Curcuma longa* can lead to adulteration of the supply chain by incorrect curcuma species (e.g. sample 32, Figs. 67 and 68). The adulteration often takes place at the polishing stage, where ground powders are added to improve the colour of the rhizomes. Because the VIVC product is not polished and is not destined to be sold at auction, (in the auction good colour is likely to have an incremental effect on the price), adulteration is more effectively controlled and prevented.

I have shown that a proportion of the sampled products, the aqueous extracts, contain few compounds that would generally be regarded as therapeutically relevant (see Figs. 64 and 69). Although some research has indicated that water-soluble polysaccharides may have some anti-inflammatory effect (Tohda et al., 2006). However, at least one of the aqueous extracts examined appeared only to contain the simple sugars sucrose and fructose (sample 7, Fig. 69).

The main compounds accepted as being therapeutically important are the curcuminoids and to a lesser extent the essential oils, all of which were undetectable in the majority of aqueous extracts tested. The one exception being an aqueous extract TCM product (sample 23), where the results indicated that some of these non-aqueous compounds were present (see Fig. 64). On subsequent investigations with representatives of the manufacturing company it was discovered that crude ground powder is added to the extract as a filler and in order to improve its chemical composition and so this product cannot be regarded as a true aqueous extract.

I have observed and measured how some products have different chemical characteristics to others, how some are different species, are extracted using different methods, and have different ratios and concentrations of phytochemical compounds.

With respect to the medicinal quality of *Curcuma longa* products, I have highlighted how only two of these products differ from the main group of herbal medicinal products and from the mass of ground turmeric available as a food ingredient. One of these is a Chinese medicinal product (samples 29 and 30, Fig. 60) (also obtained from a VIVC) and one is from the integrated chain examined during the fieldwork stage of this study (samples 12 and 47, Figs. 60 and 66).

The data generated through this project suggests that this additional metabolite is likely to be an essential oil. From the literature I had discovered that tumerone was a major ingredient in *Curcuma longa* and was chiefly responsible for its distinctive aroma. Using ^{1}H-NMR spectroscopy, I compared different samples to a tumerone reference standard and confirmed that the integrated chain product is relatively high in this compound compared to a sample taken from the traditional route of supply (see Figure 71).

It is these more volatile compounds that are likely to be lost during long term storage or due to the heat caused in the traditional grinding process and so this data supports the traditionally held view that turmeric should be stored in an air tight container and used within three months (Booker, 2012, fieldwork Interviews).

I have hypothesised that by establishing a well-managed and well monitored vertically integrated value chain, end companies can exert a greater degree of control over processes and procedures that can lead to a better quality product. The analytical study has provided crucial evidence to support this by demonstrating that the samples obtained from a VIVC are free from known adulterant dyes (see Fig. 70) and that they are comparably closer in chemical composition to the freshest rhizomes tested, than other samples in the study typically representing the traditional route of supply (see Figs 65 to 68).

Turmeric medicinal product samples obtained from within a vertically integrated value chain, show a closer resemblance to fresh samples of turmeric rhizome with respect to their metabolite content than samples obtained from the general market. Samples of turmeric obtained from a non-integrated chain have shown to be contaminated with curcuma species other than *Curcuma longa*. Most of the products sold as aqueous extracts (mainly TCM products) contained little trace of compounds that were present in the powder and that would generally be regarded as quality indicators; some contained polysaccharides but the HPTLC analysis confirmed that others only contained simple sugars.

10.0 General Discussion

One of the main priorities of research for LCIRAH is to establish, develop and promote strategies that investigate the links between agriculture and health and particularly in connection with international development. The LCIRAH ethos has been to promote interdisciplinary research in order to approach and investigate areas of interest using a wide knowledge base and using research tools from varied disciplines.

The central theme running through this project has been the investigation of value chains and how different value chains may have an impact on the livelihoods of actors working along the chain and how these different value chains may affect the quality of the finished HMPs.

Using an interdisciplinary framework, I have investigated value chains using a variety of methods. I have used a socio-economic approach to discover what types of value chains can be discovered during a comparatively short fieldwork investigation and how different actors are placed within a particular chain. I have used socio-economic methods to assess the standard of living of different actors and how livelihoods are affected through participation in different value chains and what power dynamics exist between the companies and individuals who act as the links within the chains. I have then used laboratory methods to investigate the composition and aspects of quality of different products produced within these chains.

For the first time it has been possible to link together the concepts of the value chain with analytical analysis in order to evaluate whether certain chains work better than others and whether the finished products produced through a VIVC are any different in terms of quality than those produced through more traditional methods.

Consequently it may be possible to determine whether the additional benefits or financial premiums paid to actors involved at the start of the chain (i.e. the primary producers) can be supported through the production of analytical data of this kind.

10.1 Globalisation of HMPs

Practices and attitudes to medicinal herb production in China and India have changed from being mainly local enterprises to being global commodities (Sharma, 2004). This change has particularly been prominent from a period in the mid 1980's when China officially began opening its doors to world trade, and in the early 1990's in India, following the introduction of liberal economic reforms, which lowered trade barriers and taxes, loosened the grip of state run monopolies and promoted competition within industries. These reforms enabled India to integrate more effectively into the global economy and laid the foundations for future growth (Das, 2012).

Being the largest employment sector, employing approximately 52 per cent of the total number of jobs, providing over 70 per cent of rural households' main source of income, and contributing 18 per cent to GDP, agriculture and the manufacture of goods from agricultural raw materials has been an important area for the development of overseas partnerships and industrial trade (Arjun, 2013) but unlike the information technology industry and India's 'silicon valley', the opportunities for workers have been fewer and the wages far less. It has been argued that agricultural workers have been unfairly treated by some of the major international companies that operate in India (Hilary and Dromey, 2010, Fairtrade, 2010).

The economies of India and China are growing rapidly and the development of a medicinal plant export industry should be examined in this context. China appears ahead of India in many economic areas and seems to be achieving exponential growth but in the pharmaceutical arena, India has demonstrated that it leads China in terms of pharmaceutical innovation (Adams et al., 2013) and so a challenge for Indian companies is to apply this ethos to the medicinal plant industry.

10.2 Trade and livelihoods

There is a trend developing within the food industry where consumers are becoming more interested in the provenance surrounding food (YouGov, 2013); this can be readily observed by reading the descriptions of food on the shelves in most UK supermarkets. No longer does labelling just offer a list of ingredients or information about the nutritional value of the food but it is now possible to read about from which geographical location food originates, the environment in which an animal was kept, how a plant was grown, whether any pesticides were used, there is even information about the farmers who reared the cattle or grew the coffee. In return for assurances that the food has been produced ethically, and often with added benefits to the farmers, consumers are required to accept that value has been added to the product through this philanthropy and consequently are required to pay a premium for it (Carruthers et al., 2013).

This change in ethos has the potential to move into a wide variety of consumer goods, including food supplements, functional foods and HMPs and more so than for cultivated and collected plants destined for pharmaceutical extraction and conversion into single drug entities, where efficacy remains the main driver.

As India’s GDP increases and a larger percentage of the population become wealthier, consumer demand for organic medicinal products is likely to continue to grow and will provide an additional market for high quality and organic medicinal plants.

The knowledge base and expertise needed to produce these products is most crucial at the beginning stages of production and so it is reasonable to expect that growers will have a fairer distribution of revenue through the value chain. In turn consumers in Europe can expect to gain from having access to a wider range of Asian grown, higher quality and safer herbal medicinal products.

The literature review revealed emerging evidence to indicate that farmers and pickers are beginning to move away from the traditional route of selling their herbs at the local or provincial herb markets and are beginning to form alliances with local pharmaceutical companies or with regional sourcing companies in order to gain access to the more lucrative export market (Prahalathan, 2004, Kala et al., 2006).

The perceived benefits to the farmer to this approach are mainly market price stabilisation and a fixed-term contractual arrangement that allows for longer term planning, where the buyer is able to provide target crop yields for the farmer and agree a contractual price that will not be easily affected by many of the market shocks that may negatively impact on the market traders. Moreover the farmer has access to a wide range of inputs that are necessary help to cultivate medicinal plant crops effectively.

This contractual approach was corroborated by my fieldwork investigations in China and India where by paying an agreed price for an assured quantity of herbs the buyer can expect to have greater input and control over the quality of the herb material; the buyer or appointed sourcing company can request that crops be collected at certain times of the year and that they are collected, dried and stored in accordance with the buyer's specification. This seems to be a logical and pragmatic approach to satisfying both the demands of international trade and the need to assure consistent and stable price structures.

However, it is the very nature of an unstable and fluctuating market that continues to attract and sustain interest in the medicinal plant trade at the traditional market level and it appears by far to be the more common route of supply.

It may be that there is room for both approaches; the free market for those who want to speculate, chiefly supplying to other traders and the Asian HMP manufacturing market, and those who are more inclined towards receiving a steady income with price guarantees and regular orders and who are amenable to modifying their working practices to satisfy the needs of international buyers.

Moreover there is some evidence from the literature to suggest that VIVCs can have a detrimental effect on livelihoods and lead to primary producers being exploited by large multinational companies. Work on the effect on livelihoods from the cultivation and supply of Madagascan periwinkle (Neimark, 2012) serves as an illustration of this. However, this is not a totally new phenomena as bio-prospecting and the extraction of active drug substances from plants has been born from a long history of the exploitation of other countries' natural resources and the development of drugs from them e.g. curare, caffeine, opium.

However, an important difference with respect to HMPs and the VIVC investigated is that the VIVC retail company is keen to exploit the ethno-botanical history of the use of these 'medical plants' and the socio-economic conditions that they are grown in, and so the cultivation practices and the livelihoods of the labour force that is involved in the initial stages of production become an integral factor in the successful marketing of such commodities. This is a very different position from drugs obtained from plants where the end user is unlikely to be concerned or even aware of any botanical origin a particular drug may have.

10.3 *Curcuma longa*

As a case study, *Curcuma longa* (Turmeric) has been shown to be an important plant in terms of its economic significance, usage within Europe and future potential as a herbal medicinal product. In 2011 to 2012, Indian turmeric had an estimated total export value of US$120 million, exporting approximately 80,000 tonnes of turmeric globally (IndianSpices, 2013).

Turmeric's use as both food and a medicine presents an opportunity to show how a value chain may be different for a food and a drug and how different varieties may be better suited for different uses. The quality problems that are inherent within the turmeric market will help us to understand better the influence of quality standards on the value chain and how a product may be prone to adulteration, especially when lacking suitable controls and without a VIVC in place.

For the farmers and collectors, changing working practices and changes in the governance of the regulation of medicinal plant cultivation are a priority. If higher quality raw materials can be produced for the export market, this may lead to a shift in equity towards the actors who operate at the beginning stages of the value chain. Moreover, by forming partnerships and alliances with well-established European companies, small farmers can expect greater benefits in terms of total remuneration, governance, training, supply of essential inputs and better business stability for the long term.

By examining a single plant species (*Curcuma longa*), following it through different value chains, and through the laboratory analysis of selected samples, it has been possible to highlight the differences in chemical composition of products emanating from different sources and subjected to a variety of intermediary steps before final manufacture.

10.4 Standards and quality

The cultivation and supply of medicinal plants and the manufacture of HMPs in India, although having a long history of trade, both domestically and internationally, has failed to become a major industry in terms of European exports. India has to some extent attempted to follow the Chinese initiative, with the globalisation of its traditional medical system and particularly with the export of food supplements and HMPs (Patwardhan et al., 2005).

However quality related problems inherent throughout the supply chains of manufacturing industries in India and China, has resulted in finished products that are unable to rival similar products produced within the EU. This has resulted in a poor export profile for these commodities. This deficiency in export trade potential has been further compounded by the introduction of more stringent EU regulations for herbal medicines and according to some industry stakeholders, pressures being exerted by European manufactures[20], on medicines regulators to enforce these new regulations and standards and to close any loopholes that may have allowed for less restrictive trade between Europe and LEDCs (Starling, 2011).

Although it is difficult and often unpopular to argue for less stringent standards in the realm of the food and medicines industries, there are some factors that may lie behind the decision making processes, leading to the introduction of new standards and regulations that are not always immediately apparent.

It is often the companies with the most resources that are able to influence how these higher standards are realised, manipulated and implemented and a counter argument against tighter regulation, is that the standards can be unnecessary, serving primarily the interests of larger companies in their desire for the oligopolisation and ultimately domination of the industry. A good example of this has been within the tea industry in India where a few major companies control most of production (Oldenziel, 2006).

A totally Euro-centric approach, where plants are grown in the EU, and subsequently manufactured and distributed by European companies, may be easier to regulate and have less inherent dangers attached, but in an increasingly globalised market, there should be a means to make products of a suitable standard available from farther afield. This attitude would not only result in a wider variety of products for consumers, but also, may have a positive impact on the lives and livelihoods of primary producers in LEDCs.

This is by no means a totally new concept, European consumers have already experienced food products, including tea, coffee and cocoa originating in these countries and being produced to acceptable EU standards. The difference for HMPs is that, not only are the requirements for testing different to that of foods, but unlike the food sector products, they are yet to be established as global commodities and are

[20] European manufacturers of registered HMPs have complained that many herbal products continue to be found in the retail market available as ‘food supplements’.

entering the market at a time of great change and uncertainty. This makes these products, and the companies that produce them, far more vulnerable to changes in legislation, increases in consumer expectations and market shocks than products produced by more well-established industries.

In the global pharmaceutical industry the quality of raw materials has been an important factor for many years (Strother, 2012) but in the traditional medicines industry, the focus has been directed more towards the end product, with companies investing more heavily towards packaging, marketing and advertising and other end stage activities that are seen as a means to add value to a product. Whereas, the source and quality of the plant material, and the integrity of the initial processing stages, has in many instances, been largely ignored.

Quality remains a concern. China has been plagued by instances of sub-standard quality in many of its industries, including pharmaceuticals and herbal medicines (Bate and Porter, 2009). Although India is regarded as a country that can produce acceptable quality drugs, there are major concerns regarding the production of HMPs, especially regarding authentication of raw materials, heavy metal content and pesticide use (Patwardhan et al., 2005). As found in TCM, Indian systems of herbal medicine still advocate the practice of ingesting heavy metals (Kumar et al., 2006), a practice that will never be acceptable to European medicines regulators.

The THMPD has introduced standards that will help assure the quality and safety of HMPs but its implementation has so far favoured European companies who have the infrastructure and hard-ware analytical and manufacturing platforms in place to deliver this without incurring massive costs. Manufacturers and retailers have intimated that the introduction of the THMPD has decreased their profit margins as in order to achieve the standards, far more quality related expenditure is required (Patwardhan, 2011).

However, for the farmers and collectors, changing working practice may be more important than heavy investment and if high quality raw materials can be produced then it may lead to a shift in equity towards the beginning stages of the value chain. Moreover, by forming partnerships and alliances with well-established European companies small farmers may expect greater benefits in terms of governance, training and supply of essential inputs.

This study has demonstrated for the first time that there are differences in chemical composition in plants obtained from a VIVC compared with the traditional routes and that safety and quality can be better assured through the management of such a chain. Furthermore I have shown that products obtained through a VIVC are less likely to be spoiled or contaminated through microbial growth and paradoxically fewer chemical treatments are needed throughout the chain steps.

For the end user, the customer, there are now safeguards in place to help ensure the safety and quality of HMPs through the introduction of the THMPD. However, apart from acknowledging the plausibility of a herb to treat a particular condition, the directive does not address efficacy.

I have shown how, in the case of *Curcuma longa,* the starting material can be stored for long periods, resulting in deficiency of what may be important therapeutic compounds. Although this material would still need to pass the minimum standards required as determined by the relevant monograph or pharmacopoeia, this does not mean that it would be of optimum therapeutic quality. This is particularly relevant to plant species where the active ingredient(s) are unknown or unproven, as is the case with *Curcuma longa*.

I have highlighted from the literature that although curcumin may be therapeutically beneficial, there are problems relating to its bio-availability and other compounds may also be responsible for its effects. Using ^{1}H-NMR spectroscopy metabolomics and HPTLC, I have shown that the compounds present in the samples obtained from a VIVC are more similar to fresh material than other samples tested. This may be important both therapeutically but also from a general quality perspective. My argument is that, if it is not feasible to provide the fresh plant (as nature intended), then the substitute product should be as close to the plant, phytochemically, as possible. Ensuring that HMPs are produced through VIVCs is a strategy to accomplish this.

10.5 Analytical analysis

One of the central research questions of this thesis concerns the quality of HMPs and how this quality can be measured. Assessing the quality of a plant-based product is arguably somewhat different to assessing a pharmaceutical product. In the latter, the active ingredient, known and unknown impurities, are tested to conform to within set limits, whereas with the majority of plant products, active ingredients are often unknown or unproven and the range of impurities that can be introduced at different stages along the value chain present a particular problem for analysts.

With turmeric, the quality of the material is generally assessed with respect to the content of curcumin, with a stipulated limit of not less than 3.0 per cent (WHO, 1999). However, I have described how curcumin may not be the only compound present that has a therapeutic effect and that the problems associated with its lipophilicity and poor bio-availability have been well described (Shoba et al., 1998, Jurenka, 2009). For these reasons, I chose not to look at curcumin as the only quality marker but to assess the sampled material in terms of its whole metabolite content.

In this study I used two analytical tools, ^{1}H-NMR spectroscopy and HPTLC, in order to better understand the composition and chemical variability of the herbal medicinal products sampled. Both techniques provide different and complementary data and together they can be used to effectively differentiate between a wide variety of crude drug powders and herbal medicinal products. ^{1}H-NMR spectroscopy coupled with multivariate analysis provides a quick method of separating different samples but is sometimes confused by multi-component products or by the addition of excipients. Comparing results against HPTLC helps to avoid this pitfall and together the two techniques provide a clearer picture of sample composition, offering new ways to understand how chemical quality may potentially be linked to local livelihoods and the fast developing market links of ethnopharmacological commodities.

The metabolomic profile of a plant is generally not considered relevant in orthodox testing protocols, where a crude drug or product is generally assessed as suitable or not suitable depending on the concentration of one, or sometimes several, marker compounds and on the absence of impurities. Metabolomics can offer a whole new approach to quality assessment and one that is particularly relevant to medicinal plants, whereby the active ingredient is often undefined, and any therapeutic benefits may be due to the synergistic action of multiple plant components.

As a case study, *Curcuma longa* (turmeric) has been shown to be an important plant in terms of its economic significance, usage within Europe and future potential as a herbal medicinal product. From the literature review I have shown that it has potential as a herbal medicinal product and particularly as an anti-inflammatory, digestive aid and for its use as a vulnerary.

However, the current literature also highlights that the supposed main active ingredients, the curcuminoids, are poorly absorbed even at high dosages (Jurenka, 2009). This has led manufactures to create ‘high potency’ curcumin extracts in an attempt to improve bio-availability (samples 1, 4 and 35).

The results of my study have shown that the majority of products analysed in this class, although higher in curcumin, lose many of the other compounds that have been documented as having an anti-inflammatory effect (e.g. other curcuminoids and essential oils). In a study by Ahmed and Gilani (2013), where different curcuminoids were examined for their effects on Alzheimer’s disease, the authors concluded that the beneficial effects were most pronounced when a curcuminoid mixture was used rather than the single curcumin compound and in several other studies it has been shown that the different chemical compounds work together synergistically .

10.5.1 Analytical analysis limitations

Using a metabolomics approach, where the data generated are subjected to multivariate analysis, can be subject to a certain amount of bias. Differing scaling methods can be used within the software to manipulate the data to suit the expected outcome. Moreover the software can only look at the variation and not any reason behind why a variation may exist and so the addition of excipients and differing extraction procedures need to be taken into account when viewing the statistical analysis and sometimes it is necessary to refer back to the raw NMR spectra for individual samples. I have minimised these biases and produced a truer picture of the metabolite composition through the use of HPTLC. This analytical technique gives a clearer view of individual compounds within the samples and allows for selective analysis of different groups, (e.g. sugars, essential oils), through the use of different solvent systems.

10.6 The sustainable value chain

Un-restricted growth cannot be sustainable within a contained system (Hardin, 1968) and the medicinal plant / herbal medicine industry is a good example of this. As plants are depleted in the wild, their scarcity often leads to an increase in their desirability which in turn results in an increase the price. The impact at a grass roots level is that they become more economically attractive. This process can continue until the plant is endangered or even made extinct in the wild. It is often the poorest of people who make their living from foraging plants from the wild, however, it is these same people who are most open to exploitation from middlemen and frequently only receive about six per cent of the retail price of a herbal medicament (Schippmann et al., 2002).

There seems little doubt that the Indian cultivated medicinal herb industry is some way behind that of China with over 90 per cent of medicinal plants in India still being collected from the wild (Kumar et al., 2011). As demand for Indian medicinal plants increases it is unlikely that wild collection will be sustainable in the long term and new strategies will be needed if the industry is to succeed. There is already some evidence of strategic alliances and global partnerships manifesting but sometimes with mixed results (Alam and Belt, 2009, Shahidullah and Haque, 2010).

Professionals, producers and academics should work together to share what strategies succeed and where the problems lie. Poor seed quality, unsuitable environment and lack of knowledge base have already been identified as contributory factors for failure and it is important that measures are taken to avoid repetition. It is interesting that several UK based manufacturing or distribution companies (the VIVC case study, the Taiwanese extract producer and a TCM company) have been working to develop this area and have established some very important relationships with farmers in Asia which appear to be successful. It is the development of these long term relationships which lie at the heart of building a successful value chain.

Farmers and primary producers need incentives and guarantees if they are to invest finance, time and resources into the cultivation of medicinal plants. A robust regulatory system is needed in place that controls the manufacture and delivery of plant medicines through all stages of production. The European THMPD is an example of how a pragmatic approach can be utilised to improve the quality and safety of HMPs, however, one weak point is that it fails to regulate the appropriate sourcing of plants in a meaningful way.

This situation is even more relevant to the Asian medicinal plant industry and if this industry is to develop its export capability it will be necessary for it to address issues such as endangered species, sustainability and economic viability in parallel to those of quality, safety and effectiveness. From the manufacturers' perspective, in order to implement a sustainable business model, the contracts that are put in place need to be managed effectively from both sides. Another question arising from the literature review is whether lead firms are able to manage the value chain over time and the degree to which the farmer will conform to the standards required by the buyer?

10.7 Benefits for stakeholders

There are tangible benefits to be realised by the farmer and to workers throughout the manufacturing stages. If the VIVC farm and company in India continues to grow and develops a long term relationship with the European partner, further benefits to the farm and factory workers may also be realised.

However, although a VIVC may appear to be more stable and less of a risk to the farmer, there are some instances where the farmer may not benefit. Once contracted into a chain, a degree of freedom is sacrificed and the farmer is no longer free to sell on the open market. Large companies may be able to exert a downward pressure on the farmers as I have mentioned with the tea farmers whose livelihoods can become totally dependent on a single company. In other circumstances, as pointed out by Neimark (2012), on his investigation into the *Vinca rosea* value chain and the production of chemo-therapeutic agents*;* although the finished product end of the market may be modern and well regulated, the beginning stages of the market may be may be quite unregulated, even when the farmer is integrated into a value chain, allowing the lead company to dominate the farmer.

When selling to one or two companies, which may be the main buyers for this raw material, the farmer may find himself with no alternative than to make contracts with these big corporations who are unlikely to be interested in the livelihoods of small farmers. However this is a different situation to the case study I have observed, where traceability is evident throughout the length of the chain, farm workers are required to be trained in good cultivation practices, relationships between different actors in the chain have been built up over time and the welfare and livelihood of the farmers has become an integral part of the retailers marketing strategy.

For the buyer too, some risks exist, even when under contract, there is no guarantee that the farmer will not sell his crop on the open market if the price is right and there is unlikely to be any redress for the buyer in this situation. There are also a myriad of economic, political, and climatic risks associated with the cultivation of medicinal plants and their manufacture into HMPs that need to be overcome in order to create a successful industry.

Albeit with the caveat that there are risks in any business and that no system is fool proof or without its own unique set of exogenous and endogenous problems; this study has provided evidence that, for small to medium sized businesses, that are prepared to build strong relationships with farmers over time, and who are pro-active in supply chain management strategies, and for primary producers who are prepared to adapt their working practices to comply with standards of different countries than their own; there are mutual benefits to be attained and importantly that these benefits can be measured through an interdisciplinary understanding of the strategic issues.

10.8 Future work

Following on from the mainly qualitative investigation undertaken in the socio-economic section of this project concerning the livelihoods of farmers, it would be very enlightening to conduct a more quantitative health and well-being survey on farmer and farm worker households. The cultivation of medicinal plants within VIVCs is relatively new in India and so the information gathered from this type of survey could be used as a baseline from which future improvements or declines in livelihoods associated with MPVCs can be monitored.

This study has focused on *Curcuma longa* as a case study but it is envisaged that the research strategies and methods described in this thesis can be reproduced to investigate the value chain of any medicinal plant and particularly in cases where there are many different products on the market of varying standards of quality.

Total metabolite quality profiles (TMQPs) could be developed and introduced for a wide range of medicinal plants and their resulting products. NMR spectroscopy is a commonly used technique but its cost puts it out of reach of most small to medium sized enterprises. I have demonstrated that there is a good correlation between ^{1}H-NMR spectroscopy results and those produced by HPTLC, which is a system commonly used by HMP manufactures. The development of new methods should utilise new standards, using fresh plant material or pre-generated reference data

The chosen analytical techniques have shown be effective platforms for the rapid and accurate determination of plant and plant product composition and future studies should focus on their further development and refinement. This has been the first time that different species of curcuma have been investigated by using a combination metabolomic approach using ^{1}H-NMR spectroscopy and HPTLC and the analytical investigation has shown how different information can be acquired from different methods of analysis. There are still some conflicting results regarding the differences in chemical composition of different *curcuma* species (e.g. *C. aromatica* and *C. zanthorrhiza)* and how effectively ^{1}H-NMR spectroscopy or HPTLC can separate these species.

Thorough investigation of MPVCs can provide the industry with a far more comprehensive picture of the cultivation, processing and storage history of a given HMP and this information can be used to help justify, encourage and promote the continued development of VIVCs together with the implementation and management of better contractual relationships between manufacturers of HMPs and the primary producers that supply them.

11.0 Conclusions

The establishment of a sustainable VIVC for the production of HMPs has had a positive impact on the livelihoods of the primary producers investigated in India. There is clear evidence to suggest that primary producers benefit from being employed on fixed-term contracts.

^{1}H-NMR spectroscopy coupled with multivariate analysis software and HPTLC are two analytical platforms that can provide complementary data regarding the phytochemical composition of crude plant-derived raw materials and HMPs.

HMPs that are derived from the VIVC investigated are of superior quality to those products analysed that derive from the free market. The reasons for this are primarily that products obtained through a VIVC have not been exposed to adulteration and have not been stored for long periods of time leading to the loss of volatile compounds.

12.0 References

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13.0 Appendices

13.1 Appendix 1

Value chains of herbal medicines—Research needs and key challenges in the context of ethnopharmacology.

Paper Published in the Journal of Ethnopharmacology (2012)

13.2 Appendix 2

Chemical variability along the value chain of turmeric (*Curcuma longa*): A comparison of Nuclear Magnetic Resonance Spectroscopy and High Performance Thin Layer Chromatography..

Paper Published in the Journal of Ethnopharmacology (2014)

13.3 Appendix 3

Templates for research objectives and semi-structured interviews used for fieldwork in India

Objective 1: To describe the value chain and assess the impact of quality on the chain

Activity	WHAT TO FIND OUT	HOW TO FIND INFORMATION	PRIORITY	BUDGET
Growing	Where is it grown Who grows it When is it grown How is it grown What are external inputs (fertilizers, pesticides) When harvested Who harvests	Farm visits	***	
Collecting	Who collects When collected Collection criteria	Market visits	***	
Processing	Who processes How is it processed	Visit processor	**	
Manufacturing	Who manufactures What is the product	Visit manufacturer	***	
Storage	When is storage required	Visit storage areas	*	
Exporter	Who is exporter	Visit exporter	*	
Distribution	Who are distributors How is it distributed	Visit distributor	*	
Importer	Who is importer	Visit importer	*	
Retailer	Who are retailers Where are retailers	Visit retailers	**	
Regulator	Who regulates What are the regulations	Visit regulators Visit manufacturer	**	

Objective 2: To investigate what impact medicinal plant production has on the livelihoods of producers

Activity	WHAT TO FIND OUT	HOW TO FIND INFORMATION	PRIORITY	BUDGET
Growing	Who does land belong to Who pays for land Who grows it How is grower paid Who harvests How is harvester paid Who pays for inputs What are other benefits	Farm visits	***	
Collecting	Who collects Where are plants sold How is collector paid Other benefits	Market visits	***	
Processing	Who processes How is processor paid Other benefits	Visit processor	*	
Manufacturing	Who manufactures Who are employees How are employees paid Other benefits	Visit manufacturer	***	
Storage	Where stored Who stores What are costs	Visit storage areas	*	
Exporter	Who is exporter	Visit exporter	*	

	What are costs			
Distribution	Who are distributors What are costs	Visit distributor	*	
Importer	Who is importer What are costs	Visit importer	*	
Retailer	Who are retailers Where are retailers	Visit retailers	**	
Regulator	Who regulates What are costs and who pays	Visit regulators Visit manufacturer	**	
Community	What are the living conditions like What facilities are available for the community	Community visits	***	

* Low priority ** Medium priority *** High priority

Semi structured questionnaire for farmer

Name of Farmer______________________ Age_______ Gender M / F

Site______________________________
Date________________________

1. Have you always been a farmer

2. Do you have any other work apart from farming

3. How about your family – do they work on the farm

4. What is the size of your farm

5. Do you have many employees

6. Are your employees all local

7. What crops do you grow on the farm

8. Is medicinal plant cultivation any different to food crops

9. Are there any special requirements for growing/harvesting

10. Do you keep any animals

11. How do you sell your crops – who are your buyers

12. What are your main challenges

13. What are your biggest costs

14. What plans do you have for the future

Semi structured questionnaire for farm worker

Name of Farm worker______________________ Age_______ Gender M / F

Site______________________________
Date________________________

1. Have you always been a farm worker

2. Do you have any other work apart from working on the farm

3. How about your family – do they work on the farm

4. How big is the farm

5. Are there many employees that work on the farm

6. Are you local

7. What crops do you grow on the farm

8. Are there any special requirements for medicinal plants

9. Do you look after any animals

10. What happens to the crops once harvested

11. What are your main challenges

12. Do you make a living working on the farm

13. What plans do you have for the future

Semi structured questionnaire for wild collector

Name of collector______________________ Age_______ Gender M / F

Site______________________________
Date________________________

1. How long have you been collecting herbs for

2. Do you have any other work

3. How about your family – do they collect herbs also

4. What area do you cover

5. Are there many people collecting plants from the wild

6. Are you local

7. What plants do you collect

8. Is there any special requirements for how they are collected

9. Is it only plants that you collect

10. What happens to the plants after you have collected them

11. What are your main challenges

12. Do you make a living collecting plants

13. What plans do you have for the future

Semi structured questionnaire for company representative

Name of company representative______________________ Gender M / F

Position__________________________________

Site______________________________
Date________________________

1. How do you obtain your plant raw materials

2. What relationship do you have with the farmer

3. What relationship do you have with the retailer

4. What is your marketing area

5. How many employees work in this company

6. Are you local

7. What plant products do you produce

8. Is there any special requirements for how they are farmed/collected

9. Is it only plant medicines you produce

10. How are your products distributed

11. What are your main challenges

12. Do you think farm workers can make a living collecting plants

13. How sustainable do you think medicinal plant production is

14. Do you get any help from the government or NGO’s

15. What are the regulations regarding medicinal herb products

16. How do you think the European directive will affect you

17. What plans do you have for the future

13.4 Appendix 4

Summary of results for the on-line traditional Asian herbal medicine survey

Traditional Asian Herbal Medicine Survey

1. This question relates to herbs from any country or tradition. Do you ever take medicinal herbs or herbal medicinal products for the treatment or prevention of illnesses or to promote good health? Include culinary herbs or spices if used medicinally.

		Response Percent	Response Total
1	Never	14.78%	34
2	Rarely	19.57%	45
3	Occasionally	33.04%	76
4	Yearly	3.91%	9
5	Monthly	3.48%	8
6	Weekly	9.57%	22
7	Daily	15.65%	36
		answered	230
		skipped	5

2. Have you heard of any of the following traditional medicine systems from Asia?

		Response Percent	Response Total
1	Traditional Tibetan medicine	23.85%	52
2	Traditional Korean medicine	19.72%	43
3	Traditional Chinese medicine	94.04%	205
4	Traditional Japanese medicine (Kampo)	27.52%	60

2. Have you heard of any of the following traditional medicine systems from Asia?

		Response Percent	Response Total
5	Traditional Indian medicine (Ayurveda, Siddha or Unani)	63.76%	139
6	Traditional Thai Medicine	18.81%	41
7	Traditional Vietnamese medicine	7.34%	16
		answered	218
		skipped	17

3. Which of these Asian countries do you think currently supplies medicinal herbs or medicinal herbal products to the UK?

		Response Percent	Response Total
1	China	84.28%	193
2	Japan	37.12%	85
3	Korea	31.88%	73
4	Thailand	27.51%	63
5	Tibet	13.97%	32
6	India	64.63%	148
7	Sri Lanka	20.96%	48
8	Pakistan	17.90%	41
9	Don't know	12.66%	29
10	Other: please specify	3.06%	7

3. Which of these Asian countries do you think currently supplies medicinal herbs or medicinal herbal products to the UK?

	Response Percent	Response Total
	answered	229
	skipped	6

Answers for: Other: please specify		*7 answers*
1	4/5/11 3:55PM 2502314	Malaysia Indonesia
2	4/5/11 10:51PM 2503470	Malaysia
3	10/5/11 1:35PM 2519179	and probably more
4	11/5/11 10:13AM 2521895	Singapore; Taiwan
5	11/5/11 1:36PM 2523220	I imagine all of them do - I selected those countries of which I knew from experience imports herbs.
6	8/6/11 9:39AM 2600381	Russia
7	17/6/11 5:43PM 2630326	Taiwan

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

		Response Percent	Response Total
1	Open-Ended Question	100.00%	139

1	18/3/11 5:01PM 2348112	Ginseng
2	18/3/11 8:51PM	Ginkgo

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
	2348574			
3	18/3/11 9:38PM 2348635	eucalyptus		
4	23/3/11 8:38PM 2367916	garlic		
5	24/3/11 8:51AM 2369156	I know hundreds		
6	24/3/11 5:15PM 2349888	ashwaghanda		
7	31/3/11 10:30AM 2394414	Turmeric		
8	31/3/11 10:42AM 2394452	tumeric		
9	31/3/11 11:10AM 2394989	Cumin		
10	31/3/11 11:49AM 2395066	turmeric		
11	1/4/11 10:29PM 2404783	Ginger		
12	4/4/11 3:34PM 2412275	ginseng		
13	16/4/11 1:21PM 2452394	Turmeric		
14	23/4/11 1:51AM 2471658	Misai Kucing (Orthosiphon Stamineus)		
15	24/4/11 8:31AM 2473499	Ginger		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
16	27/4/11 10:51PM 2484453	Ginger		
17	4/5/11 3:55PM 2502311	GINSENG		
18	4/5/11 3:55PM 2502314	gingko biloba		
19	4/5/11 3:57PM 2502338	Ginseng		
20	4/5/11 3:58PM 2502318	Gingko biloba		
21	4/5/11 4:04PM 2502333	cumin (culinary)		
22	4/5/11 4:10PM 2502354	Dang gui		
23	4/5/11 4:11PM 2502415	Ginger		
24	4/5/11 4:14PM 2502331	Basil		
25	4/5/11 4:14PM 2502336	Garlic		
26	4/5/11 4:14PM 2502370	Tumeric powder - as an antiseptic		
27	4/5/11 4:23PM 2502484	Ginko		
28	4/5/11 4:37PM 2502538	ginseng		
29	4/5/11 4:53PM 2502579	ginseng		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
30	4/5/11 5:09PM 2502661	None		
31	4/5/11 6:03PM 2502796	ginko biloba		
32	4/5/11 6:39PM 2502950	Aloe vera		
33	4/5/11 7:01PM 2503057	turmeric		
34	4/5/11 7:04PM 2503059	tumeric		
35	4/5/11 7:56PM 2503159	Ginger		
36	4/5/11 8:34PM 2503226	Triphala		
37	4/5/11 8:50PM 2503265	ginkgo biloba		
38	4/5/11 10:33PM 2503460	Ginseng		
39	4/5/11 10:51PM 2503470	Ginger		
40	4/5/11 11:08PM 2503517	Ginkgo biloba		
41	5/5/11 4:19AM 2503755	Gingseng		
42	5/5/11 7:25AM 2503929	tamarind		
43	5/5/11 8:54AM 2504146	Schizandra chinensis		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
44	5/5/11 12:47PM 2505164	Ginseng		
45	5/5/11 2:48PM 2505738	cinnamon		
46	5/5/11 2:59PM 2505767	Abrus cantoniensis Hance		
47	5/5/11 5:41PM 2506349	ginseng		
48	5/5/11 5:47PM 2502652	None		
49	5/5/11 10:08PM 2506994	Panax ginseng		
50	5/5/11 10:39PM 2507046	Sesam Seeds		
51	5/5/11 10:56PM 2506934	Neem		
52	5/5/11 11:02PM 2507080	Tumeric		
53	6/5/11 1:44AM 2507253	Mint		
54	6/5/11 3:30PM 2509062	ginseng		
55	6/5/11 10:21PM 2510154	curcumin		
56	7/5/11 11:32AM 2510888	tumeric		
57	8/5/11 10:31PM 2513435	Curcuma		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
58	10/5/11 8:40AM 2517255	Ginger		
59	10/5/11 8:41AM 2517272	korean ginseng		
60	10/5/11 8:52AM 2517332	Turmeric		
61	10/5/11 9:14AM 2517598	Withnia somnifera		
62	10/5/11 9:23AM 2517780	Ginseng		
63	10/5/11 9:29AM 2517835	Ginseng		
64	10/5/11 10:05AM 2518039	tumeric		
65	10/5/11 11:03AM 2518335	tian ma		
66	10/5/11 11:50AM 2518711	Ginseng		
67	10/5/11 12:13PM 2518781	Pepper		
68	10/5/11 12:47PM 2518943	Zingirber officinale (Ginger)		
69	10/5/11 1:05PM 2518994	Cumin		
70	10/5/11 1:35PM 2519179	tigers penis		
71	10/5/11 6:21PM 2520317	Ginseng		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
72	10/5/11 6:47PM 2520378	Milk thistle		
73	11/5/11 3:13AM 2521039	tumeric		
74	11/5/11 10:13AM 2521895	100s		
75	11/5/11 11:20AM 2522554	Ginger		
76	11/5/11 11:36AM 2522603	Neem		
77	11/5/11 11:49AM 2522752	Gin Seng		
78	11/5/11 12:21PM 2522941	Ginseng		
79	11/5/11 12:37PM 2522984	ginseng		
80	11/5/11 1:36PM 2523220	Turmeric		
81	11/5/11 1:39PM 2523240	Jen Jen		
82	11/5/11 2:07PM 2523340	Neem		
83	11/5/11 3:25PM 2523638	Fennel		
84	11/5/11 4:05PM 2523761	turmeric		
85	11/5/11 6:52PM 2524547	Cordycep		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
86	11/5/11 7:55PM 2524742	Acia		
87	11/5/11 11:07PM 2525144	turmeric		
88	12/5/11 12:15AM 2525202	Tumeric		
89	12/5/11 4:31AM 2518498	Ginseng		
90	12/5/11 4:14PM 2527614	turmeric		
91	12/5/11 7:31PM 2528322	Jasmine		
92	12/5/11 7:33PM 2528336	Ginger		
93	13/5/11 5:37PM 2532239	Yin Chao		
94	16/5/11 8:29PM 2539486	Gingko		
95	20/5/11 12:41PM 2551135	gingo biloba		
96	22/5/11 12:48PM 2553868	ginseng		
97	22/5/11 1:01PM 2553864	Turmeric		
98	22/5/11 5:00PM 2554098	Coriander seed		
99	24/5/11 5:21PM 2561511	sandal-wood		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
100	1/6/11 11:35PM 2583888	ma huang		
101	8/6/11 9:39AM 2600381	rhodiola		
102	9/6/11 9:00PM 2506564	Garlic		
103	15/6/11 5:49PM 2622023	ginseng		
104	15/6/11 6:31PM 2622163	Jinsen		
105	15/6/11 7:00PM 2621959	Turmeric		
106	15/6/11 7:16PM 2622252	coriander		
107	15/6/11 8:07PM 2622435	Ginseng		
108	15/6/11 9:20PM 2622871	Aloe vera		
109	16/6/11 1:33AM 2623681	Tyrmeric		
110	16/6/11 2:22PM 2625600	ginseng		
111	16/6/11 2:28PM 2625606	Aconitum		
112	16/6/11 2:35PM 2625659	Tumeric		
113	16/6/11 3:21PM 2625917	No		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
114	16/6/11 4:19PM 2626167	葛根湯		
115	16/6/11 10:39PM 2627151	Cinnamon		
116	16/6/11 10:40PM 2627166	Senna leaves		
117	17/6/11 7:04AM 2627504	Cordyceps sinesis		
118	17/6/11 10:30AM 2628019	ginger		
119	17/6/11 5:43PM 2630326	angelica sinensis		
120	18/6/11 12:40AM 2631337	ren shen		
121	18/6/11 5:35AM 2631518	Ginseng		
122	18/6/11 1:12PM 2631956	Dang gui		
123	19/6/11 12:53AM 2632965	人参		
124	20/6/11 8:17PM 2636831	Dang Gui		
125	21/6/11 12:45PM 2638835	ren shen		
126	21/6/11 4:23PM 2639698	Ginseng		
127	22/6/11 1:09PM 2642313	salvia miltiorrhiza		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

				Response Percent	**Response Total**
	128	23/6/11 10:42AM 2645106	Ginger		
	129	27/6/11 1:16AM 2654562	Ginseng		
	130	29/6/11 7:46AM 2661542	Dragon eye fruit		
	131	30/6/11 6:28PM 2667722	Ginseng		
	132	14/9/11 3:27PM 2888486	Cinnamon		
	133	2/10/11 1:00PM 2956324	jin si gao		
	134	3/10/11 8:55PM 2962581	Cinnamon		
	135	13/2/12 3:10PM 3386121	Dang GUI		
	136	8/3/12 8:28PM 3485789	cinnamon		
	137	8/7/12 12:31PM 4312578	astralagus		
	138	2/8/12 9:52AM 4410632	Ginger		
	139	16/1/13 4:18PM 5358567	ginger		
2	Open-Ended Question			81.29%	113
	1	18/3/11 5:01PM 2348112	Milk Thistle		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
2	18/3/11 8:51PM 2348574	Ephedra		
3	23/3/11 8:38PM 2367916	chilli		
4	24/3/11 5:15PM 2349888	ginko biloba		
5	31/3/11 10:30AM 2394414	ginger		
6	31/3/11 10:42AM 2394452	galangal		
7	31/3/11 11:10AM 2394989	brahmi		
8	31/3/11 11:49AM 2395066	amla		
9	1/4/11 10:29PM 2404783	Licorice		
10	4/4/11 3:34PM 2412275	dang gui		
11	16/4/11 1:21PM 2452394	Areca		
12	23/4/11 1:51AM 2471658	Hempedu Bumi (Andrographis paniculata)		
13	24/4/11 8:31AM 2473499	Ginseng		
14	27/4/11 10:51PM 2484453	Ginseng		
15	4/5/11 3:55PM 2502314	ginger		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
16	4/5/11 3:57PM 2502338	Echinacea		
17	4/5/11 3:58PM 2502318	spirulina		
18	4/5/11 4:04PM 2502333	pistacho (ice cream)		
19	4/5/11 4:10PM 2502354	Bai shao Yao		
20	4/5/11 4:14PM 2502331	curmin		
21	4/5/11 4:14PM 2502336	Ginger		
22	4/5/11 4:14PM 2502370	Bitter gourds juice - used by diabetics		
23	4/5/11 4:53PM 2502579	cinnamon		
24	4/5/11 6:39PM 2502950	tumeric (haldi)		
25	4/5/11 7:01PM 2503057	ginger		
26	4/5/11 7:04PM 2503059	green tea leaves		
27	4/5/11 7:56PM 2503159	Tumeric		
28	4/5/11 8:34PM 2503226	Salvia		
29	4/5/11 8:50PM 2503265	valerian		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
30	4/5/11 10:33PM 2503460	Garlic		
31	4/5/11 10:51PM 2503470	Rhubarb		
32	4/5/11 11:08PM 2503517	Ginseng		
33	5/5/11 4:19AM 2503755	Gingko biloba		
34	5/5/11 7:25AM 2503929	cumin		
35	5/5/11 8:54AM 2504146	Ginseng		
36	5/5/11 12:47PM 2505164	Ginkgo		
37	5/5/11 2:48PM 2505738	tumeric		
38	5/5/11 2:59PM 2505767	Aconitum autumnale, Lindl		
39	5/5/11 5:41PM 2506349	ginkgo		
40	5/5/11 10:08PM 2506994	Alium cepa		
41	5/5/11 10:39PM 2507046	Ashwagandha		
42	5/5/11 10:56PM 2506934	tamarind		
43	5/5/11 11:02PM 2507080	Ginger		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
44	6/5/11 1:44AM 2507253	ginsing		
45	6/5/11 3:30PM 2509062	ginko		
46	7/5/11 11:32AM 2510888	ginko boloba		
47	8/5/11 10:31PM 2513435	Ginger		
48	10/5/11 8:40AM 2517255	cumin		
49	10/5/11 8:41AM 2517272	korean royal jelly		
50	10/5/11 8:52AM 2517332	Ginger		
51	10/5/11 9:14AM 2517598	Andrographis paniculata		
52	10/5/11 9:23AM 2517780	Ginger		
53	10/5/11 9:29AM 2517835	Gingko Biloba		
54	10/5/11 11:03AM 2518335	jiang can		
55	10/5/11 12:13PM 2518781	Clove		
56	10/5/11 12:47PM 2518943	Ginkgo Biloba		
57	10/5/11 1:05PM 2518994	Turmeric		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
58	10/5/11 1:35PM 2519179	Cordyceps caterpillar fungus		
59	10/5/11 6:21PM 2520317	Dang Gui		
60	10/5/11 6:47PM 2520378	Camphor		
61	11/5/11 3:13AM 2521039	cumin		
62	11/5/11 11:20AM 2522554	star anise		
63	11/5/11 11:36AM 2522603	tumeric		
64	11/5/11 11:49AM 2522752	Ginger		
65	11/5/11 1:36PM 2523220	Ginger		
66	11/5/11 2:07PM 2523340	turmeric		
67	11/5/11 4:05PM 2523761	neem		
68	11/5/11 7:55PM 2524742	Aloe Vera		
69	11/5/11 11:07PM 2525144	ginger		
70	12/5/11 12:15AM 2525202	Ginseng		
71	12/5/11 4:14PM 2527614	curcumin		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	72	12/5/11 7:33PM 2528336	Mint		
	73	13/5/11 5:37PM 2532239	Ginger		
	74	16/5/11 8:29PM 2539486	ginseng		
	75	20/5/11 12:41PM 2551135	ginsen		
	76	22/5/11 12:48PM 2553868	opium		
	77	22/5/11 1:01PM 2553864	Ashvagandha		
	78	22/5/11 5:00PM 2554098	Root ginger		
	79	24/5/11 5:21PM 2561511	angelica		
	80	1/6/11 11:35PM 2583888	gui zhi		
	81	8/6/11 9:39AM 2600381	cilantro aka cardamom		
	82	9/6/11 9:00PM 2506564	Cardamom		
	83	15/6/11 6:31PM 2622163	Garlic		
	84	15/6/11 7:00PM 2621959	Cummin		
	85	15/6/11 7:16PM 2622252	rosemary		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
86	15/6/11 8:07PM 2622435	ginko biloba		
87	15/6/11 9:20PM 2622871	ginseng		
88	16/6/11 1:33AM 2623681	Ginseng		
89	16/6/11 2:28PM 2625606	Asarum		
90	16/6/11 2:35PM 2625659	Green tea		
91	16/6/11 4:19PM 2626167	加味逍遥散		
92	16/6/11 10:39PM 2627151	Ginseng		
93	16/6/11 10:40PM 2627166	Gouqi berry		
94	17/6/11 7:04AM 2627504	Astragalus membranaceus		
95	17/6/11 10:30AM 2628019	garlic		
96	17/6/11 5:43PM 2630326	ginseng		
97	18/6/11 12:40AM 2631337	dang gui		
98	18/6/11 5:35AM 2631518	Dang Gui		
99	18/6/11 1:12PM 2631956	Sheng di		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
100	19/6/11 12:53AM 2632965	麻黄		
101	20/6/11 8:17PM 2636831	Rou Gui		
102	21/6/11 12:45PM 2638835	huang qi		
103	21/6/11 4:23PM 2639698	Gingko Biloba		
104	22/6/11 1:09PM 2642313	ashwagandha		
105	23/6/11 10:42AM 2645106	Turmeric		
106	27/6/11 1:16AM 2654562	Ginkgo		
107	30/6/11 6:28PM 2667722	Chinese Angelica Root		
108	14/9/11 3:27PM 2888486	Ginseng		
109	3/10/11 8:55PM 2962581	Curcuma		
110	13/2/12 3:10PM 3386121	Huang qi		
111	8/3/12 8:28PM 3485789	tea leaves		
112	8/7/12 12:31PM 4312578	fen feng		
113	2/8/12 9:52AM 4410632	Gingseng		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			
		Response Percent	**Response Total**
3	Open-Ended Question	67.63%	94

1	18/3/11 5:01PM 2348112	Turmeric
2	23/3/11 8:38PM 2367916	cumin
3	24/3/11 5:15PM 2349888	dan gui
4	31/3/11 10:30AM 2394414	cardamon
5	31/3/11 10:42AM 2394452	ginger
6	31/3/11 11:10AM 2394989	calamus
7	31/3/11 11:49AM 2395066	ashwaganda
8	1/4/11 10:29PM 2404783	Star Anise
9	4/4/11 3:34PM 2412275	ginger
10	16/4/11 1:21PM 2452394	Curry Leaves
11	23/4/11 1:51AM 2471658	Tongkat Ali (Eurycoma longifolia)
12	24/4/11 8:31AM 2473499	Neem
13	27/4/11 10:51PM 2484453	Gingko

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
14	4/5/11 3:55PM 2502314	garlic		
15	4/5/11 4:04PM 2502333	clove (culinary)		
16	4/5/11 4:10PM 2502354	Sheng di huang		
17	4/5/11 4:14PM 2502331	garlic		
18	4/5/11 4:14PM 2502336	Ginseng		
19	4/5/11 4:14PM 2502370	neem- acne		
20	4/5/11 4:53PM 2502579	salvia		
21	4/5/11 6:39PM 2502950	holy basil		
22	4/5/11 7:01PM 2503057	garlic		
23	4/5/11 8:34PM 2503226	Magnolia Officinalis		
24	4/5/11 8:50PM 2503265	st johns wort		
25	4/5/11 10:33PM 2503460	Ginger		
26	4/5/11 10:51PM 2503470	Chrysanthemums		
27	4/5/11 11:08PM 2503517	Echinacea		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
28	5/5/11 7:25AM 2503929	pinneapple		
29	5/5/11 8:54AM 2504146	Eleutherococcus senticocus		
30	5/5/11 2:48PM 2505738	garlic		
31	5/5/11 2:59PM 2505767	Adenophora verticillata, Fisch		
32	5/5/11 5:41PM 2506349	green tea		
33	5/5/11 10:08PM 2506994	Uncaria sp.		
34	5/5/11 10:39PM 2507046	Coriander		
35	5/5/11 10:56PM 2506934	ginseng		
36	5/5/11 11:02PM 2507080	cardamom		
37	6/5/11 1:44AM 2507253	cinnamon		
38	6/5/11 3:30PM 2509062	ginger		
39	7/5/11 11:32AM 2510888	ginseng		
40	8/5/11 10:31PM 2513435	Cayenne		
41	10/5/11 8:40AM 2517255	black papper		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
42	10/5/11 9:14AM 2517598	Curcuma longa		
43	10/5/11 9:23AM 2517780	Cardamon		
44	10/5/11 11:03AM 2518335	ren shen		
45	10/5/11 12:13PM 2518781	Cinnamon		
46	10/5/11 12:47PM 2518943	Ginseng		
47	10/5/11 1:05PM 2518994	Garlic		
48	10/5/11 1:35PM 2519179	similar herbal plant medicine like in UK		
49	10/5/11 6:21PM 2520317	Ginger		
50	11/5/11 3:13AM 2521039	ginseng		
51	11/5/11 11:20AM 2522554	gou qi zi		
52	11/5/11 11:36AM 2522603	oregano oil		
53	11/5/11 11:49AM 2522752	Tree Bark		
54	11/5/11 2:07PM 2523340	ginseng		
55	11/5/11 7:55PM 2524742	Ginger		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
56	12/5/11 12:15AM 2525202	Cumin		
57	12/5/11 7:33PM 2528336	Pepper		
58	16/5/11 8:29PM 2539486	cinnamon		
59	22/5/11 1:01PM 2553864	Neem		
60	22/5/11 5:00PM 2554098	Cinnamon		
61	24/5/11 5:21PM 2561511	dry ginger		
62	1/6/11 11:35PM 2583888	xi xin		
63	8/6/11 9:39AM 2600381	Maitake / Shitake / Reishi		
64	9/6/11 9:00PM 2506564	Basil		
65	15/6/11 6:31PM 2622163	Parsley		
66	15/6/11 7:00PM 2621959	Corriander		
67	15/6/11 7:16PM 2622252	ylang ylang		
68	15/6/11 9:20PM 2622871	echinacea		
69	16/6/11 1:33AM 2623681	Peony		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
70	16/6/11 2:28PM 2625606	Ginger		
71	16/6/11 2:35PM 2625659	Ginseng		
72	16/6/11 4:19PM 2626167	柴朴湯		
73	16/6/11 10:39PM 2627151	Astragulus		
74	16/6/11 10:40PM 2627166	Ginseng		
75	17/6/11 7:04AM 2627504	Salviae miltiorrhizae		
76	17/6/11 10:30AM 2628019	chilli		
77	17/6/11 5:43PM 2630326	astragalus mebranaceous		
78	18/6/11 12:40AM 2631337	bai zhu		
79	18/6/11 5:35AM 2631518	Ban Xia		
80	18/6/11 1:12PM 2631956	Bai shao		
81	19/6/11 12:53AM 2632965	大黄		
82	20/6/11 8:17PM 2636831	Huang Qi		
83	21/6/11 12:45PM 2638835	dang gui		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.				Response Percent	Response Total
	84	21/6/11 4:23PM 2639698	Turmeric		
	85	22/6/11 1:09PM 2642313	turmeric		
	86	23/6/11 10:42AM 2645106	Ashwagandha		
	87	27/6/11 1:16AM 2654562	Ginger		
	88	30/6/11 6:28PM 2667722	Codonopsis Root (dang shen)		
	89	14/9/11 3:27PM 2888486	Bilboa		
	90	3/10/11 8:55PM 2962581	Rauwolfia		
	91	13/2/12 3:10PM 3386121	He shou wu		
	92	8/3/12 8:28PM 3485789	herbal tea		
	93	8/7/12 12:31PM 4312578	boa zu		
	94	2/8/12 9:52AM 4410632	Gingko		
4	Open-Ended Question			54.68%	76
	1	18/3/11 5:01PM 2348112	Ginkgo		
	2	24/3/11 5:15PM 2349888	yi yi ren		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
3	31/3/11 10:42AM 2394452	reishi		
4	31/3/11 11:10AM 2394989	ashwagandha		
5	31/3/11 11:49AM 2395066	guduchi		
6	1/4/11 10:29PM 2404783	Ginseng		
7	16/4/11 1:21PM 2452394	Garlic		
8	23/4/11 1:51AM 2471658	Mas Cotek (Ficus deltoidea)		
9	24/4/11 8:31AM 2473499	Tulsi/Holy basil		
10	27/4/11 10:51PM 2484453	Licorice		
11	4/5/11 3:55PM 2502314	mengkudu (malay word)		
12	4/5/11 4:04PM 2502333	cinnamon (for intestinal bloating)		
13	4/5/11 4:10PM 2502354	Chuan xiong		
14	4/5/11 4:14PM 2502331	andrographis		
15	4/5/11 4:14PM 2502336	Momordica Charantia		
16	4/5/11 4:14PM 2502370	Shallaki (boswellia serrata) - joint pain		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
17	4/5/11 4:53PM 2502579	chamomile		
18	4/5/11 6:39PM 2502950	lemon grass		
19	4/5/11 8:34PM 2503226	(Green) Tea		
20	4/5/11 8:50PM 2503265	ginseng		
21	4/5/11 10:33PM 2503460	Castor		
22	4/5/11 10:51PM 2503470	Siraitia grosvenorii		
23	4/5/11 11:08PM 2503517	St John's Wort		
24	5/5/11 8:54AM 2504146	Goji berries		
25	5/5/11 2:59PM 2505767	Anisum stellatum		
26	5/5/11 5:41PM 2506349	kefir		
27	5/5/11 10:39PM 2507046	Senna		
28	5/5/11 10:56PM 2506934	ginger		
29	5/5/11 11:02PM 2507080	cinammon		
30	6/5/11 1:44AM 2507253	gogi berry		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
31	6/5/11 3:30PM 2509062	cayenne		
32	7/5/11 11:32AM 2510888	cinamon		
33	10/5/11 8:40AM 2517255	green tea		
34	10/5/11 9:14AM 2517598	Centella asiatica		
35	10/5/11 9:23AM 2517780	Aloe Vera		
36	10/5/11 11:03AM 2518335	bai zhu		
37	10/5/11 12:13PM 2518781	Anise		
38	10/5/11 12:47PM 2518943	Artemisia Annua (sweet wormwood)		
39	10/5/11 1:05PM 2518994	Neem		
40	10/5/11 1:35PM 2519179	rhino horn		
41	10/5/11 6:21PM 2520317	Goji Berries		
42	11/5/11 11:20AM 2522554	cinnamon		
43	11/5/11 11:36AM 2522603	slippery elm		
44	11/5/11 11:49AM 2522752	Cinnamon		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
45	11/5/11 2:07PM 2523340	green tea		
46	12/5/11 12:15AM 2525202	Ginger		
47	16/5/11 8:29PM 2539486	ginger		
48	22/5/11 1:01PM 2553864	Stri rasayan		
49	1/6/11 11:35PM 2583888	Bo He		
50	8/6/11 9:39AM 2600381	astragalus		
51	9/6/11 9:00PM 2506564	Cinnamon		
52	15/6/11 6:31PM 2622163	Touyaku(weeds)		
53	15/6/11 7:00PM 2621959	All Spice		
54	15/6/11 7:16PM 2622252	type of funghi		
55	16/6/11 1:33AM 2623681	Liquorice		
56	16/6/11 2:28PM 2625606	Ginseng		
57	16/6/11 10:39PM 2627151	Rehmannia		
58	16/6/11 10:40PM 2627166	Codonopsis pilosula		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
59	17/6/11 7:04AM 2627504	Sairei-to		
60	17/6/11 10:30AM 2628019	liquorice		
61	17/6/11 5:43PM 2630326	curcuma		
62	18/6/11 12:40AM 2631337	chuan xiong		
63	18/6/11 5:35AM 2631518	Bai He		
64	18/6/11 1:12PM 2631956	Huang qi		
65	19/6/11 12:53AM 2632965	甘草		
66	20/6/11 8:17PM 2636831	San Qi		
67	21/6/11 12:45PM 2638835	bai shao		
68	22/6/11 1:09PM 2642313	ginger		
69	23/6/11 10:42AM 2645106	Pepper		
70	27/6/11 1:16AM 2654562	Japanese Plums		
71	30/6/11 6:28PM 2667722	Yu Zhu		
72	3/10/11 8:55PM 2962581	Pterocarpus		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
73	13/2/12 3:10PM 3386121	Chai hu		
74	8/3/12 8:28PM 3485789	grasses		
75	8/7/12 12:31PM 4312578	kudzu		
76	2/8/12 9:52AM 4410632	Artemisin		
5		Open-Ended Question	50.36%	70
1	18/3/11 5:01PM 2348112	Turpentine Oil		
2	24/3/11 5:15PM 2349888	corydalis		
3	31/3/11 10:42AM 2394452	ginseng		
4	31/3/11 11:10AM 2394989	coptis		
5	31/3/11 11:49AM 2395066	neem		
6	1/4/11 10:29PM 2404783	Dang Gui		
7	16/4/11 1:21PM 2452394	Cardamom		
8	23/4/11 1:51AM 2471658	Kacip Fatima (Labisa pumila)		
9	24/4/11 8:31AM 2473499	Black cumin		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
10	27/4/11 10:51PM 2484453	Lotus leaves		
11	4/5/11 4:04PM 2502333	Elderflower (drink)		
12	4/5/11 4:10PM 2502354	Yi yi ren		
13	4/5/11 4:14PM 2502331	bitter mellon		
14	4/5/11 4:14PM 2502336	Green tea		
15	4/5/11 4:14PM 2502370	Arjuna - blood circulation		
16	4/5/11 4:53PM 2502579	spearmint		
17	4/5/11 6:39PM 2502950	garlic		
18	4/5/11 8:50PM 2503265	camomille		
19	4/5/11 10:33PM 2503460	Cinnamon		
20	4/5/11 10:51PM 2503470	Ginseng		
21	4/5/11 11:08PM 2503517	Valerian		
22	5/5/11 8:54AM 2504146	Mumio		
23	5/5/11 2:59PM 2505767	Angelica sinensis		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
24	5/5/11 5:41PM 2506349	star anise		
25	5/5/11 10:39PM 2507046	Amarnath		
26	5/5/11 10:56PM 2506934	fennel		
27	5/5/11 11:02PM 2507080	clove		
28	6/5/11 1:44AM 2507253	ginger		
29	6/5/11 3:30PM 2509062	goji berry		
30	10/5/11 8:40AM 2517255	honey		
31	10/5/11 9:14AM 2517598	Bacopa monniera		
32	10/5/11 9:23AM 2517780	Echinacea		
33	10/5/11 11:03AM 2518335	dang shen		
34	10/5/11 12:13PM 2518781	Sage		
35	10/5/11 12:47PM 2518943	Willow bark		
36	10/5/11 1:05PM 2518994	Cardamom		
37	10/5/11 1:35PM 2519179	artemesin		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
38	10/5/11 6:21PM 2520317	Aloe Vera		
39	11/5/11 11:20AM 2522554	dang gui		
40	11/5/11 11:36AM 2522603	seaweeds		
41	11/5/11 11:49AM 2522752	Cardamom		
42	12/5/11 12:15AM 2525202	Cinnamon		
43	16/5/11 8:29PM 2539486	rhubarb		
44	22/5/11 1:01PM 2553864	Trikatu		
45	1/6/11 11:35PM 2583888	Chan tui		
46	8/6/11 9:39AM 2600381	Garlic		
47	9/6/11 9:00PM 2506564	Clove		
48	15/6/11 6:31PM 2622163	kuko(Leaves)		
49	15/6/11 7:00PM 2621959	Chinese 5 Spice		
50	15/6/11 7:16PM 2622252	garlic		
51	16/6/11 1:33AM 2623681	Rehmannia		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
52	16/6/11 2:28PM 2625606	Garlic		
53	16/6/11 10:39PM 2627151	Gastrodia		
54	16/6/11 10:40PM 2627166	Semen zizyphi spinosae		
55	17/6/11 7:04AM 2627504	angelica		
56	17/6/11 10:30AM 2628019	peony		
57	17/6/11 5:43PM 2630326	Mint		
58	18/6/11 12:40AM 2631337	bai shao		
59	18/6/11 5:35AM 2631518	Jin Yin Hua		
60	18/6/11 1:12PM 2631956	Dang shen		
61	19/6/11 12:53AM 2632965	生姜		
62	20/6/11 8:17PM 2636831	Huang Bai		
63	21/6/11 12:45PM 2638835	shu di		
64	22/6/11 1:09PM 2642313	ginseng		
65	23/6/11 10:42AM 2645106	Fennel seeds		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	66	27/6/11 1:16AM 2654562	Goji Berry		
	67	30/6/11 6:28PM 2667722	Cordyceps		
	68	3/10/11 8:55PM 2962581	Terminalia		
	69	13/2/12 3:10PM 3386121	Chen pi		
	70	8/7/12 12:31PM 4312578	gogi berry		
6			Open-Ended Question	43.88%	61
	1	18/3/11 5:01PM 2348112	Cajuput Oil		
	2	24/3/11 5:15PM 2349888	chen pi		
	3	31/3/11 10:42AM 2394452	fo ti		
	4	31/3/11 11:10AM 2394989	musta		
	5	31/3/11 11:49AM 2395066	coriander seed		
	6	1/4/11 10:29PM 2404783	Cinnamon		
	7	16/4/11 1:21PM 2452394	Elaichi		
	8	23/4/11 1:51AM 2471658	Ginger (Zingiber officinale)		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
9	24/4/11 8:31AM 2473499	Garlic		
10	27/4/11 10:51PM 2484453	Astragali root		
11	4/5/11 4:04PM 2502333	Jasmine flowers (tea)		
12	4/5/11 4:10PM 2502354	Ren shen		
13	4/5/11 4:14PM 2502331	planotol		
14	4/5/11 4:14PM 2502336	Neem		
15	4/5/11 4:14PM 2502370	Shigru (drumstick) - joint care		
16	4/5/11 4:53PM 2502579	valerian		
17	4/5/11 6:39PM 2502950	ginger		
18	4/5/11 8:50PM 2503265	green tea		
19	4/5/11 10:33PM 2503460	Cardamum		
20	4/5/11 10:51PM 2503470	Cordyceps		
21	5/5/11 2:59PM 2505767	Poria cocos, Wolf.		
22	5/5/11 5:41PM 2506349	chili		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
23	5/5/11 10:39PM 2507046	Multani Mitti		
24	5/5/11 10:56PM 2506934	mango		
25	5/5/11 11:02PM 2507080	honey		
26	6/5/11 1:44AM 2507253	ginko biloba		
27	6/5/11 3:30PM 2509062	turmeric		
28	10/5/11 8:40AM 2517255	nigella seeds		
29	10/5/11 9:14AM 2517598	Trigonella foenum-graecum		
30	10/5/11 9:23AM 2517780	Gingko		
31	10/5/11 11:03AM 2518335	huang qi		
32	10/5/11 12:13PM 2518781	Thyme		
33	10/5/11 1:05PM 2518994	Bay leaves		
34	11/5/11 11:20AM 2522554	huang qi		
35	12/5/11 12:15AM 2525202	Cardamom		
36	22/5/11 1:01PM 2553864	Brahami		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
37	1/6/11 11:35PM 2583888	Dan Zhu Ye		
38	8/6/11 9:39AM 2600381	horehound		
39	9/6/11 9:00PM 2506564	Nutmeg		
40	15/6/11 7:00PM 2621959	garlic		
41	15/6/11 7:16PM 2622252	cumin		
42	16/6/11 1:33AM 2623681	Asrtafalus		
43	16/6/11 2:28PM 2625606	Tumeric		
44	16/6/11 10:39PM 2627151	Agastache		
45	16/6/11 10:40PM 2627166	White paeony root		
46	17/6/11 7:04AM 2627504	Rheum palmatum L		
47	17/6/11 10:30AM 2628019	reshi		
48	17/6/11 5:43PM 2630326	Ginger		
49	18/6/11 12:40AM 2631337	dang shen		
50	18/6/11 5:35AM 2631518	Yuan Wu		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
51	18/6/11 1:12PM 2631956	Dan shen		
52	19/6/11 12:53AM 2632965	薄荷		
53	20/6/11 8:17PM 2636831	Bai Zhu		
54	21/6/11 12:45PM 2638835	chuan xiong		
55	22/6/11 1:09PM 2642313	ginkgo biloba		
56	23/6/11 10:42AM 2645106	Aloe vera juice		
57	27/6/11 1:16AM 2654562	Acai Berry		
58	30/6/11 6:28PM 2667722	American Ginseng (Hua Qi Shen)		
59	3/10/11 8:55PM 2962581	Cardamon		
60	13/2/12 3:10PM 3386121	Yuan zhi		
61	8/7/12 12:31PM 4312578	tumeric		
7	Open-Ended Question		38.85%	54
1	24/3/11 5:15PM 2349888	ginseng		
2	31/3/11 10:42AM 2394452	cardamom		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
3	31/3/11 11:10AM 2394989	amalaki		
4	31/3/11 11:49AM 2395066	ajwain		
5	1/4/11 10:29PM 2404783	Peony		
6	16/4/11 1:21PM 2452394	Nutmeg		
7	23/4/11 1:51AM 2471658	Daun Sirih (Piper betle)		
8	24/4/11 8:31AM 2473499	Arjun		
9	27/4/11 10:51PM 2484453	Angelica root		
10	4/5/11 4:10PM 2502354	Bai zhu		
11	4/5/11 4:14PM 2502331	pepper		
12	4/5/11 4:14PM 2502370	Shatavari (Asparagus) - women's health		
13	4/5/11 4:53PM 2502579	peony		
14	4/5/11 6:39PM 2502950	freshly ground black pepper		
15	4/5/11 10:33PM 2503460	Jira		
16	4/5/11 10:51PM 2503470	Chinese Angelica Root		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
17	5/5/11 2:59PM 2505767	Prunella vulgaris, L.		
18	5/5/11 5:41PM 2506349	aloe		
19	5/5/11 10:39PM 2507046	Babool		
20	5/5/11 10:56PM 2506934	jasmine		
21	5/5/11 11:02PM 2507080	pepper		
22	6/5/11 1:44AM 2507253	cannabis		
23	6/5/11 3:30PM 2509062	camomile		
24	10/5/11 8:40AM 2517255	there is more but i dont know the name in english!		
25	10/5/11 9:14AM 2517598	Guggal		
26	10/5/11 11:03AM 2518335	huang lian		
27	10/5/11 12:13PM 2518781	Ginseng		
28	10/5/11 1:05PM 2518994	Fenugreek		
29	11/5/11 11:20AM 2522554	green tea		
30	12/5/11 12:15AM 2525202	Cloves		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
31	22/5/11 1:01PM 2553864	Jawain		
32	1/6/11 11:35PM 2583888	Mu Dan Pi		
33	8/6/11 9:39AM 2600381	feverfew		
34	9/6/11 9:00PM 2506564	Peppermint		
35	15/6/11 7:00PM 2621959	saffron		
36	15/6/11 7:16PM 2622252	green tea		
37	16/6/11 1:33AM 2623681	Angelica		
38	16/6/11 2:28PM 2625606	Cinnamon		
39	16/6/11 10:39PM 2627151	Licorice		
40	17/6/11 7:04AM 2627504	Tripterygium wilfordii		
41	17/6/11 10:30AM 2628019	wolfberries		
42	17/6/11 5:43PM 2630326	Atractolodes		
43	18/6/11 12:40AM 2631337	wu jia pi		
44	18/6/11 5:35AM 2631518	Wu Wei Zi		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	45	18/6/11 1:12PM 2631956	Ren shen		
	46	19/6/11 12:53AM 2632965	牡丹		
	47	20/6/11 8:17PM 2636831	Zhi Zi		
	48	21/6/11 12:45PM 2638835	xi yang shen		
	49	22/6/11 1:09PM 2642313	gotu kola		
	50	23/6/11 10:42AM 2645106	Neem		
	51	27/6/11 1:16AM 2654562	Shiitake		
	52	30/6/11 6:28PM 2667722	Cinnamon		
	53	13/2/12 3:10PM 3386121	Suan zao ren		
	54	8/7/12 12:31PM 4312578	fennel		
8	Open-Ended Question			33.09%	46
	1	24/3/11 5:15PM 2349888	jimneema		
	2	31/3/11 10:42AM 2394452	cordyceps		
	3	31/3/11 11:10AM 2394989	schizandra		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
4	31/3/11 11:49AM 2395066	hing		
5	1/4/11 10:29PM 2404783	Hoelen		
6	16/4/11 1:21PM 2452394	Sandalwood		
7	23/4/11 1:51AM 2471658	Kunyit (Curcuma longa)		
8	24/4/11 8:31AM 2473499	Aloe vera		
9	27/4/11 10:51PM 2484453	Wolfberry		
10	4/5/11 4:10PM 2502354	Fu ling		
11	4/5/11 4:14PM 2502331	lemon grass		
12	4/5/11 6:39PM 2502950	orange peel		
13	4/5/11 10:33PM 2503460	Tumeric		
14	4/5/11 10:51PM 2503470	Astragalus		
15	5/5/11 2:59PM 2505767	Saussurea involucrate		
16	5/5/11 5:41PM 2506349	sandalwood		
17	5/5/11 10:39PM 2507046	Vasaka		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
18	5/5/11 10:56PM 2506934	tea tree		
19	5/5/11 11:02PM 2507080	basil		
20	6/5/11 3:30PM 2509062	valarian		
21	10/5/11 9:14AM 2517598	Cinnamon		
22	10/5/11 11:03AM 2518335	shu di huang		
23	10/5/11 12:13PM 2518781	Ginko		
24	10/5/11 1:05PM 2518994	Lemongrass		
25	11/5/11 11:20AM 2522554	shan yao		
26	12/5/11 12:15AM 2525202	Black Pepper		
27	22/5/11 1:01PM 2553864	Corriander		
28	1/6/11 11:35PM 2583888	Huang Qi		
29	8/6/11 9:39AM 2600381	bee propolis		
30	9/6/11 9:00PM 2506564	Thyme		
31	16/6/11 1:33AM 2623681	Ligusticum		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
32	16/6/11 10:39PM 2627151	Dioscorea		
33	17/6/11 10:30AM 2628019	rehmannia		
34	17/6/11 5:43PM 2630326	cinnamon		
35	18/6/11 12:40AM 2631337	he shou wu		
36	18/6/11 5:35AM 2631518	Suan Zao Ren		
37	18/6/11 1:12PM 2631956	Tai Zi shen		
38	19/6/11 12:53AM 2632965	丹圣		
39	20/6/11 8:17PM 2636831	Jing Jie		
40	21/6/11 12:45PM 2638835	chi shao		
41	22/6/11 1:09PM 2642313	cinnamon		
42	23/6/11 10:42AM 2645106	Andrographis		
43	27/6/11 1:16AM 2654562	Burdock Root		
44	30/6/11 6:28PM 2667722	Cumin		
45	13/2/12 3:10PM 3386121	Gan cao		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
46	8/7/12 12:31PM 4312578	shatavari		
9	Open-Ended Question		27.34%	38
1	24/3/11 5:15PM 2349888	neem		
2	31/3/11 10:42AM 2394452	astragulas		
3	31/3/11 11:10AM 2394989	lotus		
4	31/3/11 11:49AM 2395066	cumin seeds		
5	1/4/11 10:29PM 2404783	Atractylodes		
6	16/4/11 1:21PM 2452394	Mace		
7	23/4/11 1:51AM 2471658	Cinnamon		
8	24/4/11 8:31AM 2473499	Cinnamon		
9	27/4/11 10:51PM 2484453	Horny goat weed		
10	4/5/11 4:10PM 2502354	Gan cao		
11	4/5/11 6:39PM 2502950	ginseng		
12	4/5/11 10:51PM 2503470	Wolfberry		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
13	5/5/11 2:59PM 2505767	Plastrum testudinis		
14	5/5/11 5:41PM 2506349	lotus		
15	5/5/11 10:56PM 2506934	pomegranate		
16	5/5/11 11:02PM 2507080	mint leaves		
17	6/5/11 3:30PM 2509062	garlic		
18	10/5/11 9:14AM 2517598	Gymnema sylvestre		
19	10/5/11 11:03AM 2518335	dang gui		
20	10/5/11 1:05PM 2518994	Ginger		
21	11/5/11 11:20AM 2522554	shitaki mushrooms		
22	12/5/11 12:15AM 2525202	Bitter Gourd		
23	22/5/11 1:01PM 2553864	Tulsi		
24	1/6/11 11:35PM 2583888	Pu Gong Ying		
25	8/6/11 9:39AM 2600381	arnica		
26	16/6/11 1:33AM 2623681	Zingiber		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
27	16/6/11 10:39PM 2627151	Fritilleria		
28	17/6/11 5:43PM 2630326	liquorice (glycerrhiza)		
29	18/6/11 12:40AM 2631337	wu ling xian		
30	18/6/11 5:35AM 2631518	Di Huang		
31	18/6/11 1:12PM 2631956	Fu ling		
32	19/6/11 12:53AM 2632965	丹参		
33	20/6/11 8:17PM 2636831	Yi Mu Cao		
34	21/6/11 12:45PM 2638835	bai zhu		
35	23/6/11 10:42AM 2645106	Holy basil		
36	30/6/11 6:28PM 2667722	Roselle		
37	13/2/12 3:10PM 3386121	Sang bai pi		
38	8/7/12 12:31PM 4312578	ashwaganda		
10	Open-Ended Question		25.90%	36
1	24/3/11 5:15PM 2349888	bai hu		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.				
			Response Percent	Response Total
2	31/3/11 10:42AM 2394452	Chrysanthemum		
3	31/3/11 11:10AM 2394989	satavari		
4	31/3/11 11:49AM 2395066	fennel seeds		
5	1/4/11 10:29PM 2404783	Gingko		
6	16/4/11 1:21PM 2452394	Cloves		
7	23/4/11 1:51AM 2471658	Bawang putih (Allium sativum)		
8	24/4/11 8:31AM 2473499	Kerala/Bitter gourd		
9	27/4/11 10:51PM 2484453	Chrysanthemum		
10	4/5/11 4:10PM 2502354	Mo yao		
11	4/5/11 6:39PM 2502950	clove		
12	4/5/11 10:51PM 2503470	Onion		
13	5/5/11 2:59PM 2505767	Panax Ginseng, C. A. Mey.		
14	5/5/11 5:41PM 2506349	turmeric		
15	5/5/11 10:56PM 2506934	cardamom		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
16	5/5/11 11:02PM 2507080	fenugreek		
17	6/5/11 3:30PM 2509062	magosteen		
18	10/5/11 11:03AM 2518335	gan cao		
19	10/5/11 1:05PM 2518994	Aloe vera		
20	11/5/11 11:20AM 2522554	sour plum		
21	12/5/11 12:15AM 2525202	Fenugreek		
22	22/5/11 1:01PM 2553864	Fennel Seeds		
23	1/6/11 11:35PM 2583888	Ban Zhi Lian		
24	8/6/11 9:39AM 2600381	ginger		
25	16/6/11 1:33AM 2623681	Cinnamon		
26	16/6/11 10:39PM 2627151	Curcuma		
27	17/6/11 5:43PM 2630326	discorea		
28	18/6/11 12:40AM 2631337	mu xiang		
29	18/6/11 5:35AM 2631518	Dan Shen		

4. Do you know any herbs that are used in Asian Herbal Medicine? (maximum 10) You can include culinary herbs or spices if used medicinally.			Response Percent	Response Total
30	18/6/11 1:12PM 2631956	Fu shen		
31	19/6/11 12:53AM 2632965	茯苓		
32	20/6/11 8:17PM 2636831	Shu Di Huang		
33	21/6/11 12:45PM 2638835	gan cao		
34	30/6/11 6:28PM 2667722	Huang Qi		
35	13/2/12 3:10PM 3386121	Di gu pi		
36	8/7/12 12:31PM 4312578	ginseng		
			answered	139
			skipped	96

5. The next question relates specifically to India. Do you ever use Indian medicinal herbs or Indian herbal medicinal products? Include culinary herbs or spices if used medicinally.			Response Percent	Response Total
1	Never		52.65%	119
2	Rarely		11.95%	27
3	Within the last 5 years		3.10%	7
4	Within the last Year		7.96%	18

5. The next question relates specifically to India. Do you ever use Indian medicinal herbs or Indian herbal medicinal products? Include culinary herbs or spices if used medicinally.

		Response Percent	Response Total
5	Monthly	3.98%	9
6	Weekly	4.42%	10
7	Daily	7.08%	16
8	Don't know	8.85%	20
		answered	226
		skipped	9

6. Would you consider using Indian medicinal herbs or Indian medicinal herbal products in the future?

		Response Percent	Response Total
1	Yes	48.89%	110
2	No	15.11%	34
3	Not sure	36.00%	81
		answered	225
		skipped	10

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

		Response Percent	Response Total
1	Open-Ended Question	98.88%	88

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
1	18/3/11 5:01PM 2348112	Ginger		
2	24/3/11 8:51AM 2369156	triphala		
3	24/3/11 5:15PM 2349888	jimneema		
4	31/3/11 10:30AM 2394414	turmeric		
5	31/3/11 10:42AM 2394452	brahmi		
6	31/3/11 11:10AM 2394989	brahmi		
7	31/3/11 11:49AM 2395066	amla		
8	31/3/11 7:15PM 2398630	coriander		
9	1/4/11 10:29PM 2404783	Cumin		
10	16/4/11 1:21PM 2452394	Turmeric		
11	23/4/11 1:51AM 2471658	Kunyit (Curcuma longa)		
12	24/4/11 8:31AM 2473499	Neem		
13	27/4/11 10:51PM 2484453	n/a		
14	4/5/11 3:55PM 2502314	dont know		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
15	4/5/11 4:04PM 2502333	cinnamon		
16	4/5/11 4:10PM 2502354	Asafoetida		
17	4/5/11 4:11PM 2502415	Tumeric		
18	4/5/11 4:14PM 2502336	Momordica charantia		
19	4/5/11 5:09PM 2502661	tulsi		
20	4/5/11 6:39PM 2502950	holy basil		
21	4/5/11 7:01PM 2503057	garlic		
22	4/5/11 7:04PM 2503059	tumeric		
23	4/5/11 8:50PM 2503265	safron		
24	4/5/11 10:33PM 2503460	Tumeric		
25	4/5/11 11:08PM 2503517	kashayam		
26	5/5/11 4:19AM 2503755	I do not Know any		
27	5/5/11 7:25AM 2503929	curcumin		
28	5/5/11 12:47PM 2505164	N/A		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
29	5/5/11 3:22PM 2505862	fennel		
30	5/5/11 5:41PM 2506349	Ginger		
31	5/5/11 5:47PM 2502652	Don't know any		
32	5/5/11 10:39PM 2507046	Neem		
33	5/5/11 10:56PM 2506934	Don't know		
34	6/5/11 1:44AM 2507253	cannabis		
35	6/5/11 3:30PM 2509062	tumeric		
36	7/5/11 1:02PM 2510981	sanjeevni herb		
37	7/5/11 6:49PM 2511502	black cumin seeds		
38	8/5/11 10:31PM 2513435	Cayenne		
39	10/5/11 8:39AM 2517226	fennel seeds		
40	10/5/11 8:52AM 2517332	Turmeric		
41	10/5/11 9:14AM 2517598	Curcuma longa		
42	10/5/11 9:23AM 2517780	Cardamon		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
43	10/5/11 10:05AM 2518039	tumeric		
44	10/5/11 12:13PM 2518781	Sage		
45	10/5/11 1:05PM 2518994	Turmeric		
46	10/5/11 1:35PM 2519179	nil		
47	10/5/11 6:21PM 2520317	Turmeric		
48	10/5/11 6:47PM 2520378	Garlic		
49	11/5/11 3:13AM 2521039	tumeric		
50	11/5/11 10:13AM 2521895	Turmeric (Curcuma longa)		
51	11/5/11 11:20AM 2522554	curry		
52	11/5/11 11:36AM 2522603	neem		
53	11/5/11 12:21PM 2522941	no idea		
54	11/5/11 12:37PM 2522984	curcumin/turmeric		
55	11/5/11 1:36PM 2523220	Turmeric		
56	11/5/11 2:07PM 2523340	neem		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
57	11/5/11 4:05PM 2523761	turmeric		
58	11/5/11 6:52PM 2524547	Turmeric		
59	11/5/11 7:55PM 2524742	Aloe Vera		
60	12/5/11 12:15AM 2525202	Tumeric		
61	12/5/11 4:14PM 2527614	turmeric		
62	13/5/11 5:37PM 2532239	cumin		
63	22/5/11 12:48PM 2553868	not known		
64	22/5/11 1:01PM 2553864	Haldi (Tumeric)		
65	22/5/11 5:00PM 2554098	Coriander seed		
66	1/6/11 11:35PM 2583888	cardamon		
67	8/6/11 9:39AM 2600381	cilantro		
68	9/6/11 9:00PM 2506564	Aloe Vera		
69	15/6/11 7:00PM 2621959	garlic		
70	15/6/11 7:16PM 2622252	Green tea		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
71	15/6/11 9:20PM 2622871	Aloe vera		
72	16/6/11 1:33AM 2623681	Turmeric		
73	16/6/11 2:28PM 2625606	Ginger		
74	16/6/11 2:35PM 2625659	Tumeric		
75	16/6/11 3:21PM 2625917	N/A		
76	16/6/11 10:39PM 2627151	Cardamom		
77	17/6/11 10:30AM 2628019	ashwagandha		
78	17/6/11 5:43PM 2630326	Turmuric		
79	18/6/11 1:12PM 2631956	Tumeric		
80	20/6/11 8:17PM 2636831	Tumeric		
81	21/6/11 12:45PM 2638835	withania		
82	22/6/11 1:09PM 2642313	asgwagandha		
83	23/6/11 10:42AM 2645106	Neem		
84	30/6/11 6:28PM 2667722	Cumin		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
85	14/9/11 3:27PM 2888486	Ginseng		
86	3/10/11 8:55PM 2962581	Cinnamon		
87	8/3/12 8:28PM 3485789	tea leaves		
88	8/7/12 12:31PM 4312578	tumeric		
2	Open-Ended Question		62.92%	56
1	18/3/11 5:01PM 2348112	Turmeric		
2	24/3/11 8:51AM 2369156	ashwaganda		
3	24/3/11 5:15PM 2349888	garlic		
4	31/3/11 10:42AM 2394452	shatavari		
5	31/3/11 11:49AM 2395066	turmeric		
6	31/3/11 7:15PM 2398630	ashwaganda		
7	1/4/11 10:29PM 2404783	Night Jasmine		
8	16/4/11 1:21PM 2452394	Amla		
9	23/4/11 1:51AM 2471658	Cinnamon		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
10	24/4/11 8:31AM 2473499	Black cumin seeds		
11	4/5/11 4:04PM 2502333	Anise		
12	4/5/11 4:10PM 2502354	Garlic		
13	4/5/11 4:14PM 2502336	Neem (Azadirachta indica)		
14	4/5/11 6:39PM 2502950	garlic		
15	4/5/11 7:01PM 2503057	ginger		
16	4/5/11 8:50PM 2503265	cammomille		
17	4/5/11 10:33PM 2503460	Garlic		
18	4/5/11 11:08PM 2503517	aloe vera		
19	5/5/11 5:41PM 2506349	Ginseng		
20	5/5/11 10:39PM 2507046	Tulsi		
21	6/5/11 3:30PM 2509062	cumin		
22	7/5/11 11:32AM 2510888	don't know		
23	7/5/11 1:02PM 2510981	haldi - tumeric		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
24	7/5/11 6:49PM 2511502	turmeric		
25	8/5/11 10:31PM 2513435	Curcuma		
26	10/5/11 8:39AM 2517226	Ginger		
27	10/5/11 9:14AM 2517598	Withania somnifera		
28	10/5/11 9:23AM 2517780	Ginger		
29	10/5/11 1:05PM 2518994	Garlic		
30	11/5/11 3:13AM 2521039	fenugreek		
31	11/5/11 10:13AM 2521895	Bacopa monnieri		
32	11/5/11 11:36AM 2522603	tumeric		
33	11/5/11 2:07PM 2523340	turmeric		
34	11/5/11 4:05PM 2523761	neem		
35	11/5/11 6:52PM 2524547	Cloves		
36	12/5/11 12:15AM 2525202	Cinnamon		
37	22/5/11 1:01PM 2553864	Neem		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
38	22/5/11 5:00PM 2554098	Cardamom pods		
39	1/6/11 11:35PM 2583888	cinamon		
40	8/6/11 9:39AM 2600381	white tea		
41	9/6/11 9:00PM 2506564	Datura Stramonium		
42	15/6/11 7:00PM 2621959	parsley		
43	15/6/11 7:16PM 2622252	garlic		
44	16/6/11 1:33AM 2623681	Garlic		
45	16/6/11 2:28PM 2625606	Neem		
46	16/6/11 10:39PM 2627151	Guggal		
47	17/6/11 10:30AM 2628019	turmeric		
48	17/6/11 5:43PM 2630326	ginger		
49	18/6/11 1:12PM 2631956	Coriander		
50	21/6/11 12:45PM 2638835	gotu cola		
51	22/6/11 1:09PM 2642313	ginger		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	52	23/6/11 10:42AM 2645106	Turmeric		
	53	30/6/11 6:28PM 2667722	Pepper		
	54	14/9/11 3:27PM 2888486	Corriander		
	55	8/3/12 8:28PM 3485789	herbal tea		
	56	8/7/12 12:31PM 4312578	aswaganda		
3	Open-Ended Question			50.56%	45
	1	18/3/11 5:01PM 2348112	Liquorice		
	2	24/3/11 8:51AM 2369156	turmeric		
	3	24/3/11 5:15PM 2349888	turmeric		
	4	31/3/11 10:42AM 2394452	ashwaganda		
	5	31/3/11 11:49AM 2395066	neem		
	6	31/3/11 7:15PM 2398630	shatavari		
	7	1/4/11 10:29PM 2404783	Garlic		
	8	16/4/11 1:21PM 2452394	Neem		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
9	23/4/11 1:51AM 2471658	Aloe vera		
10	24/4/11 8:31AM 2473499	Tulsi/ Holy basil		
11	4/5/11 4:04PM 2502333	Peppermint		
12	4/5/11 4:10PM 2502354	Ginger		
13	4/5/11 4:14PM 2502336	Ginger		
14	4/5/11 6:39PM 2502950	tumeric (fresh one)		
15	4/5/11 10:33PM 2503460	Ginger		
16	4/5/11 11:08PM 2503517	ginger		
17	5/5/11 5:41PM 2506349	Turmeric		
18	5/5/11 10:39PM 2507046	Ashwagandha		
19	7/5/11 6:49PM 2511502	garlic		
20	10/5/11 9:14AM 2517598	Andrographis paniculata		
21	10/5/11 9:23AM 2517780	Aloe Vera		
22	10/5/11 1:05PM 2518994	Ginger		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
23	11/5/11 3:13AM 2521039	nim leaves		
24	11/5/11 10:13AM 2521895	Azadiracta indica (Neem)		
25	11/5/11 6:52PM 2524547	Fenugreek		
26	12/5/11 12:15AM 2525202	Ginger		
27	22/5/11 1:01PM 2553864	Tulsi		
28	22/5/11 5:00PM 2554098	Root ginger		
29	1/6/11 11:35PM 2583888	ginger		
30	8/6/11 9:39AM 2600381	fenugreek		
31	9/6/11 9:00PM 2506564	Hyocyamus Niger		
32	15/6/11 7:00PM 2621959	corriander		
33	15/6/11 7:16PM 2622252	funghi		
34	16/6/11 1:33AM 2623681	Ginger		
35	16/6/11 2:28PM 2625606	Garlic		
36	16/6/11 10:39PM 2627151	Neem		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
37	17/6/11 10:30AM 2628019	ginger		
38	17/6/11 5:43PM 2630326	garlic		
39	18/6/11 1:12PM 2631956	Cumin		
40	21/6/11 12:45PM 2638835	momordica		
41	22/6/11 1:09PM 2642313	gotu kola		
42	23/6/11 10:42AM 2645106	Ginger		
43	30/6/11 6:28PM 2667722	Onion		
44	14/9/11 3:27PM 2888486	Cinnamon		
45	8/7/12 12:31PM 4312578	shatavri		
4	Open-Ended Question		37.08%	33
1	18/3/11 5:01PM 2348112	Henna		
2	24/3/11 8:51AM 2369156	pepper		
3	24/3/11 5:15PM 2349888	ashviganda		
4	31/3/11 10:42AM 2394452	gunduchi		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
5	31/3/11 11:49AM 2395066	ashwaganda		
6	31/3/11 7:15PM 2398630	asafoetida		
7	1/4/11 10:29PM 2404783	Jaquirity		
8	16/4/11 1:21PM 2452394	Cinnamon		
9	23/4/11 1:51AM 2471658	curry leaves		
10	4/5/11 4:10PM 2502354	Liquorice		
11	4/5/11 4:14PM 2502336	Garlic		
12	4/5/11 6:39PM 2502950	Aloe vera		
13	4/5/11 10:33PM 2503460	Jira		
14	5/5/11 10:39PM 2507046	Chandan		
15	10/5/11 9:14AM 2517598	Centella asiatica		
16	10/5/11 1:05PM 2518994	Neem		
17	11/5/11 6:52PM 2524547	Coriander		
18	12/5/11 12:15AM 2525202	Cloves		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
19	22/5/11 1:01PM 2553864	Ginger		
20	22/5/11 5:00PM 2554098	Cinnamon		
21	1/6/11 11:35PM 2583888	fenigreek		
22	8/6/11 9:39AM 2600381	astragalus		
23	15/6/11 7:16PM 2622252	rosemary		
24	16/6/11 1:33AM 2623681	Cardamon		
25	16/6/11 2:28PM 2625606	Cinnamon		
26	16/6/11 10:39PM 2627151	Nutmeg		
27	17/6/11 10:30AM 2628019	cayenne		
28	17/6/11 5:43PM 2630326	neem		
29	18/6/11 1:12PM 2631956	Anise		
30	21/6/11 12:45PM 2638835	Brahma		
31	23/6/11 10:42AM 2645106	Holly basil		
32	30/6/11 6:28PM 2667722	Garlic		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	33	8/7/12 12:31PM 4312578	ginger		
5			Open-Ended Question	30.34%	27
	1	24/3/11 8:51AM 2369156	cinnamon		
	2	24/3/11 5:15PM 2349888	mint		
	3	31/3/11 10:42AM 2394452	neem		
	4	31/3/11 11:49AM 2395066	guduchi		
	5	31/3/11 7:15PM 2398630	brahmi		
	6	1/4/11 10:29PM 2404783	Long Pepper		
	7	16/4/11 1:21PM 2452394	Sandalwood		
	8	23/4/11 1:51AM 2471658	Clove		
	9	4/5/11 4:10PM 2502354	Turmeric		
	10	4/5/11 6:39PM 2502950	orange peel		
	11	5/5/11 10:39PM 2507046	Adrak		
	12	10/5/11 9:14AM 2517598	Gymnema sylvestre		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
13	11/5/11 6:52PM 2524547	Mint		
14	12/5/11 12:15AM 2525202	Cumin		
15	22/5/11 1:01PM 2553864	Ashvagandha		
16	1/6/11 11:35PM 2583888	cumin		
17	8/6/11 9:39AM 2600381	goldenseal		
18	15/6/11 7:16PM 2622252	Ylang Ylang		
19	16/6/11 1:33AM 2623681	Chili		
20	16/6/11 2:28PM 2625606	Nutmeg		
21	16/6/11 10:39PM 2627151	Holy Basil		
22	17/6/11 10:30AM 2628019	cinnamon		
23	17/6/11 5:43PM 2630326	cayenne pepper		
24	18/6/11 1:12PM 2631956	Pepper		
25	21/6/11 12:45PM 2638835	shatavari		
26	23/6/11 10:42AM 2645106	Andrographis		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
27	8/7/12 12:31PM 4312578	holy basil		
6	Open-Ended Question		25.84%	23
1	24/3/11 8:51AM 2369156	cilantro		
2	24/3/11 5:15PM 2349888	black pepper		
3	31/3/11 10:42AM 2394452	tulsi		
4	31/3/11 11:49AM 2395066	cumin seeds		
5	31/3/11 7:15PM 2398630	trikatu		
6	1/4/11 10:29PM 2404783	Tumeric		
7	16/4/11 1:21PM 2452394	Cloves		
8	23/4/11 1:51AM 2471658	star anise		
9	4/5/11 4:10PM 2502354	Cardamom		
10	4/5/11 6:39PM 2502950	lime		
11	11/5/11 6:52PM 2524547	Cumin seed		
12	22/5/11 1:01PM 2553864	Jawain		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.				
			Response Percent	**Response Total**
13	1/6/11 11:35PM 2583888	mustard seeds		
14	8/6/11 9:39AM 2600381	horehound		
15	15/6/11 7:16PM 2622252	cumin		
16	16/6/11 2:28PM 2625606	Ginseng		
17	16/6/11 10:39PM 2627151	Gotu Kola		
18	17/6/11 10:30AM 2628019	cardamon		
19	17/6/11 5:43PM 2630326	cardamom		
20	18/6/11 1:12PM 2631956	Cinnamon		
21	21/6/11 12:45PM 2638835	turmeric		
22	23/6/11 10:42AM 2645106	Ashwagandha		
23	8/7/12 12:31PM 4312578	brami		
7	Open-Ended Question		21.35%	19
1	24/3/11 8:51AM 2369156	etc.		
2	24/3/11 5:15PM 2349888	holy basil		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.			Response Percent	Response Total
3	31/3/11 10:42AM 2394452	aloe		
4	31/3/11 11:49AM 2395066	fennel seeds		
5	31/3/11 7:15PM 2398630	cumin		
6	1/4/11 10:29PM 2404783	Angelica		
7	16/4/11 1:21PM 2452394	Gymnaema		
8	23/4/11 1:51AM 2471658	curcuma longa		
9	4/5/11 6:39PM 2502950	clove		
10	11/5/11 6:52PM 2524547	Black pepper		
11	22/5/11 1:01PM 2553864	Fennel seeds (sauf)		
12	1/6/11 11:35PM 2583888	indian ginseng		
13	8/6/11 9:39AM 2600381	feverfew		
14	16/6/11 10:39PM 2627151	Ashwaganda		
15	17/6/11 10:30AM 2628019	neem		
16	17/6/11 5:43PM 2630326	thulsi		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

				Response Percent	**Response Total**
	17	18/6/11 1:12PM 2631956	Nutmeg		
	18	21/6/11 12:45PM 2638835	pepper		
	19	8/7/12 12:31PM 4312578	triphala		
8	Open-Ended Question			14.61%	13
	1	24/3/11 5:15PM 2349888	cinnamon		
	2	31/3/11 10:42AM 2394452	triphala		
	3	31/3/11 11:49AM 2395066	hing		
	4	31/3/11 7:15PM 2398630	black pepper		
	5	23/4/11 1:51AM 2471658	ginger		
	6	11/5/11 6:52PM 2524547	Tea		
	7	22/5/11 1:01PM 2553864	brahmi		
	8	1/6/11 11:35PM 2583888	seasame		
	9	8/6/11 9:39AM 2600381	velerian		
	10	16/6/11 10:39PM 2627151	Psyllium Husk		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	11	17/6/11 10:30AM 2628019	shatavari		
	12	18/6/11 1:12PM 2631956	Betel		
	13	21/6/11 12:45PM 2638835	neem		
9	Open-Ended Question			12.36%	11
	1	24/3/11 5:15PM 2349888	aloe vera		
	2	31/3/11 10:42AM 2394452	turmeric		
	3	31/3/11 11:49AM 2395066	coriander seed		
	4	31/3/11 7:15PM 2398630	guggul		
	5	23/4/11 1:51AM 2471658	allium sativum		
	6	22/5/11 1:01PM 2553864	Trikatu		
	7	8/6/11 9:39AM 2600381	tea tree		
	8	16/6/11 10:39PM 2627151	Henna		
	9	17/6/11 10:30AM 2628019	andrographis		
	10	18/6/11 1:12PM 2631956	Saffron		

7. What do you consider to be the most important Indian medicinal herbs? (maximum 10) You may include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
	11	21/6/11 12:45PM 2638835	gymnema		
10	Open-Ended Question			11.24%	10
	1	24/3/11 5:15PM 2349888	betal nut		
	2	31/3/11 10:42AM 2394452	boswelia		
	3	31/3/11 11:49AM 2395066	ajwain		
	4	31/3/11 7:15PM 2398630	triphala		
	5	22/5/11 1:01PM 2553864	Stri Rasayam		
	6	8/6/11 9:39AM 2600381	garlic		
	7	16/6/11 10:39PM 2627151	Ginger		
	8	17/6/11 10:30AM 2628019	brahmi		
	9	18/6/11 1:12PM 2631956	Rose		
	10	21/6/11 12:45PM 2638835	santal		
				answered	89
				skipped	146

8. What do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.

		Response Percent	Response Total
1	Open-Ended Question	100.00%	89

1	18/3/11 5:01PM 2348112	Ginger because it's active against diarrhea, nausea, anti-inflammatory, arthritis, blood thinning and cholesterol
2	24/3/11 8:51AM 2369156	I think the philosophy is more important than individual herbs
3	24/3/11 5:15PM 2349888	Turmeric, freely available good for inflamation and as an anti microbial. Know people that use it internally and externally therefore can be used by everyone.
4	25/3/11 11:34AM 2373885	all foods have an energetic quality and are therefore medicine.
5	31/3/11 10:30AM 2394414	turmeric
6	31/3/11 10:42AM 2394452	Neem- It can be used topically and internally for many different ailments- Nature's Pharmacy!
7	31/3/11 11:49AM 2395066	amla - for its general body strengthening, nourishing, immune build ability
8	1/4/11 10:29PM 2404783	Garlic has been widely used in many dishes, and is very popular; unlike many other medicinal herbs.
9	16/4/11 1:21PM 2452394	Bitter Melon in the treatment of Diabetes
10	23/4/11 1:51AM 2471658	Curry leaves because they eat curry everyday and they do eat it a lot !
11	24/4/11 8:31AM 2473499	Neem - as its widely used for a range of illnesses and its symbolic significance
12	27/4/11 10:51PM 2484453	n/a
13	4/5/11 3:55PM 2502314	not sure

8. What do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.

			Response Percent	Response Total
14	4/5/11 3:58PM 2502318	I dont know		
15	4/5/11 4:04PM 2502333	Peppermint , it is very good for any intestinal problems and soothing		
16	4/5/11 4:10PM 2502354	I believe turmeric is regarded as a 'cleansing' herb.		
17	4/5/11 4:11PM 2502415	Tumeric (anti cancer properties)		
18	4/5/11 4:14PM 2502336	Don't know		
19	4/5/11 5:35PM 2502728	i dont think I can name a single indian medicinal herb, sorry		
20	4/5/11 6:39PM 2502950	Holy basil (Tulsi) a herb considered sacred to Hindus .And is thought to aid in healing of mind ,body and spirit.		
21	4/5/11 7:01PM 2503057	garlic, ive heard more about it		
22	4/5/11 7:04PM 2503059	tumeric-can be used on the skin in a paste also put into food and good effects		
23	4/5/11 7:56PM 2503159	Tumeric - cancer prevention in rat models.		
24	4/5/11 11:08PM 2503517	kashayam, it seems to be used a lot in Ayurvedic medicine. I went to a clinic in India, and a few others I knew also went, and we were all prescribed with kashayam.		
25	5/5/11 4:19AM 2503755	Don't know		
26	5/5/11 7:25AM 2503929	curcumin colon cancer prevention		
27	5/5/11 10:07AM 2504473	Garlic		

8. What do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.

			Response Percent	Response Total
28	5/5/11 12:47PM 2505164	N/A		
29	5/5/11 5:47PM 2502652	N/A		
30	5/5/11 10:39PM 2507046	Neem, because it can help purify blood.		
31	5/5/11 10:56PM 2506934	don't know		
32	6/5/11 1:44AM 2507253	Cannabis - oldest and most used medicine in the world		
33	6/5/11 3:30PM 2509062	I dont know.		
34	7/5/11 1:02PM 2510981	sanjeevni herb from himalayas. can revive a person on the brink of death.		
35	10/5/11 8:39AM 2517226	Ginger. It can be found easilyy and it has many properties. I use it for digestive problems.		
36	10/5/11 8:40AM 2517255	nigella seed		
37	10/5/11 8:52AM 2517332	Turmeric- cancer		
38	10/5/11 9:14AM 2517598	Andrographis - really excellent for the immune system when other herbs don't work. Works very quickly as well		
39	10/5/11 9:23AM 2517780	Don't know.		
40	10/5/11 9:29AM 2517835	Don't know		
41	10/5/11 10:05AM 2518039	not sure		

8. What do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.

			Response Percent	Response Total
42	10/5/11 12:02PM 2518761	Turmeric, Others as well i dont know the names		
43	10/5/11 12:13PM 2518781	Pepper		
44	10/5/11 1:05PM 2518994	Garlic - based on anecdotal evidence of the various medicinal ailments it can treat		
45	10/5/11 1:35PM 2519179	am not aware there is much evidence for efficacy of any of this		
46	10/5/11 6:21PM 2520317	Turmeric. Easily obtained and commonly used as food additives. Affordable remedies.		
47	10/5/11 6:47PM 2520378	Garlic Proven benefits		
48	11/5/11 3:13AM 2521039	tumeric because its used so widely for many ailments. I have seen it applied topically as well as ingested for healing properties.		
49	11/5/11 5:26AM 2521091	n/a		
50	11/5/11 10:13AM 2521895	Turmeric - anti-inflammatory		
51	11/5/11 11:20AM 2522554	Don't know		
52	11/5/11 11:36AM 2522603	neem, it has so many uses and is cheep and plentyfull		
53	11/5/11 12:37PM 2522984	Curcumin [or turmeric]. it's possibly good for overall health.		
54	11/5/11 1:36PM 2523220	Turmeric - I use this herb daily for anti-inflammatory properties		
55	11/5/11 2:07PM 2523340	Neem, for it's properties which help the immune system; skin problems; dental health; digestion and gut health.		

8. What do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.

			Response Percent	Response Total
56	11/5/11 4:05PM 2523761	neem		
57	11/5/11 6:52PM 2524547	Turmeric for antiseptic treatments in general.		
58	11/5/11 7:34PM 2523427	Tumeric Powder applied to an inflammed area, can reduce inflammation.		
59	11/5/11 7:55PM 2524742	Aloe Vera for it's internal and external benefits. I use it to prevent prickly heat (tablets) and as a hunger supressor when dieting		
60	12/5/11 12:15AM 2525202	Tumeric		
61	12/5/11 4:31AM 2518498	Ginseng		
62	12/5/11 4:14PM 2527614	don't know		
63	12/5/11 7:33PM 2528336	ginger because it's warming.		
64	13/5/11 5:37PM 2532239	n/a		
65	22/5/11 12:48PM 2553868	not known		
66	22/5/11 1:01PM 2553864	Turmeric- can heal internal and external wounds. Very good for keeping good immune system. Easily ingested with food, and flavoursome!		
67	22/5/11 5:00PM 2554098	Cardamom		
68	1/6/11 11:35PM 2583888	Ashwaganda. Indian ginseng, which is not heating		
69	8/6/11 9:39AM 2600381	cilantro for the binding & removal of heavy metals in the liver		

8. What do do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.			Response Percent	Response Total
70	15/6/11 7:00PM 2621959	Garlic because it is anti-viral and anti-inflammatory		
71	15/6/11 7:16PM 2622252	Garlic for cleansing blood and controlling lipids and cholesterol		
72	15/6/11 9:20PM 2622871	Garlic. Lowers cholesterol prevents blood clots.		
73	16/6/11 1:33AM 2623681	Turmeric Anti oxidant		
74	16/6/11 2:28PM 2625606	Neem		
75	16/6/11 2:35PM 2625659	Tumeric, good for general good health and easy to use in everyday cooking		
76	16/6/11 10:39PM 2627151	Ashwaganda The ginseng of India!		
77	17/6/11 10:30AM 2628019	Ashwagandha because it is very nutritive, calming yet adaptogenic and gives energy, cardioprotective, immonomodulatory and can be used with cancer patients as it is very nutritive.		
78	17/6/11 5:43PM 2630326	Turmuric- because i have heard it recommended by the most different people		
79	18/6/11 12:40AM 2631337	ashwangwanda?		
80	18/6/11 1:12PM 2631956	I don't know		
81	20/6/11 8:17PM 2636831	?		
82	21/6/11 12:45PM 2638835	gotu cola - for all its effects		
83	22/6/11 1:09PM 2642313	ashwagandha because it is a proven AchE inhibitor as well as an adaptogen		

8. What do you regard as the single most important Indian medicinal herb and why? Again, you can give a food herb if it used for a medical reason.

			Response Percent	Response Total
84	23/6/11 10:42AM 2645106	Turmeric - many medicinal uses (used against cancer, digestive...). Culinary uses as well.		
85	30/6/11 6:28PM 2667722	Cumin		
86	3/10/11 8:55PM 2962581	Cinnamon - this is being used a lot in C. Europe and whilst it is strictly a Sri Lankan plant, it has potential to be further developed.		
87	13/2/12 3:10PM 3386121	All the aromatics		
88	8/3/12 8:28PM 3485789	Tea leaves - because they are very common and widely used.		
89	8/7/12 12:31PM 4312578	ashwaganda		
			answered	89
			skipped	146

9. What 5 conditions do you think would respond best to Indian herbal medicine treatment?

			Response Percent	Response Total
1	Colds,flu etc		39.90%	81
2	Digestive problems		48.77%	99
3	Gynaecological conditions		10.84%	22
4	Infertility		6.90%	14
5	Skin diseases		32.02%	65
6	Musculo-skeletal conditions		7.39%	15

9. What 5 conditions do you think would respond best to Indian herbal medicine treatment?

			Response Percent	Response Total
7	Respiritory illnesses		15.27%	31
8	Neurological diseases		4.43%	9
9	Diabetes		14.29%	29
10	Cardio-vascular disease		13.79%	28
11	Mental-emotional conditions (depression, anxiety etc)		12.32%	25
12	Low libido		10.34%	21
13	Tiredness, fatigue		32.51%	66
14	Poor immune system		33.50%	68
15	Poor memory and concentration		17.73%	36
16	Insomnia		17.24%	35
17	Don't know		31.53%	64
18	Other: please specify		5.91%	12
			answered	203
			skipped	32

Answers for: Other: please specify — *12 answers*

1	25/3/11 11:34AM 2373885	A wide range conditions.
2	4/5/11 4:14PM 2502336	Pain
3	10/5/11 1:35PM 2519179	you may get a placebo effect or true effect which should be further investigated, as far as am aware the mechanisms put forward by traditionalists are without evidence

9. What 5 conditions do you think would respond best to Indian herbal medicine treatment?

				Response Percent	Response Total
	4	11/5/11 3:13AM 2521039	cuts and bruises		
	5	11/5/11 12:21PM 2522941	I am sceptical about any medical benefits		
	6	11/5/11 12:37PM 2522984	cancer, alzheimer's		
	7	11/5/11 1:39PM 2523240	I do not know any indian herbs		
	8	11/5/11 2:07PM 2523340	dental health		
	9	16/6/11 3:04PM 2625841	not a clue		
	10	18/6/11 1:12PM 2631956	I don't use it		
	11	23/6/11 10:42AM 2645106	All these conditions could be treated using Ayurvedic / Unani medicine (not only herbal medicine).		
	12	28/6/11 9:53PM 2660931	never heard of these meds and treatment systems listed under question2! I could not say the best of trying them		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

				Response Percent	Response Total
1	Open-Ended Question			100.00%	78
	1	18/3/11 5:01PM 2348112	turmeric, ginger,		
	2	18/3/11 8:51PM	None		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
	2348574			
3	24/3/11 8:51AM 2369156	same as in 7)		
4	24/3/11 5:15PM 2349888	aloe vera garlic turmeric black pepper corydalis cordyceps		
5	25/3/11 11:34AM 2373885	all foods have an energetic quality and are therefore medicine.		
6	31/3/11 10:30AM 2394414	ginger and turmeric		
7	31/3/11 10:42AM 2394452	neem, shatavari, ashwaganda, ginger, tumeric, tulsi, shankahpushpi		
8	31/3/11 11:10AM 2394989	brahmi satavari ghee		
9	31/3/11 11:49AM 2395066	amla, ahswaganda, guduchi, neem, turmeric, cumin seeds, fennel seeds, hing, curry leaves, methi seeds, ajwain		
10	1/4/11 10:29PM 2404783	Cumin, to make curry~		
11	16/4/11 1:21PM 2452394	Bitter Melon Gymnaema		
12	23/4/11 1:51AM 2471658	curry leaves, star anise , clove, ginger, curcumin		
13	24/4/11 8:31AM 2473499	Ginger, tulsi (as a tea)		
14	27/4/11 10:51PM 2484453	n/a		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
15	4/5/11 4:04PM 2502333	cumin		
16	4/5/11 4:10PM 2502354	None medicinally.		
17	4/5/11 4:11PM 2502415	None		
18	4/5/11 4:14PM 2502336	None		
19	4/5/11 4:14PM 2502370	Tumeric powder in water - used for coughs or a paste is made and put on cuts to prevent infection		
20	4/5/11 5:09PM 2502661	pudina		
21	4/5/11 7:01PM 2503057	none		
22	4/5/11 11:08PM 2503517	Aloe vera		
23	5/5/11 4:19AM 2503755	I have not seen any		
24	5/5/11 7:25AM 2503929	curry		
25	5/5/11 12:47PM 2505164	None		
26	5/5/11 10:39PM 2507046	Tulsi		
27	5/5/11 10:56PM 2506934	none		
28	5/5/11 11:02PM 2507080	tumeric powder and salt mixed with warm water, for cold and flu symptoms		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
29	6/5/11 3:30PM 2509062	none		
30	7/5/11 11:32AM 2510888	tumeric		
31	10/5/11 8:40AM 2517255	ginger		
32	10/5/11 8:52AM 2517332	None		
33	10/5/11 9:14AM 2517598	Withania Centella Andrographis		
34	10/5/11 9:23AM 2517780	None		
35	10/5/11 9:29AM 2517835	None		
36	10/5/11 12:13PM 2518781	None		
37	10/5/11 1:05PM 2518994	Turmeric, Garlic, Ginger, Fenugreek, Cumin, Bay leaves,		
38	10/5/11 1:35PM 2519179	nil		
39	10/5/11 6:47PM 2520378	None		
40	11/5/11 3:13AM 2521039	I don't use any medicinally		
41	11/5/11 5:26AM 2521091	n/a		
42	11/5/11 10:13AM 2521895	Turmeric		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
43	11/5/11 11:20AM 2522554	none		
44	11/5/11 11:36AM 2522603	neem tumeric oregano oil		
45	11/5/11 12:37PM 2522984	Curry...ocasionally. ginger sometimes.		
46	11/5/11 1:36PM 2523220	turmeric		
47	11/5/11 1:39PM 2523240	None I use only European Herbs (Sage, St John Worth, Garlic, Onion)		
48	11/5/11 2:07PM 2523340	(Thought I'd just answered this question) Neem Turmeric		
49	11/5/11 4:05PM 2523761	neem, turmeric		
50	11/5/11 6:52PM 2524547	Turmeric		
51	11/5/11 7:19PM 2524599	I use tumeric medicinally since being diagnosed with breast cancer in Dec 2010		
52	11/5/11 7:55PM 2524742	Aloe Vera		
53	12/5/11 12:15AM 2525202	Cinnamon and Cloves		
54	22/5/11 12:48PM 2553868	None		
55	22/5/11 1:01PM 2553864	Turmeric, ginger, neem, fennel seeds, jawain.		
56	22/5/11 5:00PM	None		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
	2554098			
57	1/6/11 11:35PM 2583888	Seasame, cardaomon		
58	8/6/11 9:39AM 2600381	cilantro garlic		
59	15/6/11 7:00PM 2621959	garlic		
60	15/6/11 7:16PM 2622252	green tea, garlic, rosemary, cumin		
61	15/6/11 9:20PM 2622871	Garlic		
62	16/6/11 1:33AM 2623681	Turmeric		
63	16/6/11 2:28PM 2625606	None		
64	16/6/11 2:35PM 2625659	Tumeric		
65	16/6/11 3:04PM 2625841	none		
66	16/6/11 10:39PM 2627151	Cardamom Ginger Holy Basil Nutmeg		
67	16/6/11 10:40PM 2627166	NONE		
68	17/6/11 10:30AM 2628019	I use the digestive spices a lot such as cardamon and cinnamon because they are very goo for flatulence, for upset and aching stomach and belly and they taste nice.		
69	18/6/11 5:35AM	None		

10. Which Indian medicinal herbs or Indian herbal medicinal products do you use regularly? You may include culinary herbs or spices if used medicinally.

			Response Percent	Response Total
	2631518			
70	18/6/11 1:12PM 2631956	N/a		
71	18/6/11 10:40PM 2632806	None.		
72	20/6/11 8:17PM 2636831	tumeric		
73	21/6/11 12:45PM 2638835	gotu cola		
74	22/6/11 1:09PM 2642313	ginger cinnamon		
75	23/6/11 10:42AM 2645106	I do not use any at the moment.		
76	30/6/11 6:28PM 2667722	cumin		
77	3/10/11 8:55PM 2962581	Curcuma! Great for my aching bones tony!		
78	8/7/12 12:31PM 4312578	ginger, tumeric, ashwaganda, shatavari, holy basil, triphala		
			answered	78
			skipped	157

11. Approximately how much do you spend per month on buying Indian medicinal herbs or Indian medicinal herbal products?

	Response Percent	Response Total

11. Approximately how much do you spend per month on buying Indian medicinal herbs or Indian medicinal herbal products?

		Response Percent	Response Total
1	Under £20	29.58%	63
2	£20-49	3.29%	7
3	£50-79	0.94%	2
4	£80-119	0.00%	0
5	£120-179	0.00%	0
6	£180-250	0.00%	0
7	Above £250	0.00%	0
8	Not applicable	63.38%	135
9	Other: please specify	2.82%	6
		answered	213
		skipped	22

Answers for: Other: please specify — *6 answers*

1	4/5/11 10:33PM 2503460	do not buy something speically, other than what may be used to cook normally
2	10/5/11 12:02PM 2518761	I dont know, My father sends some
3	11/5/11 10:13AM 2521895	None
4	16/6/11 4:09PM 2626169	used vary rarely to answer
5	23/6/11 10:42AM 2645106	I do not purchase Indian medicinal herbs monthly
6	8/7/12 12:31PM 4312578	only familiar with us dollars

12. Where do you obtain your medicinal Indian herbs/spices or Indian herbal medicinal products? List all the places that you use.

		Response Percent	Response Total
1	Healthfood shop	18.18%	38
2	Supermarket	20.10%	42
3	General store	4.78%	10
4	Pharmacy	6.22%	13
5	Practitioner clinic	6.70%	14
6	Wholesaler	3.83%	8
7	Internet	3.83%	8
8	Brought from India by friends or family.	9.09%	19
9	Don't use them	56.46%	118
10	Other: please specify	5.26%	11
		answered	209
		skipped	26

Answers for: Other: please specify — *11 answers*

1	24/3/11 5:15PM 2349888	Practitioner friends and family
2	31/3/11 11:49AM 2395066	indian shops
3	4/5/11 6:39PM 2502950	home country
4	5/5/11 2:48PM 2505738	indian general store/grocery shop

12. Where do you obtain your medicinal Indian herbs/spices or Indian herbal medicinal products? List all the places that you use.

			Response Percent	Response Total
5	10/5/11 12:47PM 2518943	Dont know		
6	11/5/11 4:05PM 2523761	we stock them for resale to the the dog-owning public.		
7	15/6/11 5:44PM 2622036	I would see a practitioner		
8	16/6/11 2:35PM 2625659	Indian grocery store		
9	16/6/11 3:18PM 2625860	I used them when I was in India for 5 years since I have moved to the UK I haven't used any!		
10	22/6/11 7:05AM 2640817	we have special Ayurvedic Pharmacy in India		
11	8/7/12 12:31PM 4312578	herb store		

13. In what form do you take your Indian medicinal herbs? List all forms that you use.

		Response Percent	Response Total
1	powders	23.22%	49
2	capsules	13.74%	29
3	tablets	8.06%	17
4	tinctures	5.69%	12
5	dried loose herbs (including teabags)	16.59%	35
6	fresh herbs	16.11%	34

13. In what form do you take your Indian medicinal herbs? List all forms that you use.

			Response Percent	Response Total
7	Not applicable		58.77%	124
8	Other: please specify		4.27%	9
			answered	211
			skipped	24

Answers for: Other: please specify — *9 answers*

1	31/3/11 10:30AM 2394414	tea
2	4/5/11 11:08PM 2503517	creams, facewash
3	5/5/11 10:56PM 2506934	freshly prepared paste to be used topically or orally
4	11/5/11 12:37PM 2522984	In Food
5	11/5/11 2:07PM 2523340	toothpaste
6	11/5/11 7:55PM 2524742	juice
7	1/6/11 11:35PM 2583888	oil
8	15/6/11 5:49PM 2622023	liquid form
9	22/6/11 7:05AM 2640817	Tonics and ointments

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.

		Response Percent	Response Total
1	Open-Ended Question	100.00%	45

1	24/3/11 8:51AM 2369156	pukka herbs
2	24/3/11 5:15PM 2349888	Pukka herbs
3	31/3/11 10:30AM 2394414	pukka herbs
4	31/3/11 10:42AM 2394452	Pukka
5	31/3/11 11:10AM 2394989	pukka herbs
6	31/3/11 11:49AM 2395066	pukka herbs
7	31/3/11 7:15PM 2398630	himalay herbal
8	1/4/11 10:29PM 2404783	Tescos
9	16/4/11 1:21PM 2452394	Himalaya Herbs
10	23/4/11 1:51AM 2471658	BABA'S MALAYSIA
11	24/4/11 8:31AM 2473499	Pukka herbs
12	27/4/11 10:51PM 2484453	PukkaHerb
13	4/5/11 4:10PM 2502354	Balance healthcare?

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.

			Response Percent	Response Total
14	4/5/11 4:14PM 2502370	Himalayas (available in india)		
15	4/5/11 11:08PM 2503517	Aloeclins		
16	5/5/11 4:19AM 2503755	No		
17	5/5/11 12:47PM 2505164	No.		
18	5/5/11 5:47PM 2502652	None		
19	5/5/11 10:39PM 2507046	Hamdard (Pakistan/India)		
20	5/5/11 10:56PM 2506934	none		
21	5/5/11 11:02PM 2507080	V.B & Sons		
22	10/5/11 9:14AM 2517598	Baldwins		
23	10/5/11 1:05PM 2518994	TRS (culinary)		
24	10/5/11 1:35PM 2519179	no		
25	11/5/11 10:13AM 2521895	Pukka herbs		
26	11/5/11 12:21PM 2522941	Maharishi Ayurveda used to - think they've stopped though		
27	11/5/11 12:37PM	No idea...		

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.

			Response Percent	Response Total
	2522984			
28	11/5/11 2:07PM 2523340	Mekuti		
29	11/5/11 4:05PM 2523761	Mekuti		
30	11/5/11 6:52PM 2524547	Mina Stores London (Romford Road)		
31	22/5/11 12:48PM 2553868	Not known		
32	22/5/11 1:01PM 2553864	Pukka		
33	22/5/11 4:39PM 2554070	Yogi tea?		
34	1/6/11 11:35PM 2583888	no		
35	15/6/11 7:00PM 2621959	No		
36	15/6/11 7:16PM 2622252	no		
37	16/6/11 2:35PM 2625659	Pukka		
38	16/6/11 3:21PM 2625917	N/A		
39	16/6/11 10:40PM 2627166	Jinay Exports International		
40	17/6/11 10:30AM 2628019	Pukka		

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.				
			Response Percent	Response Total
41	21/6/11 12:45PM 2638835	pukka		
42	22/6/11 1:09PM 2642313	Himalaya		
43	23/6/11 10:42AM 2645106	Pukka		
44	3/10/11 8:55PM 2962581	Turmeric extra (Schwabe)		
45	8/7/12 12:31PM 4312578	himalayan		
2	Open-Ended Question		40.00%	18
1	24/3/11 5:15PM 2349888	Pataks		
2	31/3/11 10:42AM 2394452	Organix South		
3	31/3/11 11:10AM 2394989	banyan botanicals		
4	31/3/11 7:15PM 2398630	pukka herb		
5	1/4/11 10:29PM 2404783	Holland and Barrett's		
6	23/4/11 1:51AM 2471658	ADABI MALAYSIA		
7	4/5/11 4:10PM 2502354	Oxford medical ?		
8	5/5/11 10:39PM 2507046	Safi		

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.

				Response Percent	Response Total
	9	10/5/11 9:14AM 2517598	Herbs In A Bottle		
	10	10/5/11 1:05PM 2518994	Divya Herbal Medicines		
	11	11/5/11 2:07PM 2523340	Neem Genie		
	12	11/5/11 4:05PM 2523761	NeemGenie		
	13	22/5/11 1:01PM 2553864	Divya Pharmacy		
	14	16/6/11 2:35PM 2625659	Solgar		
	15	16/6/11 10:40PM 2627166	Savalia Group		
	16	21/6/11 12:45PM 2638835	panacea		
	17	23/6/11 10:42AM 2645106	Phyto		
	18	8/7/12 12:31PM 4312578	bayan		
3	Open-Ended Question			17.78%	8
	1	24/3/11 5:15PM 2349888	mediherb		
	2	31/3/11 10:42AM 2394452	Nature's formulary		
	3	31/3/11 11:10AM 2394989	organic india		

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.

				Response Percent	Response Total
	4	1/4/11 10:29PM 2404783	Sainsburys		
	5	5/5/11 10:39PM 2507046	Wings Pharma		
	6	10/5/11 9:14AM 2517598	Avicenna		
	7	21/6/11 12:45PM 2638835	herbs in a bottle		
	8	8/7/12 12:31PM 4312578	mountain rose herbs		
4	Open-Ended Question			6.67%	3
	1	24/3/11 5:15PM 2349888	shwabay		
	2	5/5/11 10:39PM 2507046	Divya Pharma		
	3	21/6/11 12:45PM 2638835	avicenna		
5	Open-Ended Question			2.22%	1
	1	24/3/11 5:15PM 2349888	siddhalemar		
6	Open-Ended Question			2.22%	1
	1	24/3/11 5:15PM 2349888	mayway		
7	Open-Ended Question			2.22%	1
	1	24/3/11 5:15PM 2349888	sunten		

14. Are you aware of any companies that supply Indian herbs or Indian medicinal herbal products? Please list any brand names or company names that you can remember.

			Response Percent	Response Total
8	Open-Ended Question		2.22%	1
1	24/3/11 5:15PM 2349888	slogar		
9	Open-Ended Question		2.22%	1
1	24/3/11 5:15PM 2349888	bioforce		
10	Open-Ended Question		2.22%	1
1	24/3/11 5:15PM 2349888	health pure		
			answered	45
			skipped	190

15. Have you had a consultation with a practitioner of traditional Indian medicine?

			Response Percent	Response Total
1	Never		88.21%	187
2	More than 5 years ago		4.72%	10
3	Within the last 5 years		4.72%	10
4	Within the last year		2.36%	5
5	Within the last month		0.00%	0
			answered	212
			skipped	23

16. If you have had a consultation with a practitioner, do you know which branch of Indian medicine was used?

		Response Percent	Response Total
1	Ayurveda	14.37%	25
2	Siddah	0.57%	1
3	Unani	0.57%	1
4	Don't know	6.90%	12
5	Not applicable	78.16%	136
6	Other: please specify	1.15%	2
		answered	174
		skipped	61

Answers for: Other: please specify — *2 answers*

1	11/5/11 11:07PM 2525144	In English was called Neurotherapy. Can't remember Indian name.
2	23/6/11 10:42AM 2645106	I do not know Siddah medicine. I find both Ayurveda and Unani interesting.

17. If you visit a practitioner, approximately how much does it cost per visit including the cost of the herbs?

		Response Percent	Response Total
1	Under £20	5.91%	11
2	£20-39	1.61%	3
3	£40-59	2.69%	5
4	£60-79	1.61%	3

17. If you visit a practitioner, approximately how much does it cost per visit including the cost of the herbs?

			Response Percent	Response Total
5	£80-99		0.00%	0
6	£100-200		0.00%	0
7	Above £200		0.54%	1
8	Not applicable		84.41%	157
9	Other: please specify		3.23%	6
			answered	186
			skipped	49

Answers for: Other: please specify — *6 answers*

1	4/5/11 4:14PM 2502370	free consultation in india
2	11/5/11 11:07PM 2525144	around 12 to 15 years ago
3	22/5/11 1:01PM 2553864	They are based in India
4	29/5/11 11:35PM 2575409	No Herbs just massage
5	23/6/11 10:42AM 2645106	It depends on the cost of the prescribed herbs. £ 80 - 120
6	8/7/12 12:31PM 4312578	between 80-150 us dollars

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

	Response Percent	Response Total

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

		Response Percent	Response Total
1	Open-Ended Question	100.00%	76

1	18/3/11 8:51PM 2348574	Have they been tested to the same stringent levels as required by European or US Pharma companies?
2	24/3/11 5:15PM 2349888	1. Plant variability 2. Efficacy 3. Sustainability 4. Transport and storage conditions and spoilage 5. contamination chemical and biological 6. toxicology
3	25/3/11 11:34AM 2373885	No
4	31/3/11 10:30AM 2394414	will too much hurt u? will they have a reverse affect from the purpose.
5	31/3/11 11:49AM 2395066	no
6	1/4/11 10:29PM 2404783	NO
7	4/4/11 3:34PM 2412275	no
8	24/4/11 8:31AM 2473499	If I was to use them a lot and specifically for medical reasons I may be concerned as to their quality and regulation.
9	27/4/11 10:51PM 2484453	They don't seem to have any quality standards or have been regulated in the UK. Moreover, the products should be used only under consultation.
10	4/5/11 3:55PM 2502314	originality
11	4/5/11 3:58PM 2502318	Not so familiar with them to be concerned
12	4/5/11 4:04PM 2502333	yes, i do. quality, dose in each product may vary, contamination

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.			Response Percent	Response Total
		adulterant.		
13	4/5/11 4:10PM 2502354	Contamination Adulteration Quantification of active ingredients Drug/ herb interaction Labelling		
14	4/5/11 4:14PM 2502370	no		
15	4/5/11 4:37PM 2502538	I'd be worried that: a) market isn't regulated so you wouldn't know if the product was any good - if it contained what it said it contained b) don't know if they work		
16	4/5/11 6:32PM 2502967	I would be worried the conditions in which the medicines are produced and whether the medicines are hygenic.		
17	4/5/11 7:01PM 2503057	i dont think they work as well as conventional medicines		
18	4/5/11 7:04PM 2503059	no		
19	4/5/11 8:34PM 2503226	In most cases these herbs are not able to replace western medicine. There is a danger of people using these herbs instead of going for the 'true' tested and scientifically proven treatment. Also several reports have noted that some herbs used in traditional asian medicine in general are toxic, with even cases of liver or kidney cancer causing death.		
20	4/5/11 8:50PM 2503265	reproducibility quality of products safety issues lack of regulation		
21	4/5/11 10:33PM 2503460	As with anything, excessive use can be dangerous, and if individuals do opt for pills and the sort, purity and even placebos might be a problem.		
22	5/5/11 4:19AM 2503755	I' have never used any.		
23	5/5/11 7:25AM	Yes, adulteration and toxicity such as hepato and renal toxicity		

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

			Response Percent	Response Total
	2503929			
24	5/5/11 12:47PM 2505164	Yes. Quality, content, side effects, clinical efficacy, drug interactions.		
25	5/5/11 5:41PM 2506349	- purity - hygene - ecological - toxilogical		
26	5/5/11 5:47PM 2502652	N/A		
27	5/5/11 10:39PM 2507046	No, its natural		
28	7/5/11 11:32AM 2510888	contraindications with other prescribed medicines. Safety and efficacy of the herbal medicines		
29	10/5/11 8:52AM 2517332	That they have not been tested for their toxicology or efficacy		
30	10/5/11 9:14AM 2517598	Would never buy anything over the Internet in case it was adulterated or simply not the authentic plant		
31	10/5/11 9:29AM 2517835	I would prefer standardised medicines with a license.		
32	10/5/11 1:35PM 2519179	Yes. As far as i'm aware these medicines are either unproven or need research to understand them further. The example of artmesin for malaria is a good one.		
33	10/5/11 6:21PM 2520317	1. Purpose of use 2. Clinical data or evidence of efficacy 3. Side effects/adverse reactions 4. Possible interactions with drugs (prescriptions or over the counter)		
34	10/5/11 6:47PM 2520378	Unregulated and unmonitored		
35	11/5/11 5:26AM 2521091	n/a		

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

			Response Percent	Response Total
36	11/5/11 10:13AM 2521895	Lack of assurance about herbal identity, adulteration and toxicity especially associated with the use of heavy metals and the processing of herbs such as Aconitum to create bashmas which apparently renders them harmless.		
37	11/5/11 11:20AM 2522554	not as regulated as chinese herbs		
38	11/5/11 11:36AM 2522603	just quality, freshness, being free of pesticides		
39	11/5/11 11:49AM 2522752	Whether product is genuine (i.e. health and safety)		
40	11/5/11 12:21PM 2522941	No		
41	11/5/11 12:37PM 2522984	(i) Have they been rigorously for contraindications (ii) do they contain toxins?		
42	11/5/11 1:36PM 2523220	I ensure that I buy organic products in the hopes of avoiding pest/herb/fungicides		
43	11/5/11 1:39PM 2523240	I have been working in Indian restaurant and their higene was unaceptable - I left the place		
44	11/5/11 2:07PM 2523340	Potency, quality and purity are based very much on trust.		
45	11/5/11 4:05PM 2523761	none		
46	11/5/11 7:55PM 2524742	Would only buy from know high street store on the assumption the quality is assured by that retailer.		
47	12/5/11 12:15AM 2525202	No as the ones I use are also used in everyday food usage and cooking		
48	13/5/11 5:37PM 2532239	no		
49	22/5/11 12:48PM 2553868	Not applicable		

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

			Response Percent	Response Total
50	22/5/11 1:01PM 2553864	Could have better labelling. I would prefer the use of Sanskrit rather than Latin names Should explain on packaging uses of the herb.		
51	22/5/11 4:39PM 2554070	1) Lack of controlled randomised trials for testing efficacy or safety?		
52	22/5/11 5:00PM 2554098	No		
53	1/6/11 11:35PM 2583888	no		
54	7/6/11 12:46PM 2598111	These products are not licensed and have not been properly tested, so may not be safe.		
55	8/6/11 9:39AM 2600381	I worry about herbs mixed with metals & animal ingredients		
56	9/6/11 9:00PM 2506564	Might not be produced in a safe and controlled way. Could result in harm or side effects to the consumer.		
57	15/6/11 7:00PM 2621959	None		
58	15/6/11 7:08PM 2622263	The ingredients must be validated and must be from reliable sources		
59	15/6/11 9:20PM 2622871	N/a		
60	16/6/11 1:33AM 2623681	No		
61	16/6/11 2:22PM 2625600	Possible contaminants		
62	16/6/11 3:18PM 2625860	I was never sure about the safety and quality		
63	16/6/11 3:21PM 2625917	N/A		

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

			Response Percent	Response Total
64	16/6/11 10:39PM 2627151	No		
65	16/6/11 10:40PM 2627166	Similar to Chinese herbal medicine, toxicology should be introduced to the research on Indian herbs or Indian herbal medicinal products.		
66	17/6/11 10:30AM 2628019	Yes, which is why I do not really use them other than teas. I would like to try more Indian herbs but I have to find a professional therapist who I know supplies quality medicines.		
67	17/6/11 5:43PM 2630326	no, more concerned about endangered species and environmental impact		
68	18/6/11 1:12PM 2631956	No		
69	18/6/11 10:40PM 2632806	I would be worried about the regulation of their safety, quality and origin.		
70	21/6/11 12:45PM 2638835	the usual ones - plant identification , freshness of samples		
71	22/6/11 1:09PM 2642313	adulteration		
72	23/6/11 10:42AM 2645106	Sanitary concerns when not manufactured or regulated by EU legislation.		
73	29/6/11 7:46AM 2661542	Consistency Purity Sustainability Traceability Efficacy		
74	14/9/11 3:27PM 2888486	Indian Not widely known. Lot of bad press about Chinese and use of steroids and illegal substances in their medicines		
75	3/10/11 8:55PM 2962581	I prefer to take a standardised product from a reputable phytopharmaceutical company.		
76	8/7/12 12:31PM 4312578	studies have shown that heavy metals have been found in herbal formulas imported from india		

18. Do you have any concerns regarding the safety or quality of Indian herbs or Indian herbal medicinal products? If so please list them.

	Response Percent	Response Total
	answered	76
	skipped	159

19. Do you have any other comments about Indian herbal medicine?

		Response Percent	Response Total
1	Open-Ended Question	100.00%	49

1	31/3/11 10:30AM 2394414	wish it was more widely used especially in the US.
2	31/3/11 10:42AM 2394452	the most effective system i have used
3	1/4/11 10:29PM 2404783	Very effective, no side effect, allows for creativity, cooking is an art and I happily integrate medicinal herbs in the food I prepare!
4	23/4/11 1:51AM 2471658	use them a lot in cooking and not specifically for health purposes sometimes we are even aware of it health benefit
5	27/4/11 10:51PM 2484453	n/a
6	4/5/11 3:58PM 2502318	None
7	4/5/11 4:10PM 2502354	I know very little about it. It must have a PR problem in the UK.
8	4/5/11 6:32PM 2502967	Never really came across it.
9	4/5/11 7:01PM 2503057	no
10	4/5/11 7:04PM	no

19. Do you have any other comments about Indian herbal medicine?

			Response Percent	Response Total
	2503059			
11	4/5/11 8:34PM 2503226	"Herbal" is often seen as good as it comes directly from "nature", so "it must be good". However, botulinum toxines are natural as well and are deadly when not used in a scientifically proven way. The same goes for many poisonous plants. If 'nature' would really be that good, than why has human kind, pharmacists, doctors and scientists spent ages and ages identifying the active substance in plants and purifying and extracting these substances from the rest of the plant? We have done this so we can have a true cure, which is powerful enough to work, which does not fluctuate in percentage of substance by factors like amount of sunlight. We have scientifically test the western tablets to be completely safe, and they do not contain any more side toxins than necessary.		
12	4/5/11 10:33PM 2503460	Use them, very occasionally, allone on "made" in a home-remidy medcinal form. Some herbs that are a part of my everyday diet, as a part of foods do have "medicinal" use, or in other words, are good for ones health, normally.		
13	5/5/11 4:19AM 2503755	Same as number 18		
14	5/5/11 12:47PM 2505164	No.		
15	5/5/11 5:47PM 2502652	N/A		
16	5/5/11 10:39PM 2507046	Its effective		
17	5/5/11 10:56PM 2506934	On the rare occasions that i have used them where traditional western medicines have been less effective eg. indigestion, muscular aches and pains they have prooved to be very effective.		
18	7/5/11 1:02PM 2510981	they work better and faster than western medicine		
19	10/5/11 9:29AM 2517835	None		
20	10/5/11 1:35PM 2519179	don't know enough about it but am aware that many traditional medicine systems prey on the poor, uninformed and afraid. They are also a significant factor in the exploitation of endangered plants and animal. I would support efforts to enhance the evidence base for the active compounds which may		

19. Do you have any other comments about Indian herbal medicine?			Response Percent	Response Total
		be present in some herbal medicines but would not support promotion of these belief systems as they currently stand		
21	10/5/11 6:21PM 2520317	Mysterious and powerful		
22	11/5/11 5:26AM 2521091	n/a		
23	11/5/11 10:13AM 2521895	I know little of Indian herbal medicine other than it has 3 main branches, a long history and philosophy and a considerable written record, but not nearly so extensive as that of Traditional Chinese herbal medicine. Is there a government -recognised set of references herbs and corresponding herbarium specimens that can be used as a scientific platform for authentication, quality control and activity research? If not, then this ought to be instigated in order to ensure its future scientific credibility. The use of the herbs in powdered form prevents the use of morphological checks for identity and quality; such tests need therefore to be totally reliant on lab-based methods. Have such test been undertaken and published?		
24	11/5/11 11:36AM 2522603	it's the root of Chinese medicine but don't see it much, would be nice to see it as much as TCM		
25	11/5/11 12:37PM 2522984	No.		
26	11/5/11 1:39PM 2523240	We have a lot of European herbs that are underused I do not see the sense of shipping something thousands of kilometers- especially that bacterial flora in our guts is quite different.		
27	11/5/11 4:05PM 2523761	It's underused, under-rated but so effective at so many levels. Turmeric is recognised by homeopathic vets as being-anti-cancer, but neem's properties are less well known. We wouldn't be without it - used for our dog who has joint problems, helped our other dog get well from cancer, and we use it for many, many things.		
28	11/5/11 9:49PM 2525036	Never used them!		
29	11/5/11 10:19PM 2525081	Not familiar with it at all, but know it is an ancient medicine form.		
30	12/5/11 12:15AM 2525202	Traditional, economically viable, therapeutically effective on its own or as an adjunctive to western medicine.		

19. Do you have any other comments about Indian herbal medicine?			Response Percent	Response Total
31	22/5/11 12:48PM 2553868	No		
32	22/5/11 1:01PM 2553864	Need a more comrehensive source of buying herbs in the UK- currently very dispirate distribution networks. Would like to see better labelling, more user friendly and explainatory.		
33	22/5/11 5:00PM 2554098	No		
34	29/5/11 11:35PM 2575409	I do not use them but I do use herbal remedies which i make myself from own grown plants ie: Elderberry cordial for colds		
35	1/6/11 11:35PM 2583888	no		
36	8/6/11 9:39AM 2600381	surprisingly good results so far		
37	9/6/11 9:00PM 2506564	No		
38	15/6/11 7:00PM 2621959	None except they can be used to make a lovely curry!		
39	15/6/11 7:16PM 2622252	I am interested in any complementary medicines so have no worries about using them.		
40	15/6/11 9:20PM 2622871	N/a		
41	16/6/11 1:33AM 2623681	No		
42	16/6/11 2:35PM 2625659	There are many others made by people in India, which are a mix of various products, in a combination unavailable in the UK.		
43	16/6/11 3:21PM 2625917	No		
44	16/6/11 10:39PM 2627151	No		

19. Do you have any other comments about Indian herbal medicine?

			Response Percent	Response Total
45	17/6/11 10:30AM 2628019	It would be a shame if Indian and Asian herb would not be available in the UK or that the natives in Asia could not grow their own herbs and make their medicines. The role of these herbs is vital as it has been part of their cultures for thousands of years.		
46	18/6/11 10:40PM 2632806	Contrary to other types of herbal medicine, I have never heard anybody talking about having used Indian herbal medicine, or seen a shop selling it.		
47	22/6/11 7:05AM 2640817	Minor conditions like cold and allergies work better. most often the effect is very slow patience is important.		
48	23/6/11 10:42AM 2645106	We have little knowledge about it.		
49	29/6/11 7:46AM 2661542	My understanding is that most traditional medicines are prescribed as a result of a consultation. Off the shelf remedies are therefore questionable.		
			answered	49
			skipped	186

20. What is your gender?

		Response Percent	Response Total
1	female	66.52%	149
2	Male	33.48%	75
		answered	224
		skipped	11

21. What is your age range?

			Response Percent	Response Total
1	21 and Under		16.44%	37
2	22 to 34		49.78%	112
3	35 to 44		12.00%	27
4	45 to 54		14.22%	32
5	55 to 64		4.44%	10
6	65 to 74		2.67%	6
7	75 and over		0.44%	1
			answered	225
			skipped	10

22. Where were you born?

			Response Percent	Response Total
1	United Kingdom and Ireland		45.98%	103
2	Europe		17.41%	39
3	Asia		17.86%	40
4	Africa		7.14%	16
5	Australasia		0.45%	1
6	North America		9.38%	21
7	Central or South America		1.79%	4
			answered	224
			skipped	11

23. Your ethnic group

		Response Percent	Response Total
1	White	58.04%	130
2	Black or Black British – Black Caribbean	0.89%	2
3	Black or Black British – Black African	4.46%	10
4	Asian or Asian British – Indian	9.82%	22
5	Asian or Asian British – Pakistani	1.79%	4
6	Asian or Asian British – Bangladeshi	2.23%	5
7	Chinese or Other Ethnic Group – Chinese	4.46%	10
8	Black or Black British – Other Black	0.00%	0
9	Asian or Asian British – Other Asian	6.25%	14
10	Chinese or Other Ethnic Group – Other	4.02%	9
11	Mixed White/Black Carribean	0.89%	2
12	Mixed White/Asian	0.89%	2
13	Mixed - other	6.25%	14
		answered	224
		skipped	11

24. Your occupation group

			Response Percent	Response Total
1	Managers & Administrators		7.46%	17
2	Professional Occupations		28.07%	64
3	Associate Professionals & Technical Occupations		1.75%	4
4	Clerical & Secretarial Occupations		0.88%	2
5	Craft & Related Occupations		1.32%	3
6	Personal & Protective Service Occupations		0.88%	2
7	Sales Occupations		0.88%	2
8	Plant & Machine Operatives		0.44%	1
9	Students		44.74%	102
10	Unemployed		1.32%	3
11	Retired		3.51%	8
12	Other: please specify		8.77%	20
			answered	228
			skipped	7

Answers for: Other: please specify — *20 answers*

1	23/3/11 8:38PM 2367916	acupuncturist TCM style (not herbal)
2	31/3/11 7:15PM 2398630	naturopath
3	4/4/11 3:34PM 2412275	acupuncture

24. Your occupation group				
			Response Percent	Response Total
4	10/5/11 8:52AM 2517316	Uni. Researcher		
5	10/5/11 9:14AM 2517598	Also - herbalist		
6	10/5/11 11:19AM 2518458	Health Policy Researcher		
7	10/5/11 12:02PM 2518761	Academic researcher		
8	11/5/11 12:23PM 2522953	graphic designer		
9	11/5/11 2:07PM 2523340	self employed		
10	11/5/11 4:05PM 2523761	self-employed online retail		
11	11/5/11 11:07PM 2525144	Graphic designer		
12	12/5/11 7:33PM 2528336	Acupuncturist		
13	20/5/11 12:41PM 2551135	research		
14	15/6/11 5:49PM 2622023			
15	17/6/11 1:28PM 2628915	Professional Sportsperson		
16	19/6/11 12:53AM 2632965	Chinese Medicine Expert		
17	21/6/11 12:45PM 2638835	herbalist and acupuncturist		

24. Your occupation group

		Response Percent	Response Total
18	22/6/11 7:05AM 2640817	PhD researcher at DKFZ Germany	
19	28/6/11 9:53PM 2660931	Academia	
20	16/1/13 4:18PM 5358567	medical doctor	

25. Where do you currently live

			Response Percent	Response Total
1	United Kingdom		83.19%	188
2	Ireland		0.88%	2
3	Other country in Europe		3.98%	9
4	North America		5.75%	13
5	Central or South America		0.44%	1
6	Asia		3.10%	7
7	Africa		0.44%	1
8	Australasia		1.33%	3
9	Other, please specify:		0.88%	2
			answered	226
			skipped	9

Answers for: Other, please specify:		*2 answers*
1	23/4/11 1:51AM	Malaysia

25. Where do you currently live

			Response Percent	Response Total
	2471658			
2	4/5/11 8:34PM 2503226	Belgium		

13.5 Appendix 5

Price and market trends for herbs sold in Bozhou herb market, Anhui, PRC – obtained on 20-3-2011

Name	Specifications	Produce Area	Price /kg (YUAN)	Trend
AJIAO	FUPAI	SHANGDONG	450	Stable
AJIAO	DONGA	SHANGDONG	1050	Stable
AWEI	Mixed	Import	350	
AIYE	Mixed	All over	3.5	
Anxixiang	Mixed	Import	90	
BAJIAOFENG	Mixed	Guangxi	3.8	
BAJIAOLIAN	Mixed	Hubei	25	
BAIJIAOLIAN	Mixed	Sichuan	14	
BAYUEZHA	White	Anhui	20	Little
BAYUEZHA	Mixed	Anhui	15	
BADOU	mixed	Sichuan	9	
BAJITIAN	Body	Guangdong	120	
BAJITIAN	Mixed	Guangdong	85	
BAJI	Mixed	Anhui	3	
BAIBEI	Root	Guangxi	3	
BAIBIANDOU	Skin	Sichuan	5.5	
BAIBIANDOU	Mixed	Import	9.5	
BAIBIANDOU	Mixed	Sichuan	10	
BAICHANHUA	Mixed	Zhejiang	19	
BAIDOUKOU	Mixed	Import	51	Increase
BAIFAN	Mixed	Zhejiang	1	
BAIFUZI	Mixed	DOONGBEI	85	Little
BAIGUO	Mixed, Kernel	All over	13	
BAIGUO	Mixed, good	All	10	
BAIGUO	Mixed	All	6.5	

BAIGUO	Kernel	All	17	
BAIHUJIAO	Mixed	Vietnam	46.5	Little
BAIHUJIAO	Mixed	HAINAN	46.5	Increase
BAIHUASHE	Each	Jiangxi	36	
Baihuasheshecao	Farm	Henna	8.5	
Baihuasheshecao	Wild	Jiangxi	12.5	
BAIJI	Select	Guizhou	230	Little
BAIJI	Mixed	Guizhou	170	Little
BAIJILI	Mixed	Neimeng	7	
BAIJILI		Neimeng	9	
BAIJIEZI	Mixed	Sichuan	12	
BAIJUSHENG	Mixed	Hebei	25	
baimaoXiakucao	Mixed	Dabieshan	6	
BAI LIAN	Mixed	ANHUI	15.5	Increase
BAIMAOGEN	Mixed	Hebei	11	
BAIMAOGEN	Select	Anhui	12	
BAIQIAN	Washed	Hubei	58	little
BAIQIAN	Mixed	Hubei	40	
BAISHAO	Tail	Anhui	14	
Baishao	Grade 3/4	Anhui	19	
Baishao	Mixed	Anhui	18	
Baishao	Grade 2/3	Anhui	22	
Baishao	Grade 1/2	Anhui	24	
Baishao	Black	Anhui	14.5	
Baishao	Cooked	Anhui	10	
BAISHOUWU	Mixed	Jiangsu	1	
BAISHIZHI	Mixed		2	

Name	**Specifications**	**Produce Area**	**Price / kg (YUAN)**	**Trend**
BAIZHU	Select	Anhui	43	Short
Baizhu	Mixed	Zhejiang	35	Down
Baizhu	Mixed	Anhui	40	Down
Baizhu	Mixed	Hebei	28	
Baizhu	Mixed	Zhejiang	40	Little
BAIZHU seeds	Mixed	Anhui	95	
Baituoweng	Mixed	Dongbei	24	
Baiwei	Farmed	Dongbei	14	
Baiwei	Mixed	Gansu	9	
Baixianpi	Mixed	Korea	34	
Baixianpi	Select	Dongbei	60	
Baixianpi	Mixed	Dongbei	38	
Baiyaozi	Mixed	Hunan	8.5	
Baiying	Mixed	Hubei	4	
Baizhi	Mixed	Hebei	15	
Baizhi	Mixed	Sichuan	20	
Baizhi	Mixed	Anhui	16	
Baizhi	Mixed	Anhui	19	
Baibu	Large	Hubei	13	
Baibu	Large	Yunnan	13	
Baibu	Small	Sichuan	14	
Baihe	Large	Hunan	40	
Baihe	Small	Henan	40	
Baihe	High grade	Gansu	95	
Baihe	Mixed	Gansu	45	

Name	**Specifications**	**Produce Area**	**Price / kg (YUAN)**	**Trend**
Baihehua	Mixed	Hunan	22	
Bairuicao	Mixed		39	Little
Baiziren	Year 98	Shandong	70	
Baiziren	Mixed	Shandong	68	
Baijiangcao	Yellow flower	Anhui	7	
Baijiangcao	North	Hebei	3	
Baijiangcao	South		5	
Banlangen	Mixed	Gansu	12	
Balangen	Mixed	Dongbei	12	
Banlangen	Mixed	Henna	12	
Banbianlian	Mixed	Jiangsu	26	Little
Banfenghe	Mixed	Guangdong	7	
Banzhilian	Second cut	Henna	6.5	
Banzhilian	First	Henna	7.5	
Baoshilian	Mixed	Guangdong	16	
Beidougen	Mixed	Dongbei	9.5	
Beishashen	Mixed	Neimeng	62	Little
Beishashen	Mixed	Hebei		Increase
Bibo	Mixed	Yunnan	42	Little
Bibo	Mixed	Import	43	Little
Beidougen	Mixed	Dongbei	9.5	
Beishashen	Mixed	Neimeng	62	Little
Bixie			10.5	
Bixie		Anhui	11.5	
Bimazi	Mixed	Anhui	6	

Name	**Specifications**	**Produce Area**	**Price / kg (YUAN)**	**Trend**
Bitaogan	Mixed		7	
Biandouhua	Mixed		58	Little
Bianxu	Mixed		2	
Biejia	Mixed		65	
Bianlang	Mixed	Import	9	
Binpian	White	Guangzhou	140	
Binqiuzi	Mixed	Mguizhou	180	Little
Bohe	High grade		15	
Bohe	Mixed		5	
Bohe	M(leaves)		12	
Bohenao		Shanghai	260	
Boheyou	Plain oil		120	
Boheyou	Raw oil		170	
Buguzhi	Mixed	Import	35	
Cansha	Mixed	Hainan	3	
Cangerzi	Small		6.5	
Cangerzi	Large		3.5	
Cangzhu	Plain	Neimeng	31	
Cangzhu	Half skin off	Neimeng	26	
Caodoukou	Mixed	Hainan	27	
Caoguo	Seeds	Yunnan	80	Little
Caoguo	Mixed	Yunnan	54	Down
Caoheche	Mixed	Gansu	14.5	
Caojueming	High grade		7	Little
Caojueming	Mixed		4.5	

Name	Specifications	Produce Area	Price / kg (YUAN)	Trend
Caojueming	Mixed	Import	3.5	
Caowu	Sliced	Sichuan	20	Little
Caowu	Mixed	Sichuan	18	
Cebeiye	Mixed		2	
Chaihu	Farmed	Gansu	60	briskly &easily
Chaihu	Red	Neimeng	95	
Chaihu	Wild	Gansu	65	briskly &easily
Chaihu	Wild	Shanxi	70	briskly &easily
Chaihu baby plants	Autumn plants		3.5	
Chaihu baby pants	Spring plants		4.5	
Chantui	Washed	Shangdong	140	Little
Chantui	Mixed	Shandong	100	briskly &easily
Chenpi	Mixed	Jianghsu	24	
Chenpi	Skin/piece	Jiangsu	5	
Chansu	6%	Jiangsu	3200	Little
Changchunhua	Mixed	Yunnan	10	
Changshan		Sichuan	7	
Changshan		Dabieshan	5	
Cheqiancao	Mixed		3	
Cheqianzi	Mixed	Dongbei	20	
Cheqianzi	Mixed	Jiangxi	21	
Chenxiang	Out of standard	Indonesia	150	

Name	Specifications	Produce Area	Price / kg (YUAN)	Trend
Chenxiang	Mixed	Indonesia	580	Little
Chenxiang	15-20%	Indonesia	1200	Little
Chensha	Mixed	Guangxi	180	
Chenpi	Thread	Zhejiang	4.8	
Chenpi	Mixed	Zhejiang	3.8	
Chishao		Dongbei	21.5	
Chishao		Neimeng	26.5	
Chishizhi	Mixed	Shanxi	1,5	
Chixiaodou	Mixed		8.5	
Chongweizi	Mixed	Anhui	20	Little
Chushizi	Mixed	Anhui	22	
Chuanbei	Blue	Sichuan	1500	
Chuanbei		Sichuan	1850	
Chuanlianzi	Mixed	Yunnan	3.5	
Chuanlianzi	Mixed	Sichuan	3.5	
Chuannuxi	Mixed	Hubei	13	
Chuanniuxi	Mixed	Sichuan	15	
Chuanwu	Sliced	Sichuan	23	Little
Chuanwu	Mixed	Sichuan	16	
Chuanxiong	Mixed	Sichuan	30	
Chuanposhi	Mixed	Hunan	3.5	
Chuanshanjia	Plain scale	LAOS	2400	Little
Chuanshanlong	Mixed	Dongbei	9	
Chuanxinlian	Stem	Guangxi	3.5	
Chuanxinlian	Leaves	Anhui	11	Little

Name	Specifications	Produce Area	Price / kg (YUAN)	Trend
Chuanxinlian	Whole plant	Guangxi	6.5	
Chuipengcao	Washed	Zhejiang	9	
Chuipengcao	Mixed	Zhejiang	7	
Chunpi	Mixed		2.2	
Name	**Specifications**	**Produce Area**	**Price / kg (YUAN)**	**Trend**
Chunpi	Root skin		5.5	
Cishi	Mixed	Jiangsu	1.5	
Cihuang	Mixed		30	
Ciwei	Skin/high grade		125	Little
Ciwei	Skin		90	
Ciwujia	Stem	Dongbei	5	
Ciwujia	Root	Dongbei	6.5	
Ciwujia	Peel	Dongbei	35	little
Dafengzi	Mixed	Hainan	11	
Dafupi	Hard shell	Import	4.5	
Dafupi	Soft shell	Import	4.5	
Dahuang	Water root		4.5	
Dahuang		Gansu	18	Little
Dahuang	Water root		4.5	
Dahuang		Gansu	4	
Dahuang		Gansu	7.5	Little
Dahui	Mixed	Guangxi	27	
Daji	Root		18	
Daji	Mixed		5	
Dajiangjun	Mixed	Neimeng	245	

Name	Specifications	Produce Area	Price / kg (YUAN)	Trend
Daqingyan	Mixed		2	
Daqingye	Mixed	Dongbei	2.3	
Daqingye	Mixed	Gansu	2.8	
Daidaihua	Mixed	Zhejiang	60	Little
Daimao	Mixed	Import	800	
Danshen	Mixed	Shangdong	13	
Danshen	Mixed	Anhui	11.5	briskly &easily
Danshen	Large	Jiangsu	18	
Danshen	Select	Anhui	15	
Danshen	Second	Jiangsu	11	
Dansheng	Mixed	Shanxi	11.5	
Danpi	Mixed	Tongling	35	
Danpi		Anhui	29	briskly &easily
Danpi		Anhui	36	briskly &easily
Danpi	White, small	Anhui	20.5	briskly &easily
Danfan	Mixed	Tianjing	20	
Dandouzhi	Mixed		4.5	
Danzhuye	Mixed		6.5	
Danggui	Box	Gansu	38	briskly &easily
Danggui		Gansu	25	briskly &easily
Danggui		Gansu	27	briskly &easily

Name	Specifications	Produce Area	Price / kg (YUAN)	Trend
Danggui	Sliced	Gansu	33	briskly &easily
Dangshen	White, medium	Gansu	46	
Dangshen	Veins	Gansu	45	Short
Dangshen	White, small	Gansu	42	
Dangshen	White, large	Gansu	53	briskly &easily
Daodoukou	Mixed	Southern anhui	5.5	
Daodouzi	Black		4	Little
Daodouzi	White	Southern anhui	5.5	
Daokoucao	Mixed	Guangdong	2	
Daoya	Mixed		3.5	
Dengxincao	Whole package	Jiangxi	153	Little
Dengxincao	Small package	Jiangxi	120	Little
Dengzhanhua	Mixed	Guangxi	19	
Didancao	Mixed	Guangxi	5.5	
Diding	Redish	Jiangsu	12	
Diding	Bitter	Hebei	7	Little
Diding	Purple flower	Shanxi	6	
Difuzi	Mixed	Dongbei	4	
Difuzi	Washed	Dongbei	5	
Digupi	White	Shanxi	12	
Digupi	Pure, Red	Shanxi	35	Little
Digupi	Red	Shanxi	21	
Dimiancao	Hard	Jiangxi	12	

Name	**Specifications**	**Produce Area**	**Price / kg (YUAN)**	**Trend**
Dimiancao	Soft		7	
Dilong	Mixed	Shanghai	55	
Dilong	Opened	Guangxi	160	Short
Dilong	Mixed	Guangxi	85	
Dilong	Opened	Shanghai	85	Little
Diyu	Mixed		4.5	
Diyu	Select		7	
Dianqie	Farmed		5	
Dinggongten	Mixed	Guangdong	4	
Dongchongxiacao	3500 worms	Tibet	85,000	
Dongchongxiacao	2600 worms	Tibet	130,000	
Dongchongxiacao	2200 worms	Tibet	146,000	
Dongchongxiacao	Feed	Tibet	35,000	
Dongchongxiacao	4000 worms	Tibet	75,000	
Dongguapi	Mixed		5.5	
Dongguazi	Double side		35	Little
Dongguazi	Single side		5	
Donghua	Mixed	Hebei	90	Increase
Donghua	High grade	Gansu	150	Little
Donghua	Mixed	Gansu	90	Increase
Dongkuizi	Large	Guangxi	6.5	
Dongkuizi	Small	Anhui	8	
Donglingcao	Mixed		4.5	
Douzhijiang	Mixed	Guangdong	4	
Duhuo	Mixed	Gansu	9	briskly &easily

Name	Specifications	Produce Area	Price / kg (YUAN)	Trend
Duhuo	Mixed	Hubei	8	briskly &easily
Duyiwei	Leaves	Sichuan	20	
Duyiwei	Root	Sichuan	55	
Duzhong	Stem bark 1mm		15	
Duzhong	Twig bark		13.5	
Duzhong	Stem bark 2mm		16.5	
Duzhong leaves	Mixed		3.8	Little
Duanchangcao	Mixed	Guangdong	10	
Danxueliu	Mixed	Yunnan	3.5	
Danshuhua	Mixed	Yunnan	24	
Eshu	Mixed	Yunnan	9	
Eshu	Mixed	Guangxi	9.5	Little
Ebushicao	Mixed	Anhui	8	
Eguanshi	Mixed		6	

13.6 Appendix 6

NMR spectroscopy raw data with sample key.

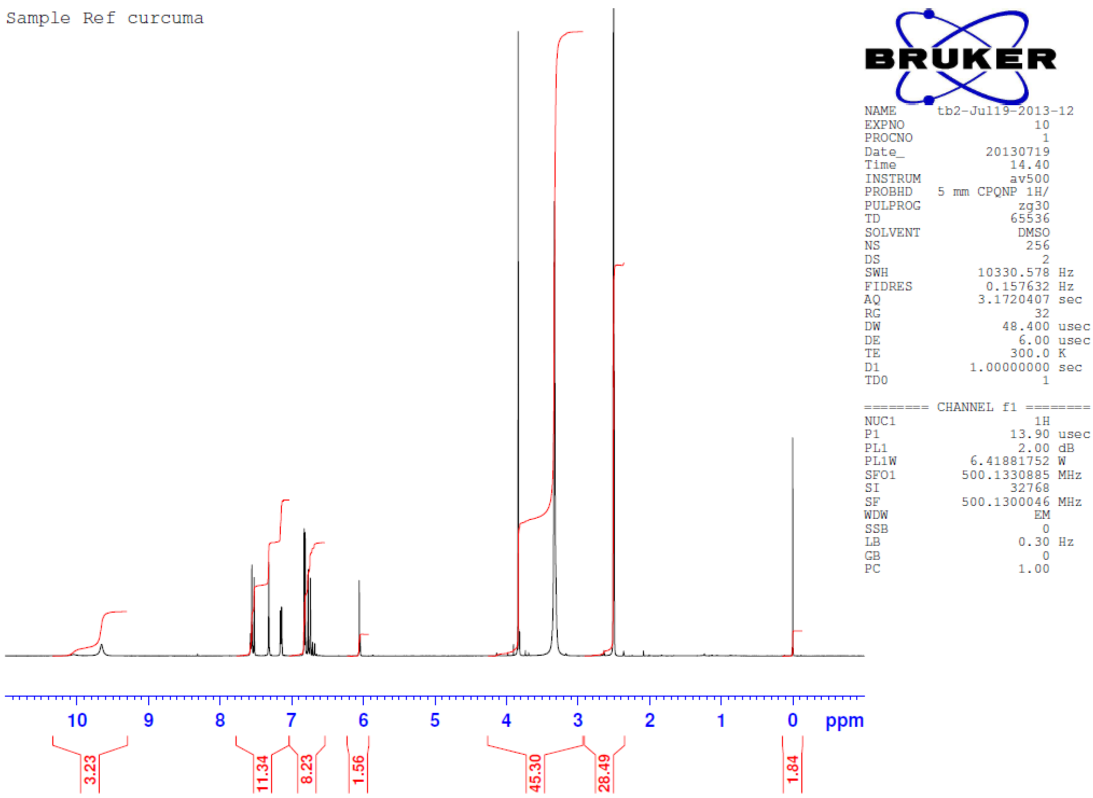
Simca No	Details of product	NMR spectra no / sample	Use	Preparation
1	Tablets. 10,000mg (as 500mg of extract) providing 95% curcumins. Manufactured in UK. Supplied via internet. Dosage: 1 tablet daily. Ingredients: Turmeric root extract, calcium carbonate, dicalcium phosphate, microcrystalline cellulose. Tablet coating: (hydroxypropyl methylcellulose (HPMC), glycerine. Colours: Iron oxides and titanium dioxide), hydroxypropyl methylcellulose, carboxymethylcellulose, silicon dioxide, stearic acid, magnesium stearate.	JUL-20-12-10 s1	M	EE
2	500mg capsules manufactured in UK and supplied via internet. Dosage: 1 capsule, 3 times daily. Complies with British Pharmacopoeia. Ingredients: Turmeric rhizome, hypromellose.	JUL-20-12-20 s3	M	PW
3	400mg gelatine capsules, manufactured in USA and supplied via retail health food shop in UK. Dosage: 1 capsule, twice daily. Ingredients: Turmeric powder (*C. longa* L.) microcrystalline cellulose, silicon dioxide, magnesium stearate, stearic acid.	JUL-20-12-30 s4	M	PW
4	500mg capsules provided by Ayurvedic company in Tamil Nadu, India. Dosage 1 capsule, 3 times daily. Ingredients: Curcumin extract (*C. longa*)	JUL-20-12-40 s5	M	EE
5	Combination product with *C. amada Roxb.* and *Frangula purshiana* Cooper Rhamnaceae *(Rhamnus purshiana synonym on label)*. Tablets manufactured in NL. Dosage: 3-4 tablets, 1 or 2 times daily. Ingredients: Curcuma rhizome extract 600mg, *C. amada* rhizome pulverized 100mg, *Frangula purshiana* Cooper cortex 30mg, sugar 75mg.	JUL-20-12-50 s6	M	PW and EE. Mixed species
6	400mg capsules, manufactured in USA and supplied via retail health food shop in NL. Dosage: 1 capsule, twice daily. Ingredients: Turmeric powder (*C. longa*), microcrystalline cellulose, silicon dioxide, magnesium stearate, stearic acid.	JUL-20-12-60 s7	M	PW

7	UK supermarket(UK)	JUL-20-12-70 s8	F	PW (organic)
8	Standardised 500mg tablets. Manufactured in UK and supplied via internet. Dosage: 1 to 3 tablets, daily. Ingredients: Curcumin powder extract 350mg (standardised for a minimum of 95% curcuminoids), turmeric powder (*C. longa*)150mg, Bromelain 20mg, di-calcium phosphate, microcrystalline cellulose, silicon dioxide, stearic acid. Coating: HPMC, propylene glycol.	JUL-20-12-80 s9	M	PW and EE
9	500mg capsules. Standardised for 95% curcuminoids. Manufactured in USA and supplied via internet. Dosage: 1 capsule daily. Ingredients: Turmeric powder (. *longa* root) 450mg Turmeric extract (C. longa root) 50mg, gelatin, silica, magnesium stearate, stearic acid.	JUL-20-12-90 s10	M	PW and EE
10	UK supermarket.	JUL-20-12-100 s12	F	PW
11	UK retail shop.	JUL-20-12-110 s13	F	PW
12	Integrated Chain Product	JUL-20-12-120 s14	M	fine ground PW (organic)
13	Integrated Chain Product	JUL-20-12-130 s15	M	course ground PW (organic)
14	Market in Delhi, India	JUL-20-12-140 s16	F	PW
15	UK retail shop.	JUL-20-12-150 s17	F	PW
16	Retail shop in South India.	JUL-20-12-160 s18	F	PW
17	Retail shop in South India.	JUL-20-12-170 s19	F	PW
18	UK retail shop.	JUL-20-12-180 s20	F	PW

19	Sourced in Bangalore, India	JUL-20-12-190 s21	F	PW
20	UK retail shop.	JUL-20-12-200 s22	F	PW
21	*C. kwangsiensis* S.G. Lee and C.F. Liang. Manufactured as granules in PRC and supplied by UK TCM company	JUL-20-12-210 s23	M	AE
22	*C. longa.* Full spectrum 5:1 herb extract powder. (Replenished essential oils). Manufactured in PRC and supplied by UK TCM company.	JUL-20-12-220 s24	M	AE
23	*C. longa*. Manufactured in Taiwan and supplied by UK TCM company. Ingredients: Curcuma longa rhizome concentrated extract (66%), corn starch (34%).	JUL-20-12-230 s25	M	AE and PW
24	Capsules supplied by an Ayurvedic company in India.	JUL-20-12-240 s26	M	PW
25	*C. aromatica*. Sourced in India	JUL-20-12-250 s27	F	PW
26	Supplied by UK company	JUL-20-12-260 s28	M	AE
27	*C. aromatica*. Sourced in India	JUL-20-12-270 s29	C	PPW
28	Supplied by retail shop in Kerala, India	JUL-20-12-280 s30	F	DRh
29	Manufactured in PRC and supplied by UK TCM company.	JUL-20-12-290 s31	M	PW
30	Cultivated in PRC and supplied by UK TCM company.	JUL-20-12-300 s32	M	DRh
31	Farm in Erode, India	JUL-20-12-310 s33	F/M	DRh
32	Farm in Erode, India	JUL-20-12-320 s34	F/M	DRh (polished)

33	Farm in Erode, India	JUL-20-12-330 s35	F/M	Dried root tuber
34	Cultivated in PRC and supplied by UK TCM company.	JUL-20-12-340 s36	M	DRh
35	500mg gelatin capsules. Standardised for 95% curcuminoids. manufactured in USA and supplied via internet. Dosage: 1 capsule daily. Ingredients: Turmeric concentrate 500mg (*C. longa*), cellulose, magnesium stearate, silicon dioxide.	JUL-20-12-350 s37	M	EE
36	Manufactured in Austria and supplied by retail shop in Iceland.	JUL-20-12-360 s38	F	PW (organic)
37	*C. zanthorrhiza* Roxb. rhizome, Tropilab	APR-08-13-10 s50	M	PW
38	Market in Delhi, India	APR-08-13-20 s51	F	FRh
39	UK supermarket	APR-08-13-30 s52	F	FRh
40	UK supermarket and freeze dried	APR-08-13-40 s53	F	FRh
41	Market in Udaipur, India	APR-08-13-50 s54	F	DRh (polished)
42	Market in Udaipur, India	APR-08-13-60 s55	F	PW
43	*C. aromatica* Salisb., Kasturi Manjal from India, sourced via internet	APR-08-13-70 s56	C	PW
44	*C. aromatica*, rhizome, Kasturi Manjal from India, sourced via internet	APR-08-13-80 s57	C	PW
45	*C. aromatica*, Kasturi Manjal from India and sourced via internet	APR-08-13-90 s58	C	PW

46	An Agmark certified food powder sourced in Hyderabad, India	APR-08-13-100 s59	F	PW
47	Medicinal powder. Integrated Chain Finished Product in 425mg capsules manufactured in UK and sourced via internet. Dosage: 2 capsules, 3 times daily. Ingredients: Turmeric root (*C. longa*), HPMC.	APR-08-13-110 s60	M	PW (organic)
48	Medicinal Super Critical Fluid (SCF) extract 400mg soft gel capsules. Manufactured in USA and sourced via internet. Dosage: 1 capsule daily. Ingredients: Turmeric (*C. longa*), olive oil, gelatine, glycerine, yellow beeswax, carob.	APR-08-13-120 s2	M	SCF
49	*C. zanthorrhiza* CAMAG 9765	APR-08-13-130 9765	M	PW
50	*C. zanthorrhiza* CAMAG 9767	APR-08-13-140 9767	M	PW
51	*C. zanthorrhiza* CAMAG 10565	APR-08-13-150 10565	M	PW
52	*C. zanthorrhiza* CAMAG 10567	APR-08-13-160 10567	M	PW
53	Retail shop in Greenland		F	PW
54	Integrated chain product, manufactured and sourced in UK. Ingredients turmeric rhizome, ethanol.		M	EE (organic)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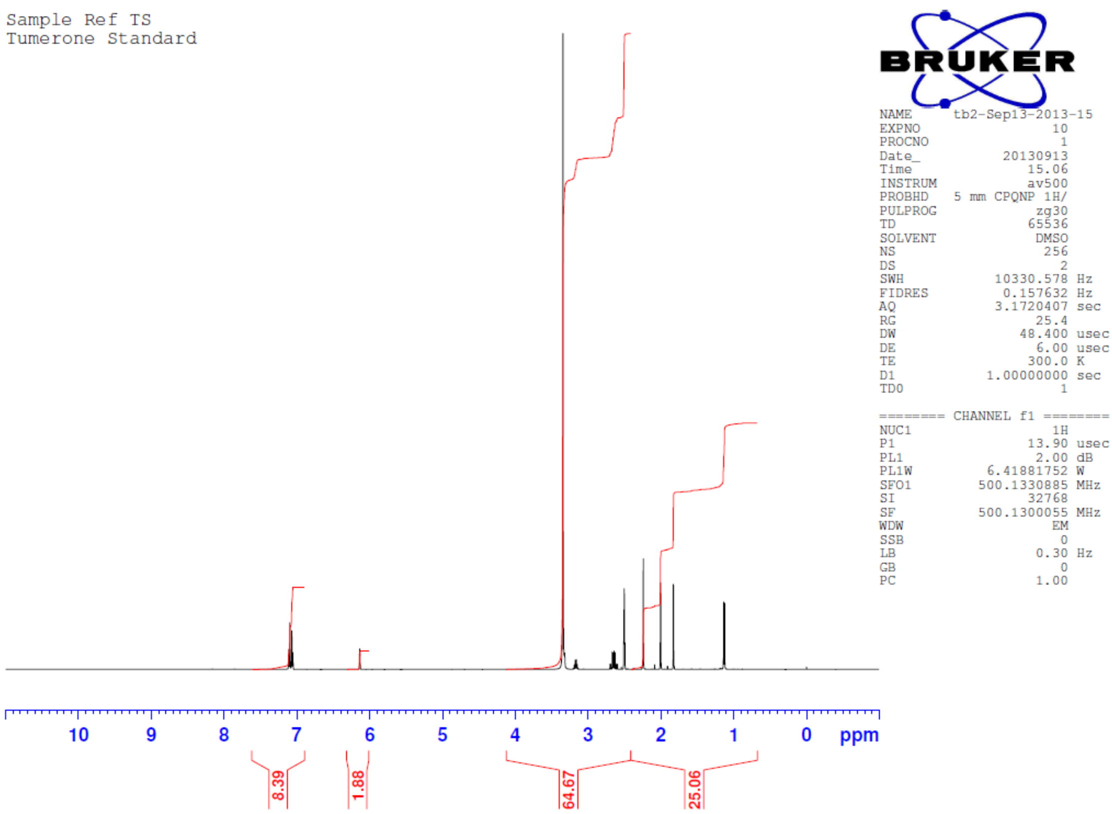
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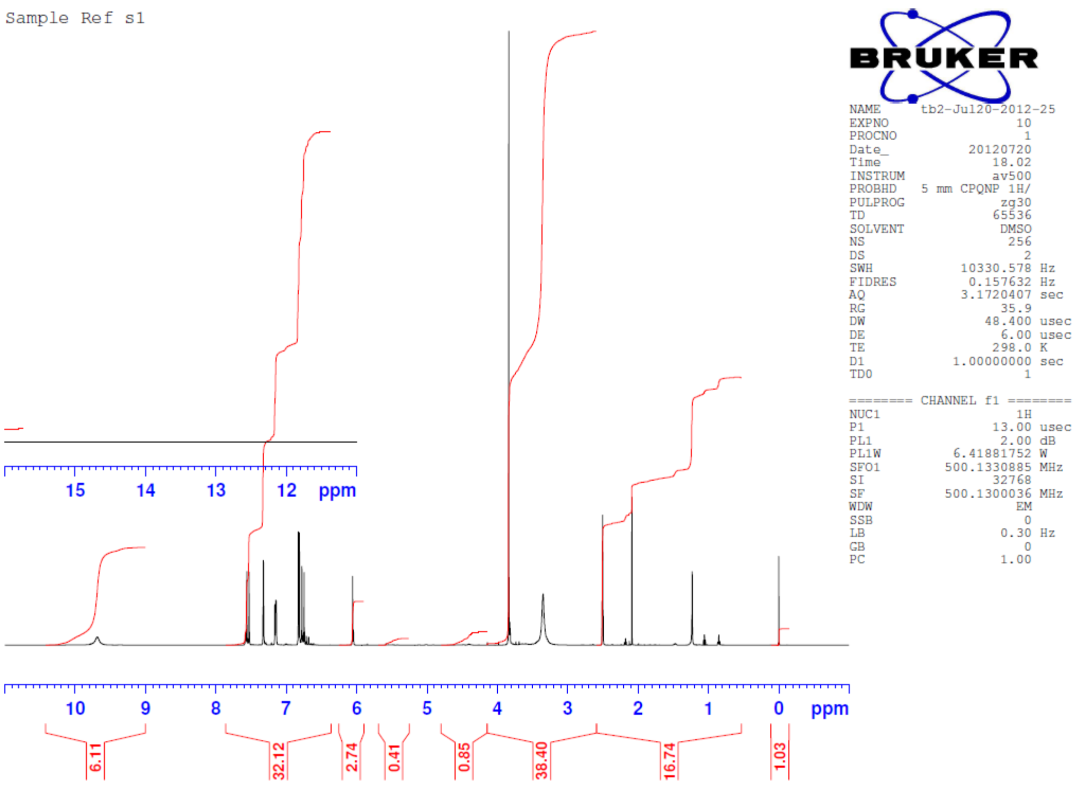
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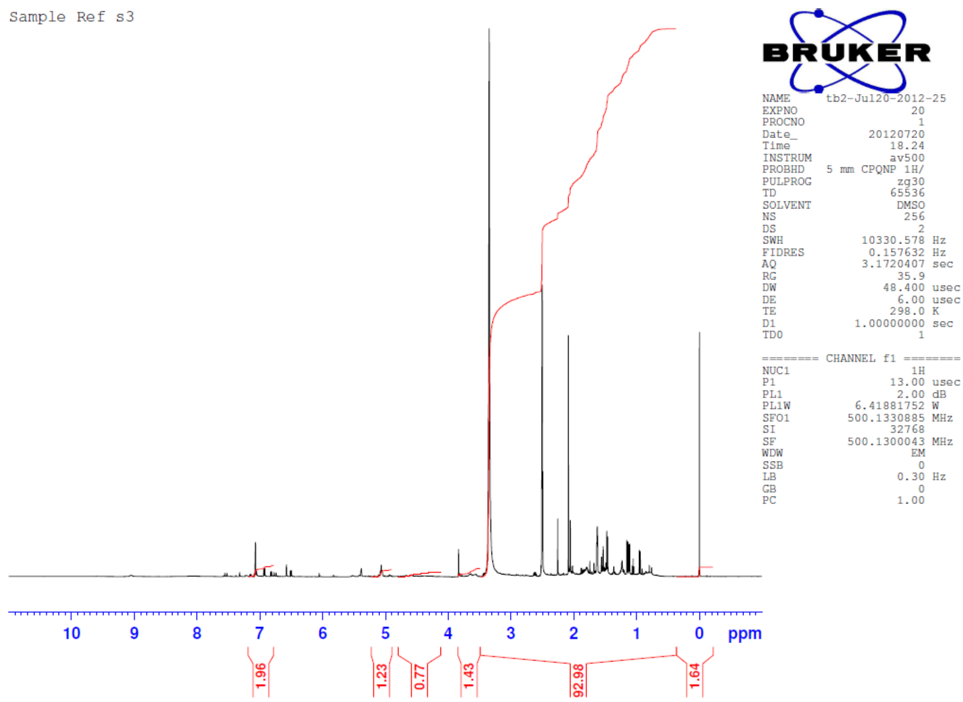
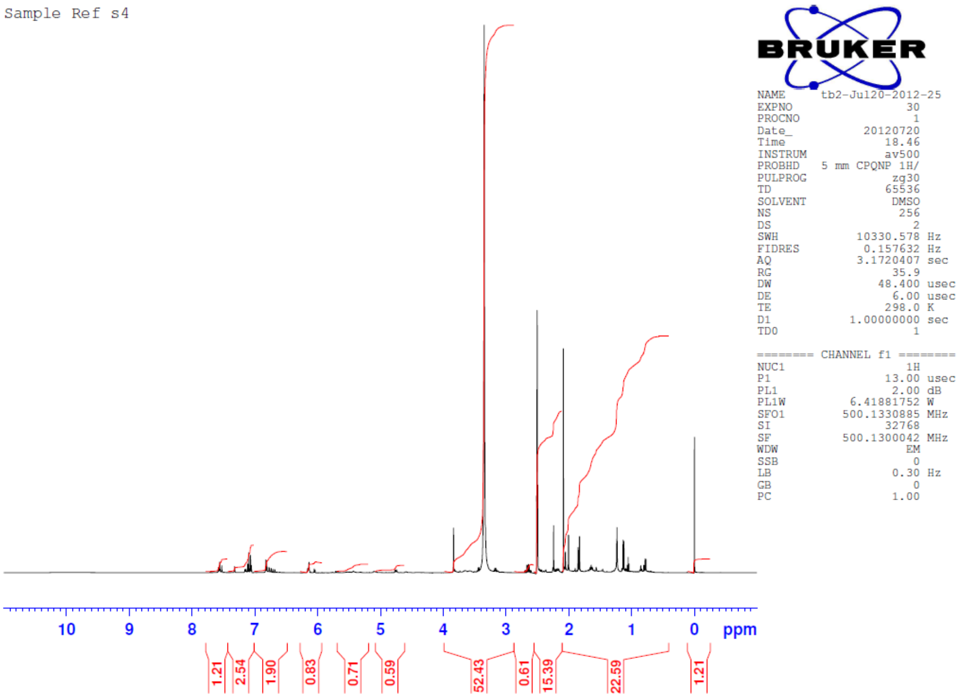
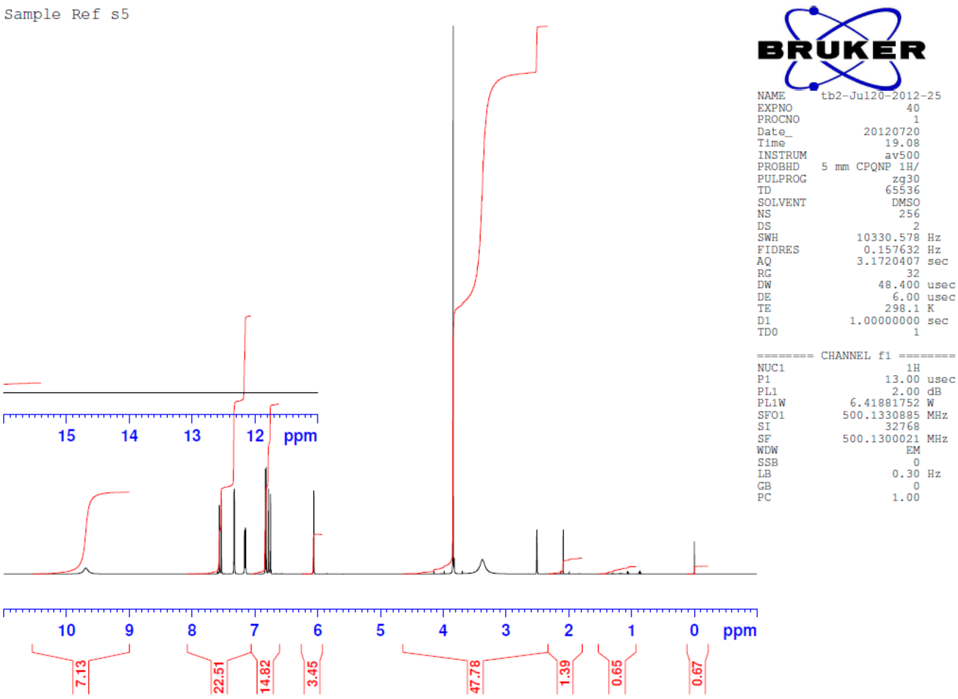
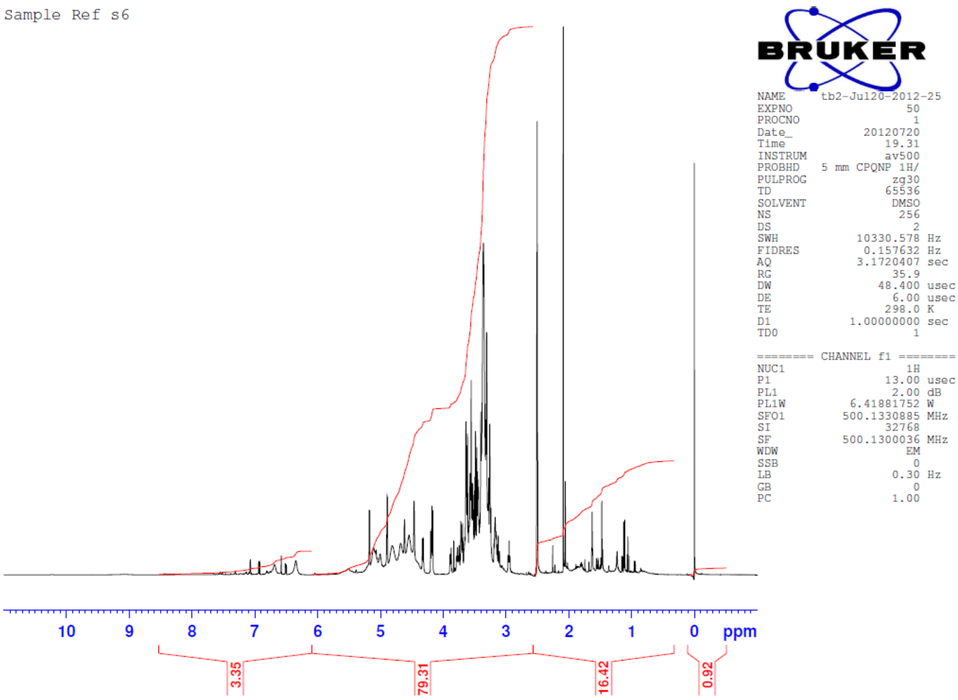
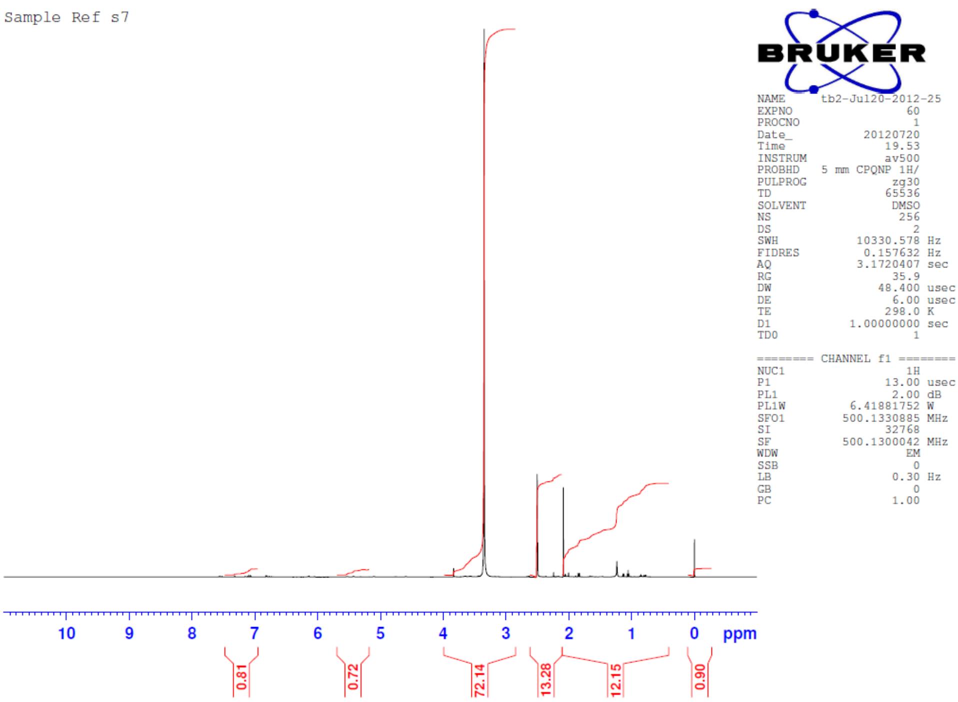
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300036 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
15 14 13 12 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
6.11
32.12
2.74
0.41
0.85
38.40
16.74
1.03

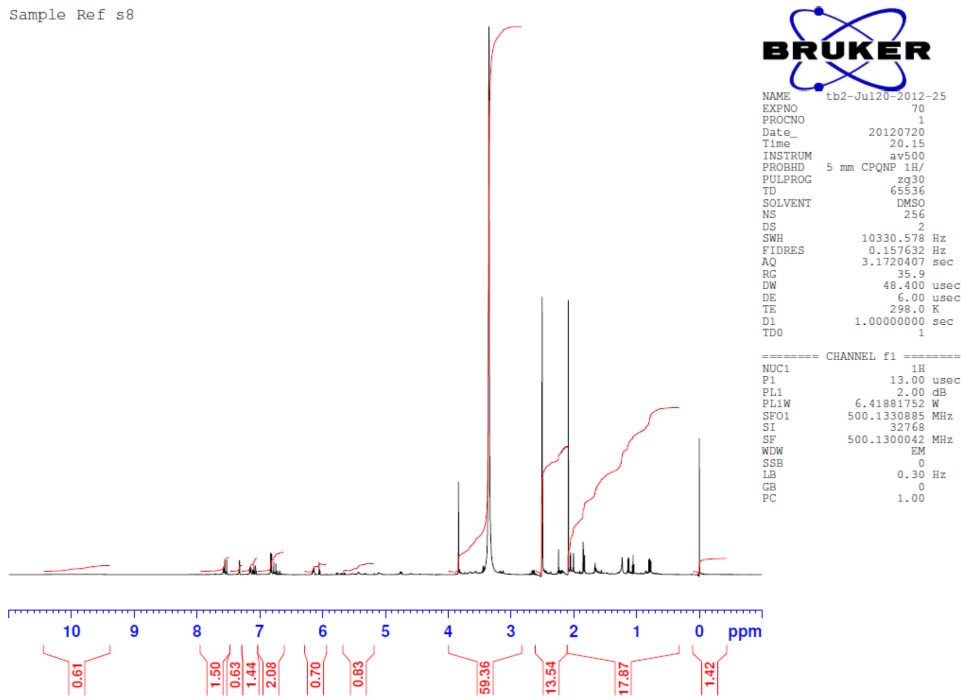

Sample Ref s3
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 20
PROCNO 1
Date_ 20120720
Time 18.24
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300043 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.96
1.23
0.77
1.43
92.98
1.64

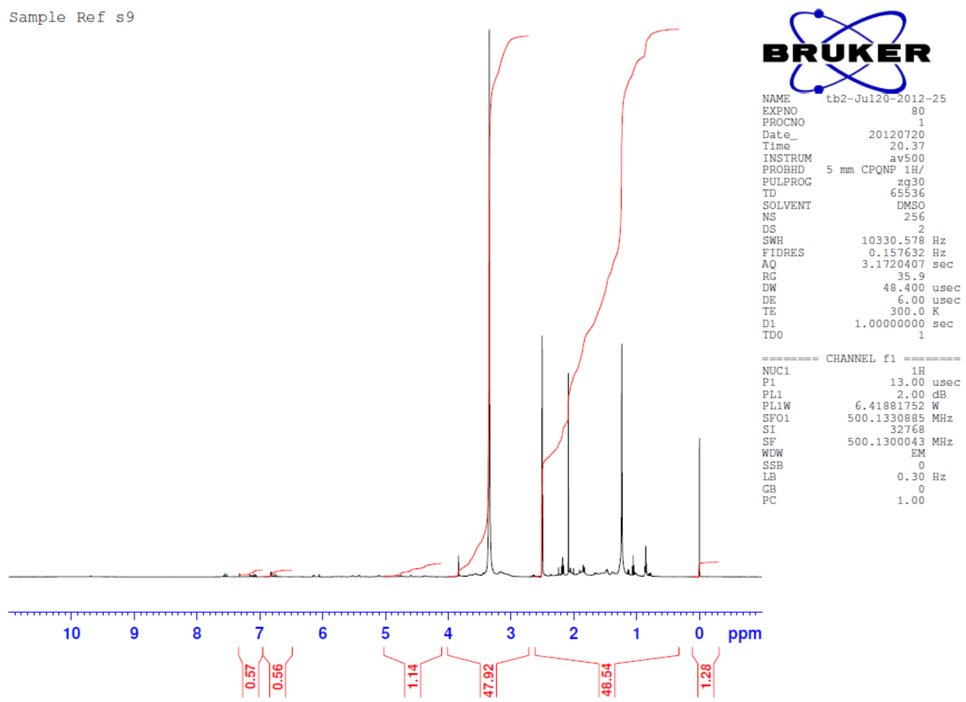

Sample Ref s4
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 30
PROCNO 1
Date_ 20120720
Time 18.46
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.21 2.54 1.90 0.83 0.71 0.59 52.43 0.61 15.39 22.59 1.21


Sample Ref s5
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 40
PROCNO 1
Date_ 20120720
Time 19.08
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 32
DW 48.400 usec
DE 6.00 usec
TE 298.1 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300021 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
15 14 13 12 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
7.13 22.51 14.82 3.45 47.78 1.39 0.65 0.67

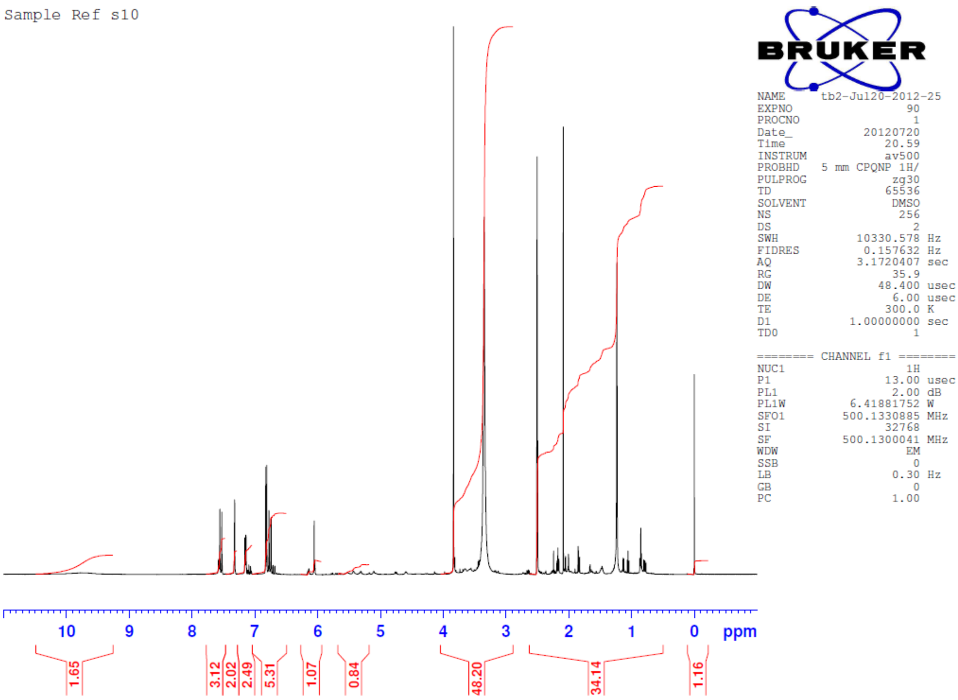

Sample Ref s6
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 50
PROCNO 1
Date_ 20120720
Time 19.31
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300036 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
3.35
79.31
16.42
0.92


Sample Ref s7
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 60
PROCNO 1
Date_ 20120720
Time 19.53
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.81
0.72
72.14
13.28
12.15
0.90

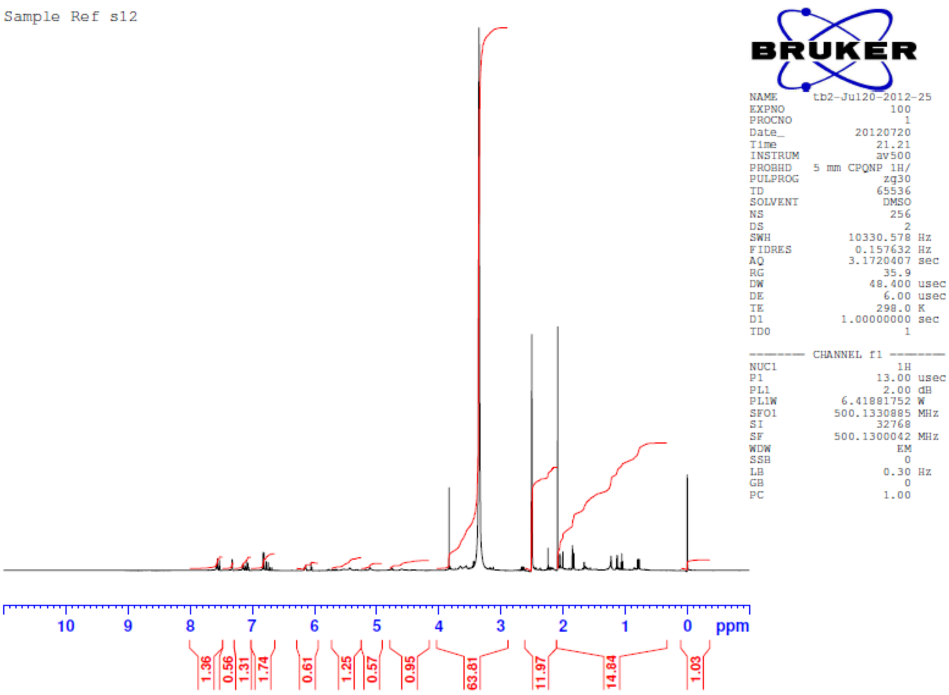

Sample Ref s8
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 70
PROCNO 1
Date_ 20120720
Time 20.15
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.61
1.50
0.63
1.44
2.08
0.70
0.83
59.36
13.54
17.87
1.42


Sample Ref s9
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 80
PROCNO 1
Date_ 20120720
Time 20.37
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300043 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.57
0.56
1.14
47.92
48.54
1.28

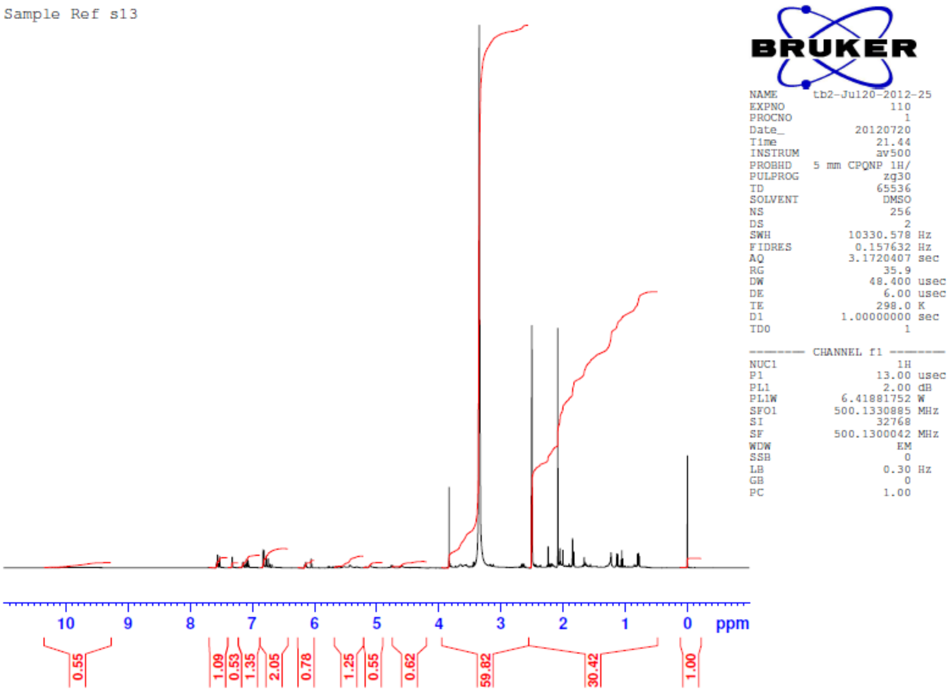
Sample Ref s10



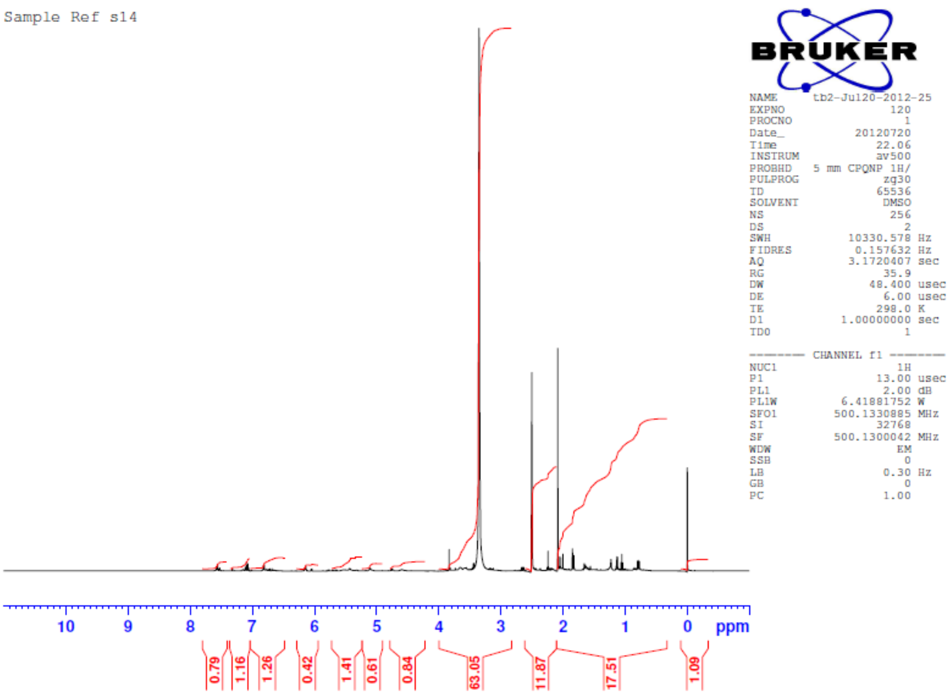
Sample Ref s12

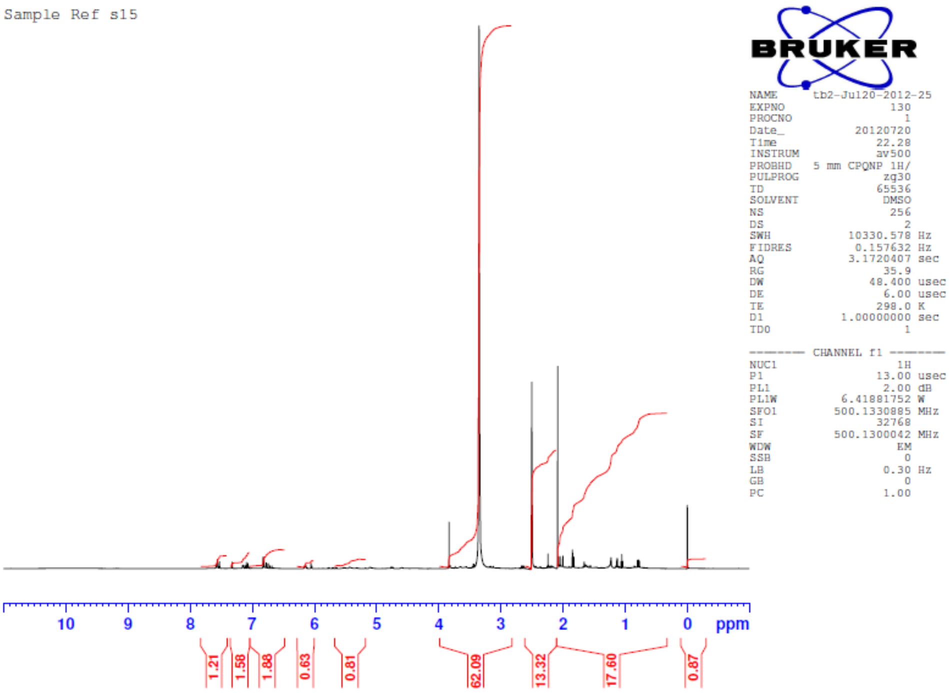


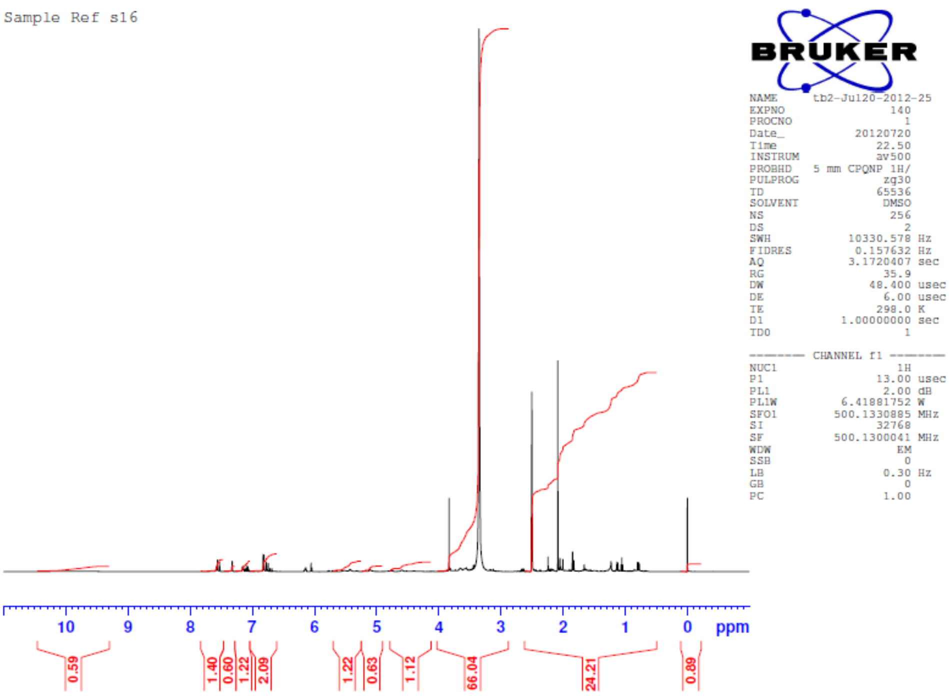
Sample Ref s13

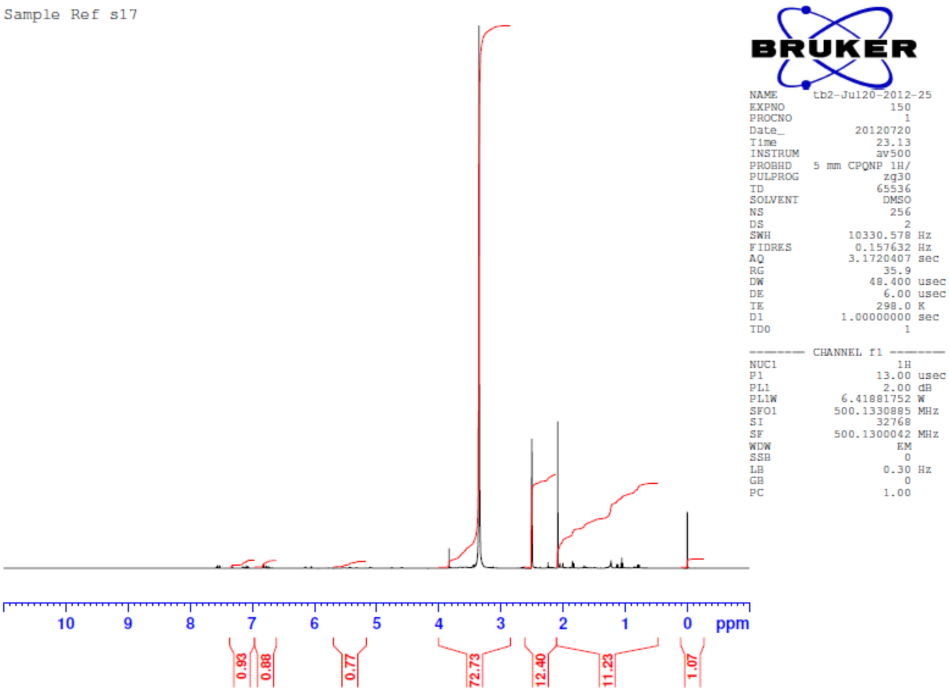


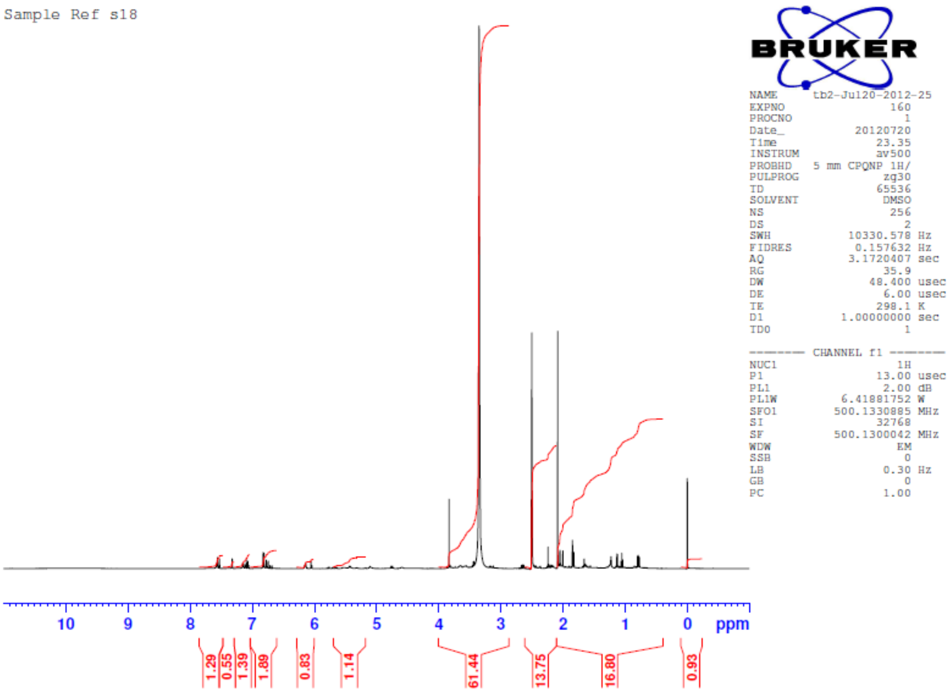
Sample Ref s14

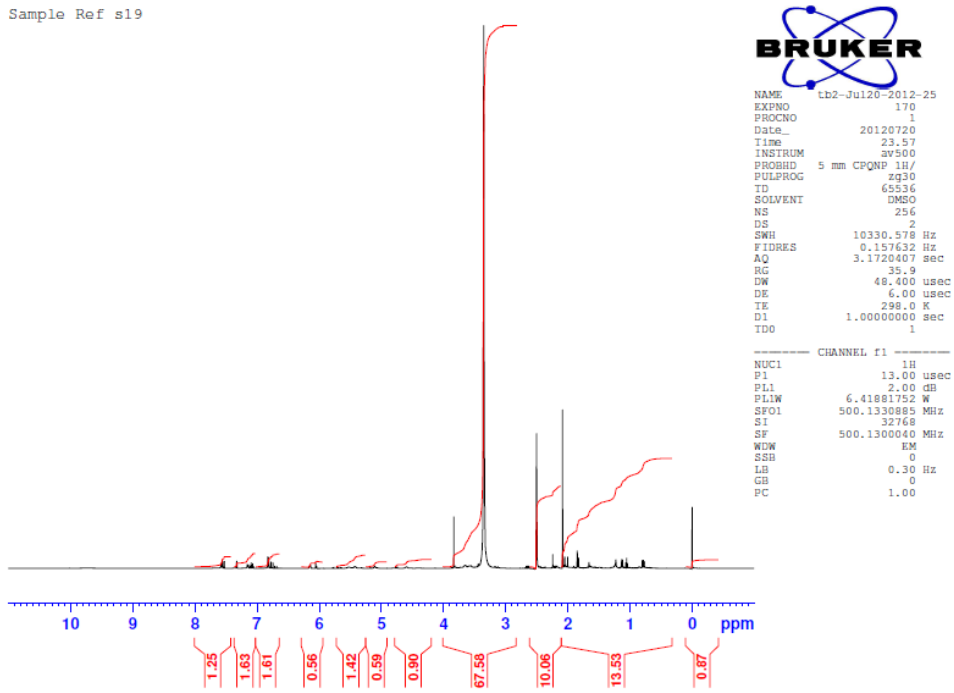


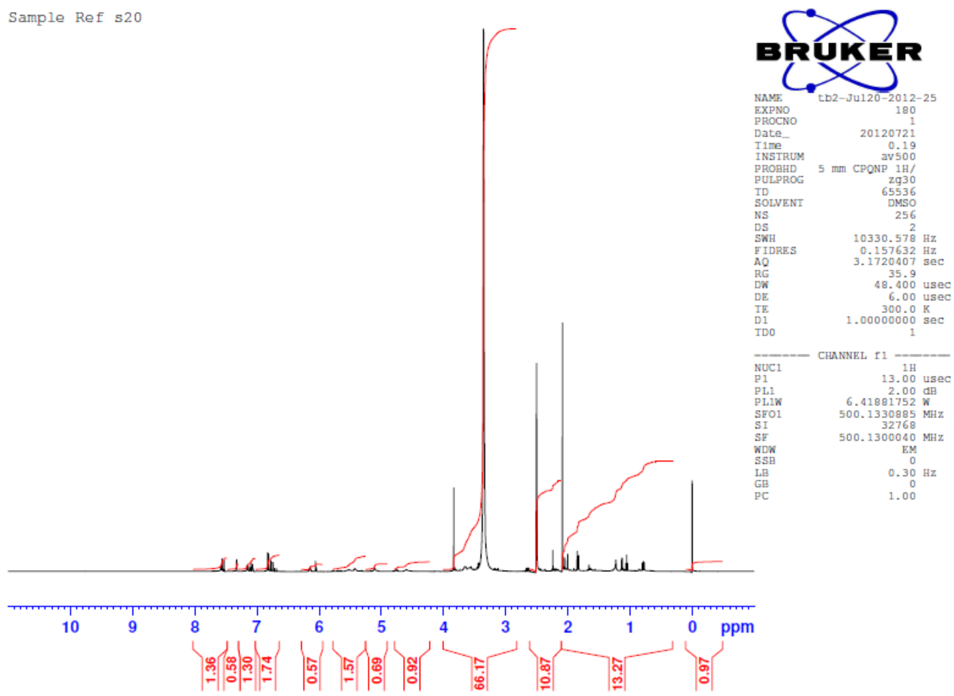

Sample Ref s15
NAME tb2-Jul20-2012-25
EXPNO 130
PROCNO 1
Date_ 20120720
Time 22.28
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
0
ppm
1.21
1.58
1.88
0.63
0.81
62.09
13.32
17.60
0.87

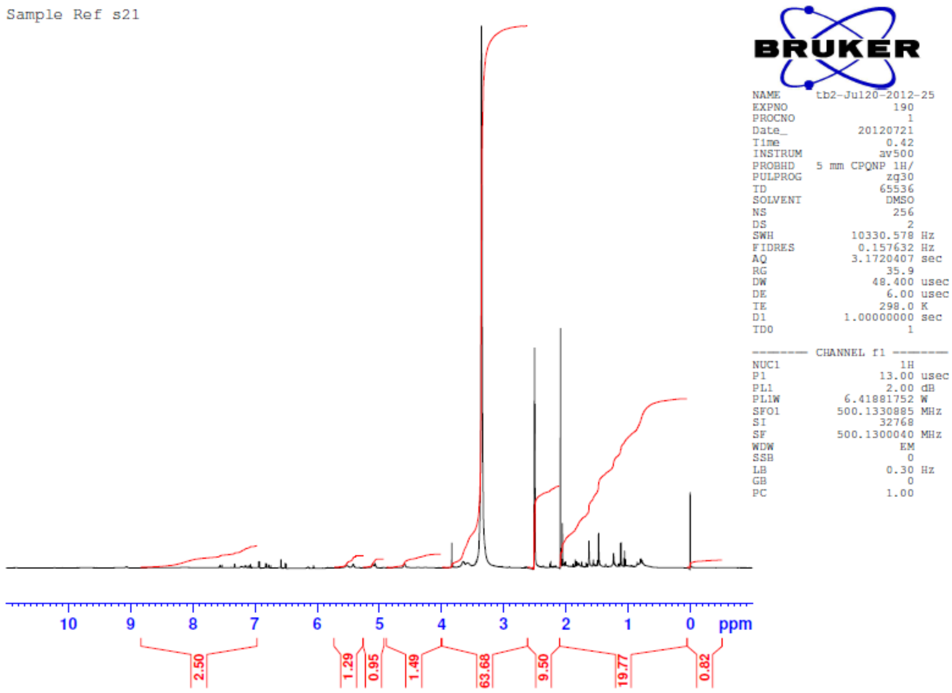

Sample Ref s16
NAME tb2-Jul20-2012-25
EXPNO 140
PROCNO 1
Date_ 20120720
Time 22.50
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300041 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
0
ppm
0.59
1.40
0.60
1.22
2.09
1.22
0.63
1.12
66.04
24.21
0.89

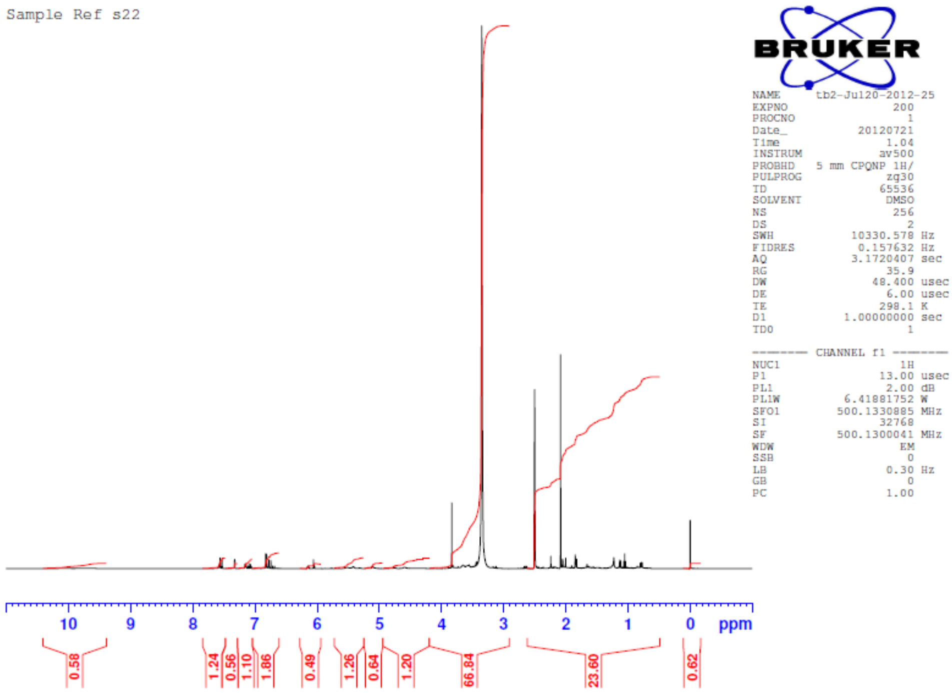

Sample Ref s17
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 150
PROCNO 1
Date_ 20120720
Time 23.13
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.93 0.88 0.77 72.73 12.40 11.23 1.07

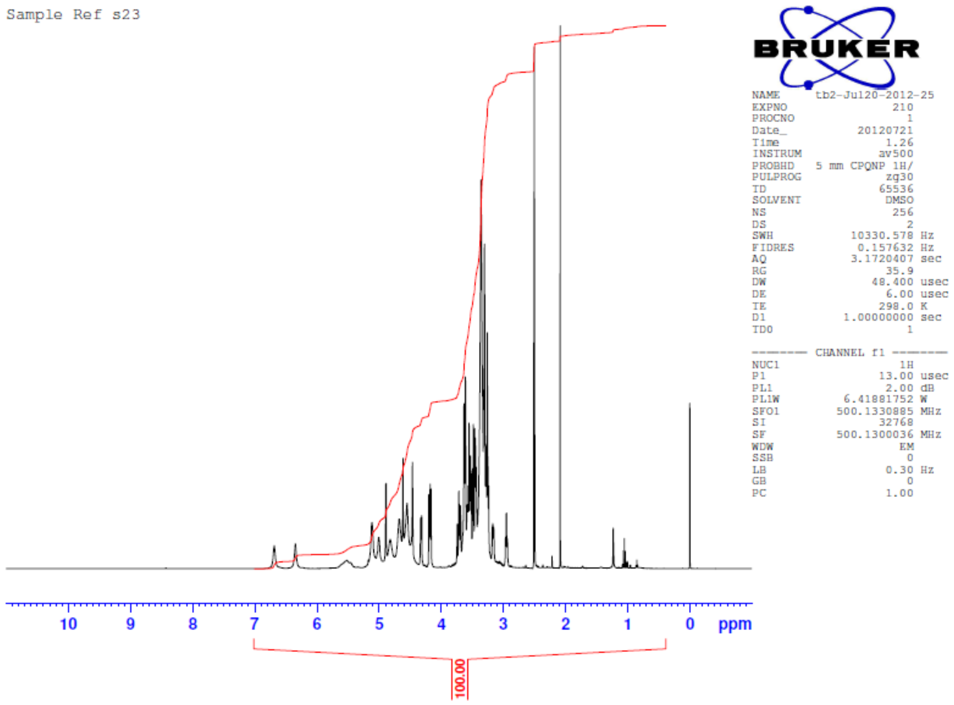

Sample Ref s18
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 160
PROCNO 1
Date_ 20120720
Time 23.35
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.1 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.29 0.55 1.39 1.89 0.83 1.14 61.44 13.75 16.80 0.93

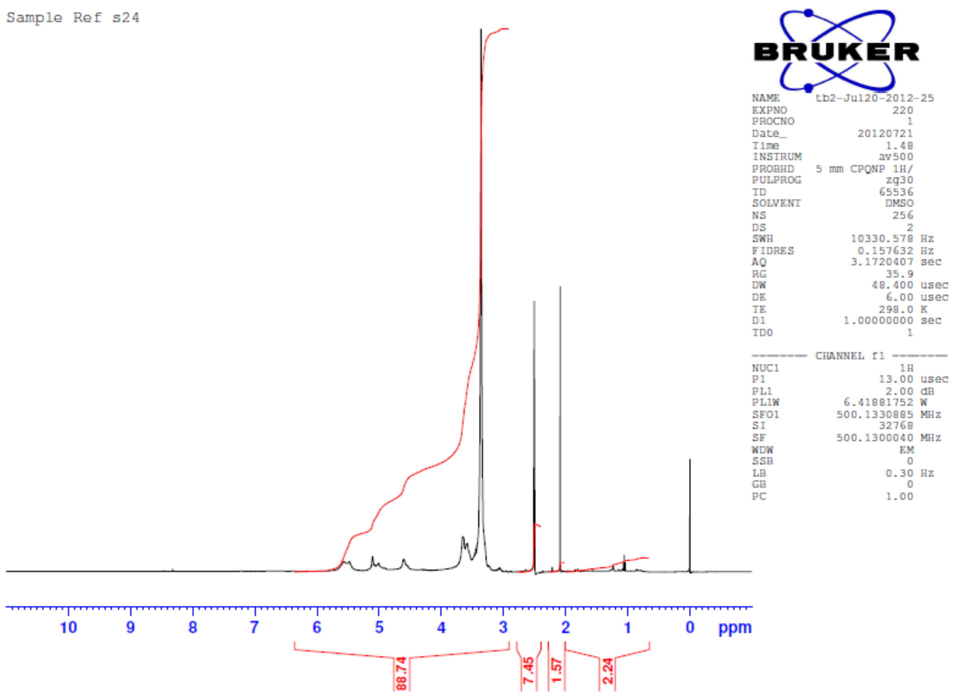

Sample Ref s19
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 170
PROCNO 1
Date_ 20120720
Time 23.57
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300040 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.25 1.63 1.61 0.56 1.42 0.59 0.90 67.58 10.06 13.53 0.87

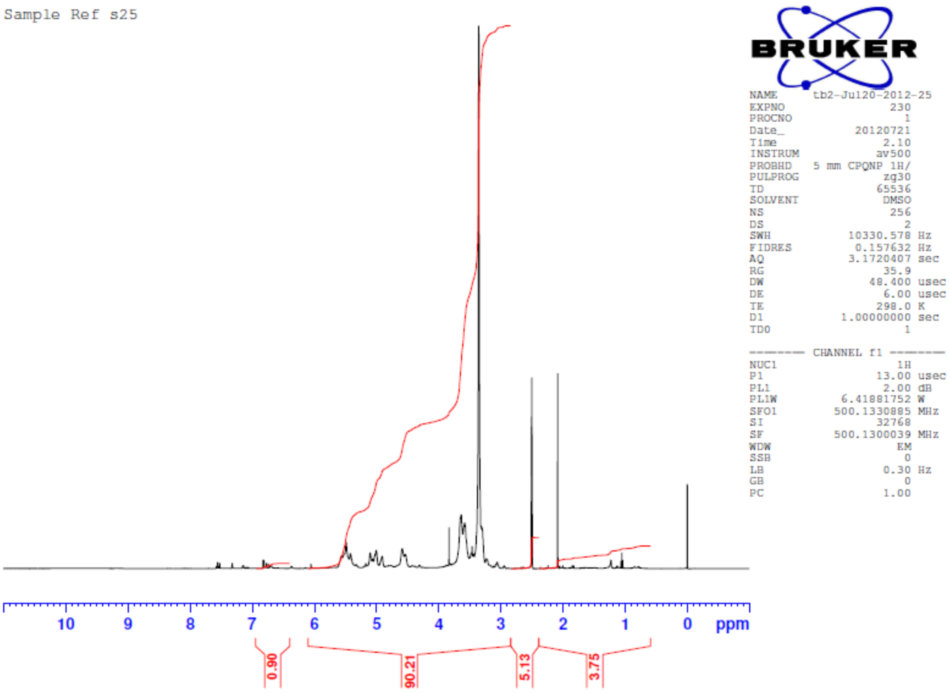

Sample Ref s20
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 180
PROCNO 1
Date_ 20120721
Time 0.19
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300040 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.36 0.58 1.30 1.74 0.57 1.57 0.69 0.92 66.17 10.87 13.27 0.97

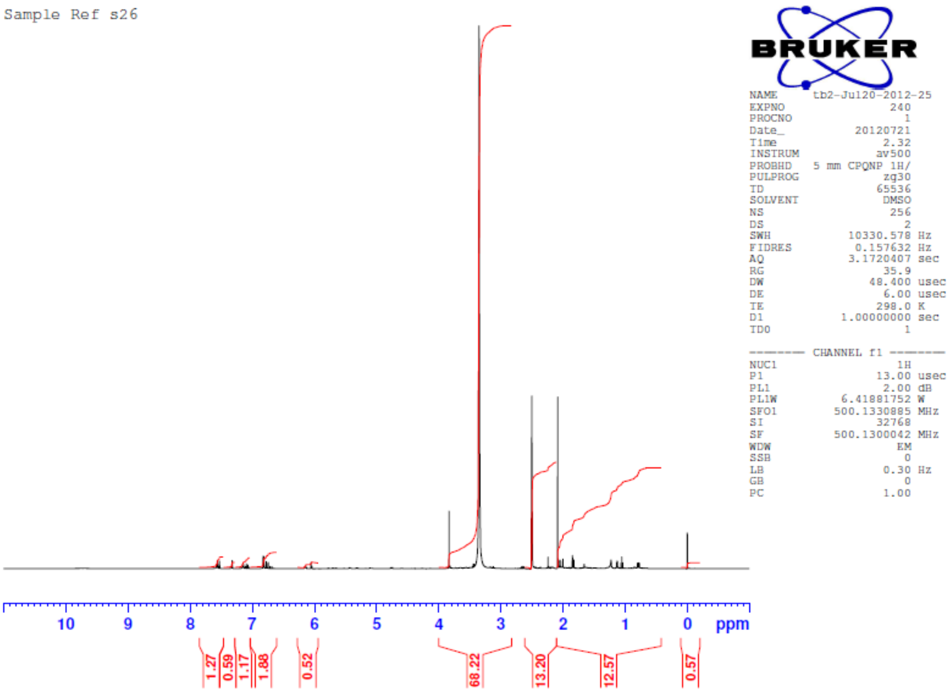

Sample Ref s21
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 190
PROCNO 1
Date_ 20120721
Time 0.42
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300040 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
2.50
1.29
0.95
1.49
63.68
9.50
19.77
0.82

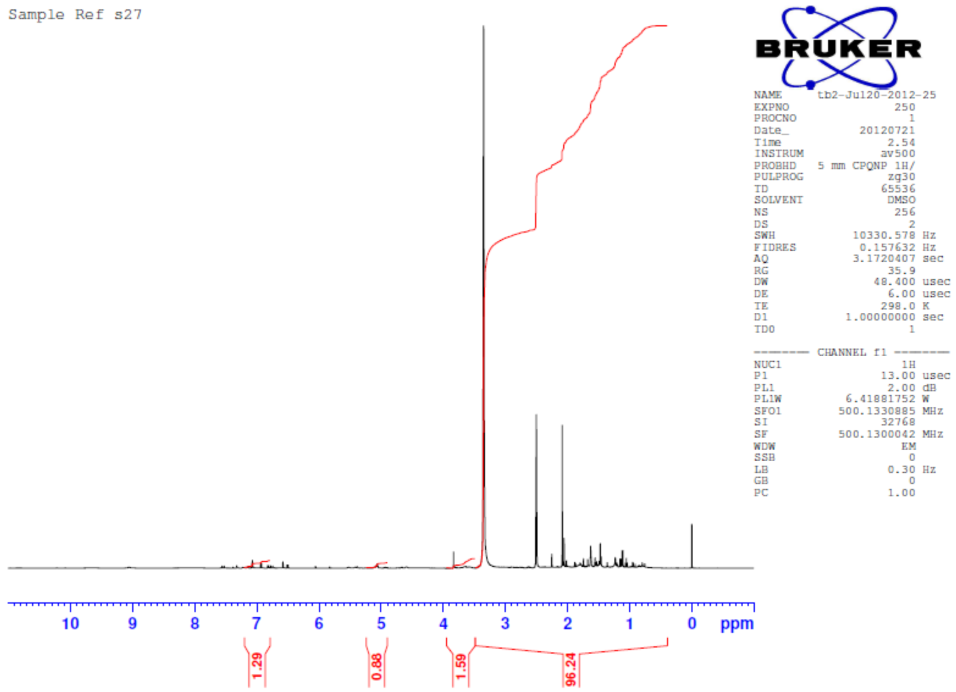

Sample Ref s22
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 200
PROCNO 1
Date_ 20120721
Time 1.04
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.1 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300041 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.58
1.24
0.56
1.10
1.86
0.49
1.26
0.64
1.20
66.84
23.60
0.62

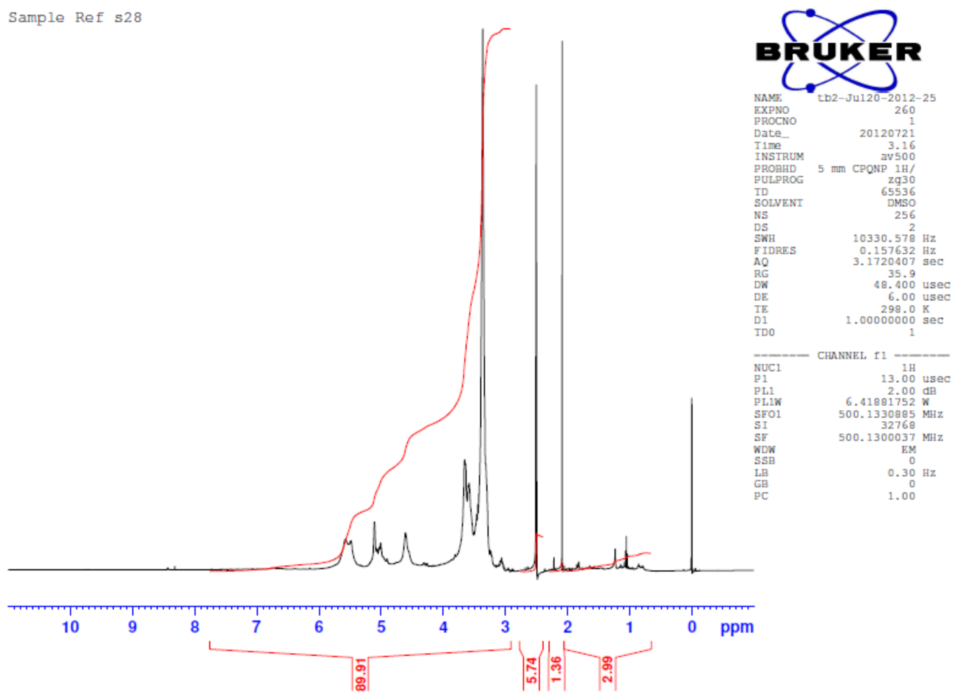

Sample Ref s23
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 210
PROCNO 1
Date_ 20120721
Time 1.26
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300036 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
100.00


Sample Ref s24
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 220
PROCNO 1
Date_ 20120721
Time 1.48
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300040 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
88.74
7.45
1.57
2.24

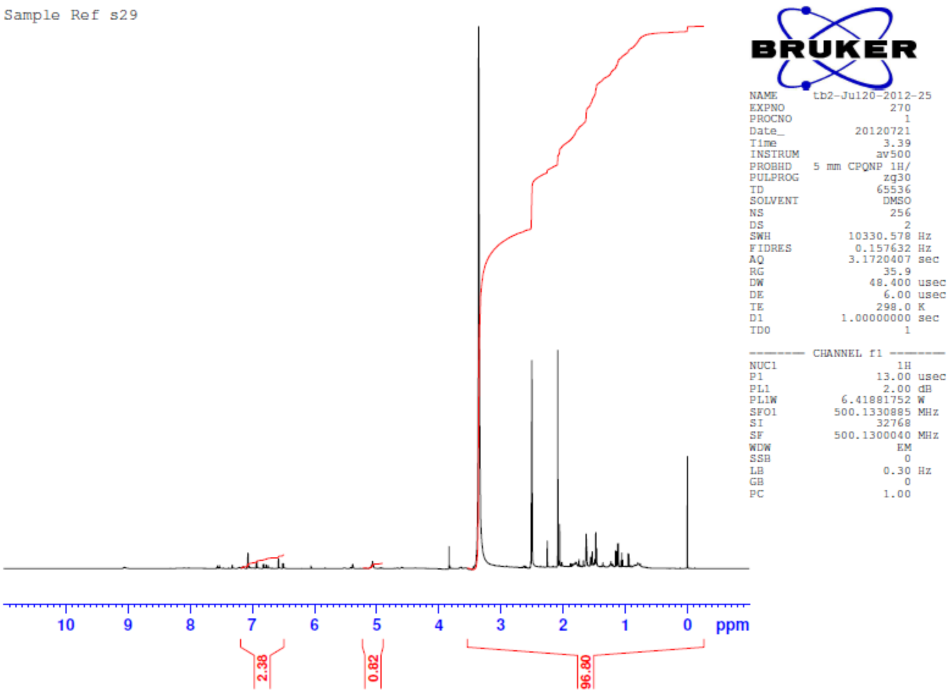

Sample Ref s25
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 230
PROCNO 1
Date_ 20120721
Time 2.10
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300039 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.90
90.21
5.13
3.75


Sample Ref s26
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 240
PROCNO 1
Date_ 20120721
Time 2.32
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.27
0.59
1.17
1.88
0.52
68.22
13.20
12.57
0.57

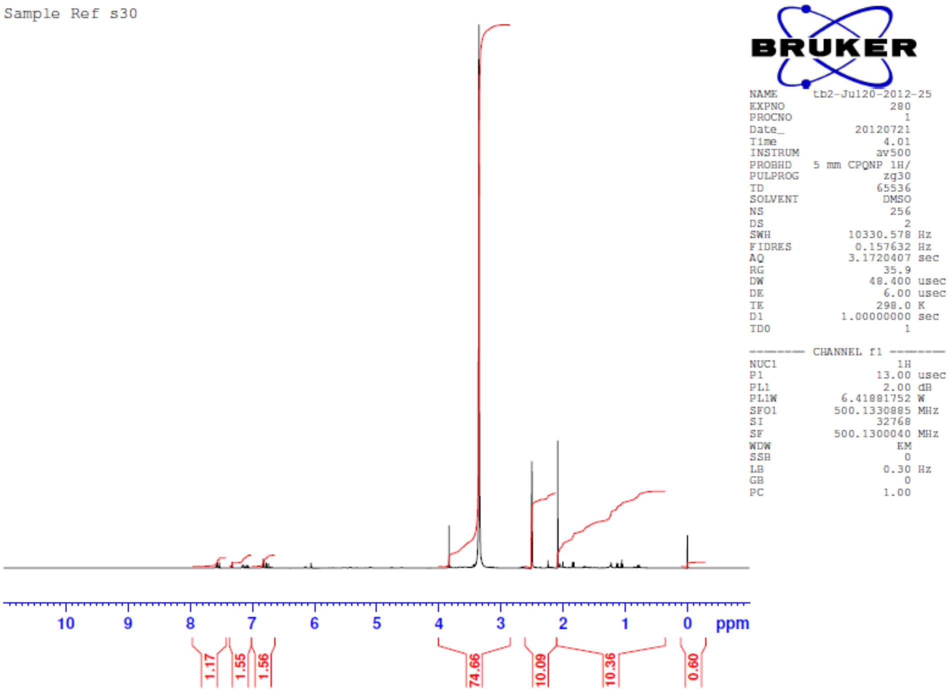

Sample Ref s27
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 250
PROCNO 1
Date_ 20120721
Time 2.54
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300042 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.29
0.88
1.59
96.24


Sample Ref s28
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 260
PROCNO 1
Date_ 20120721
Time 3.16
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300037 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
89.91
5.74
1.36
2.99

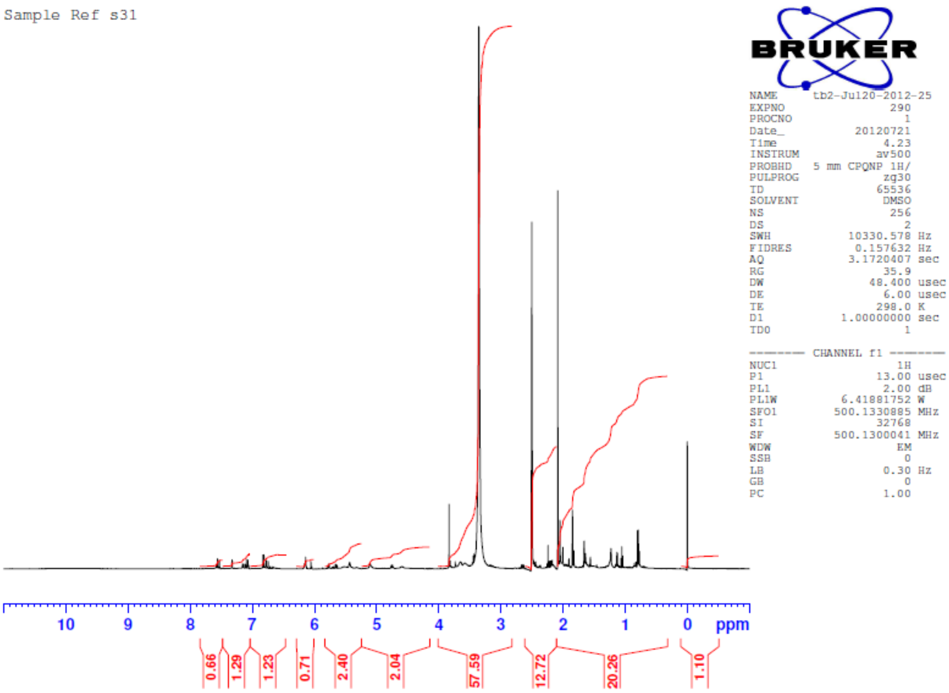
Sample Ref s29



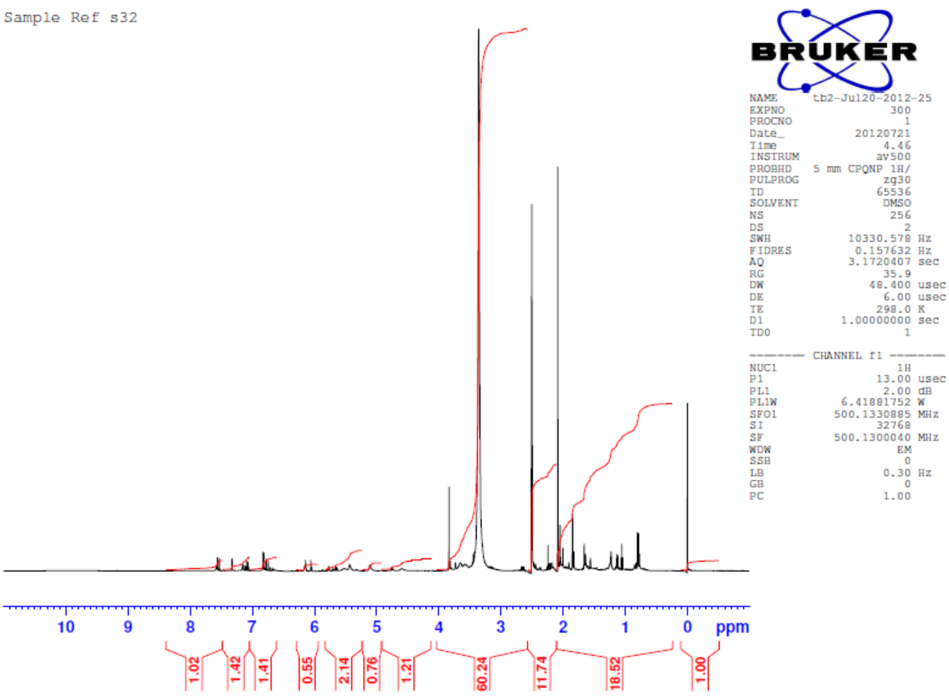
Sample Ref s30

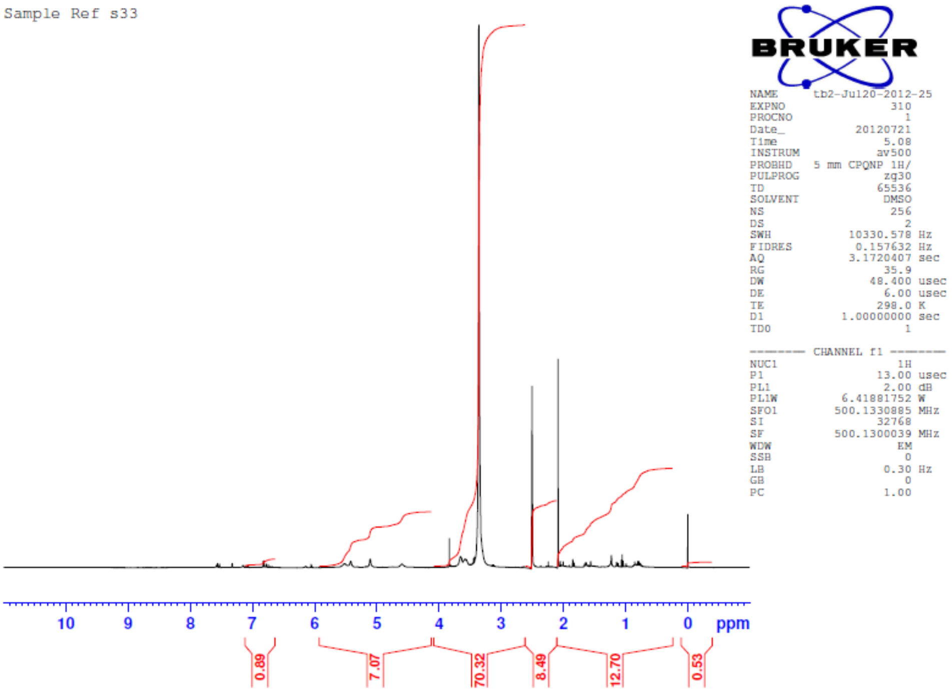


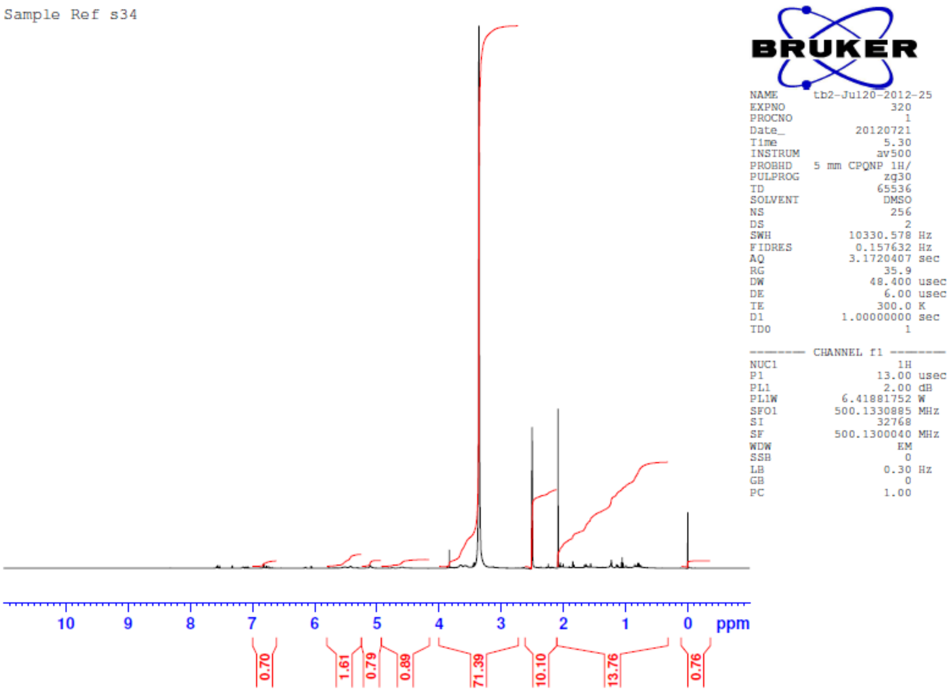
Sample Ref s31



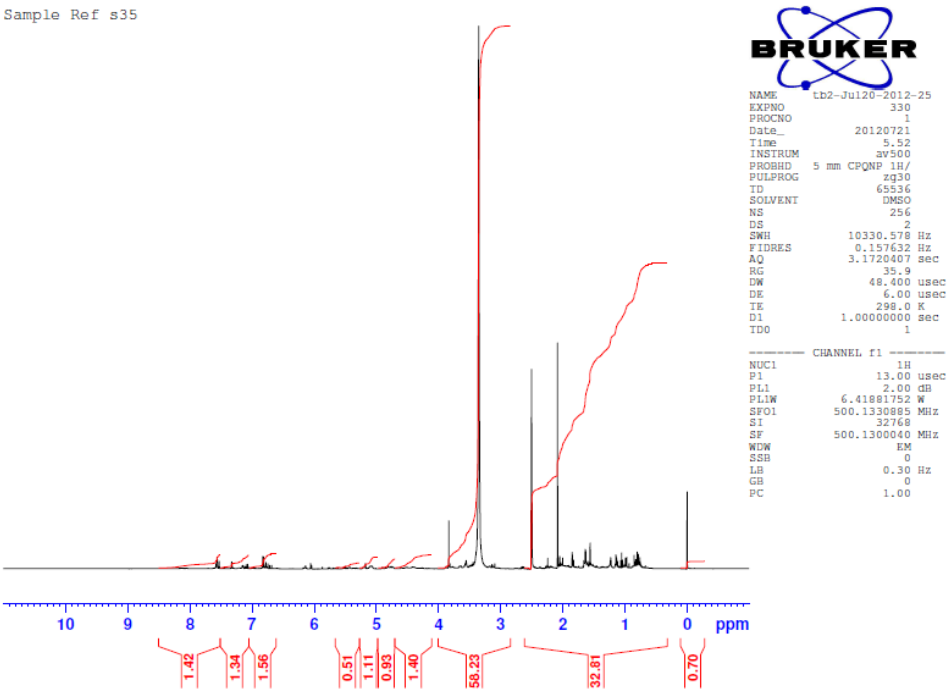
Sample Ref s32



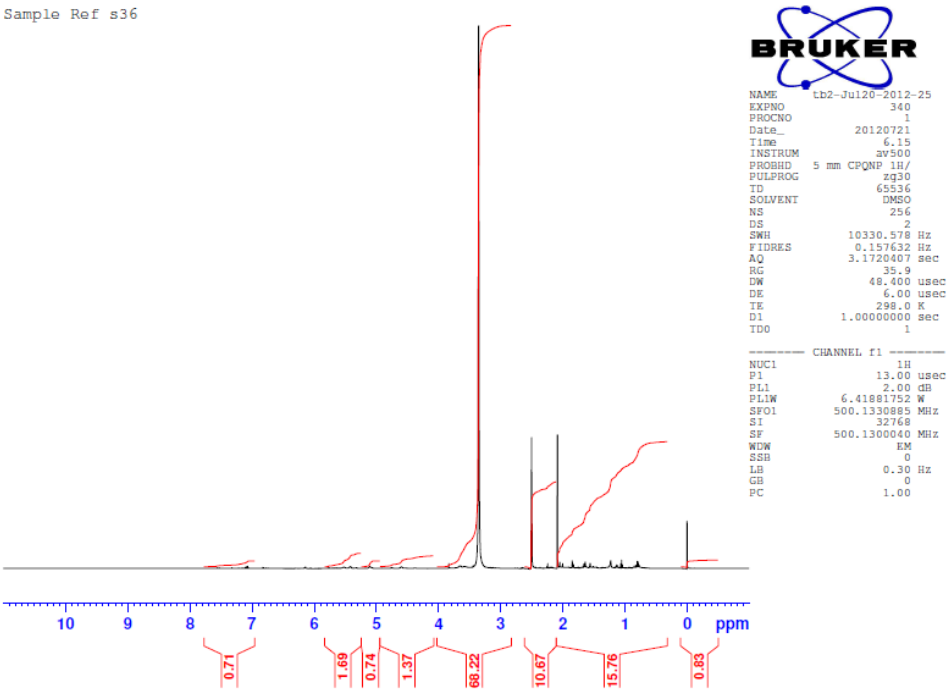

Sample Ref s33
NAME tb2-Jul20-2012-25
EXPNO 310
PROCNO 1
Date_ 20120721
Time 5.08
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300039 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
0
ppm
0.89
7.07
70.32
8.49
12.70
0.53

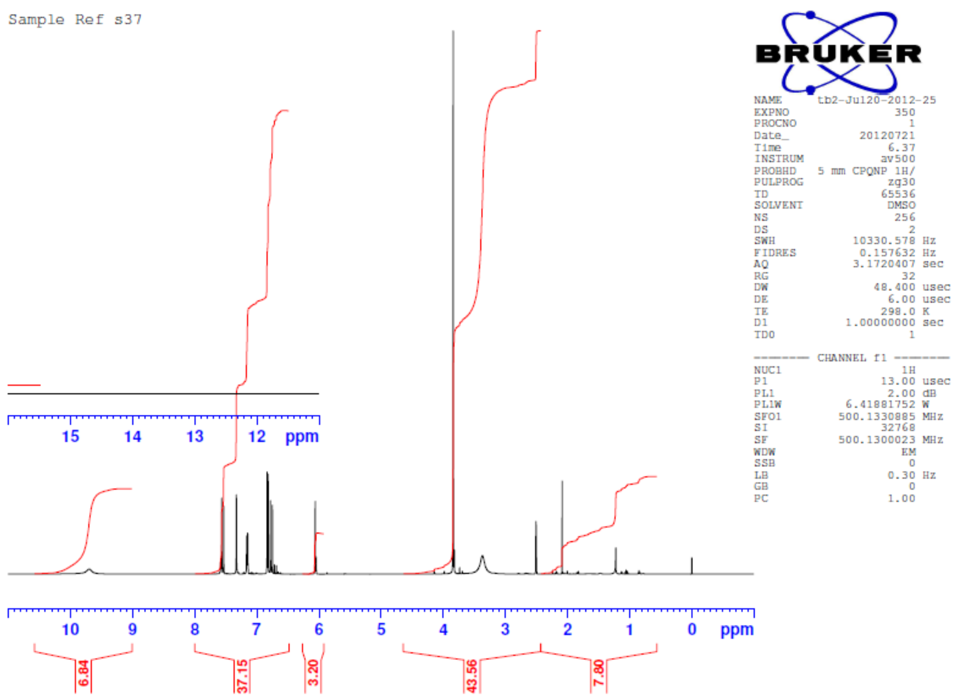

Sample Ref s34
NAME tb2-Jul20-2012-25
EXPNO 320
PROCNO 1
Date_ 20120721
Time 5.30
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300040 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
0
ppm
0.70
1.61
0.79
0.89
71.39
10.10
13.76
0.76

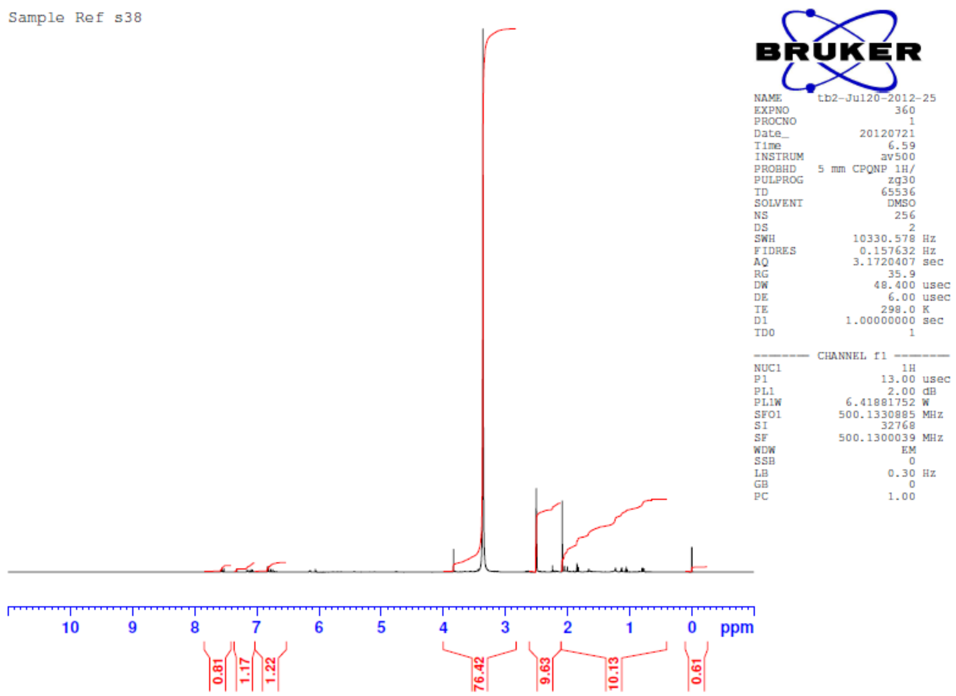
Sample Ref s35

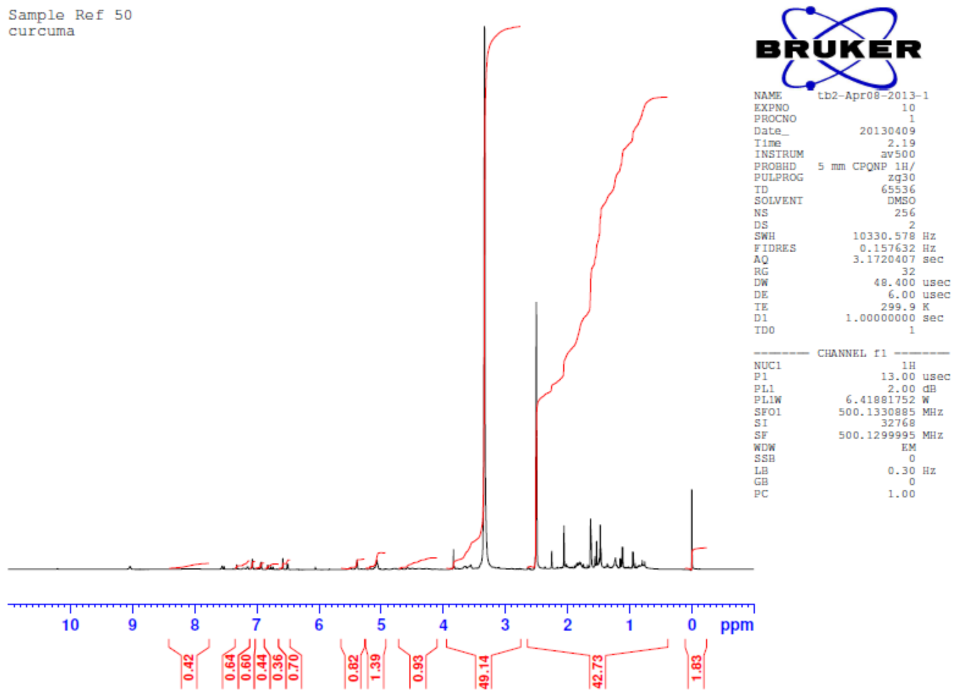


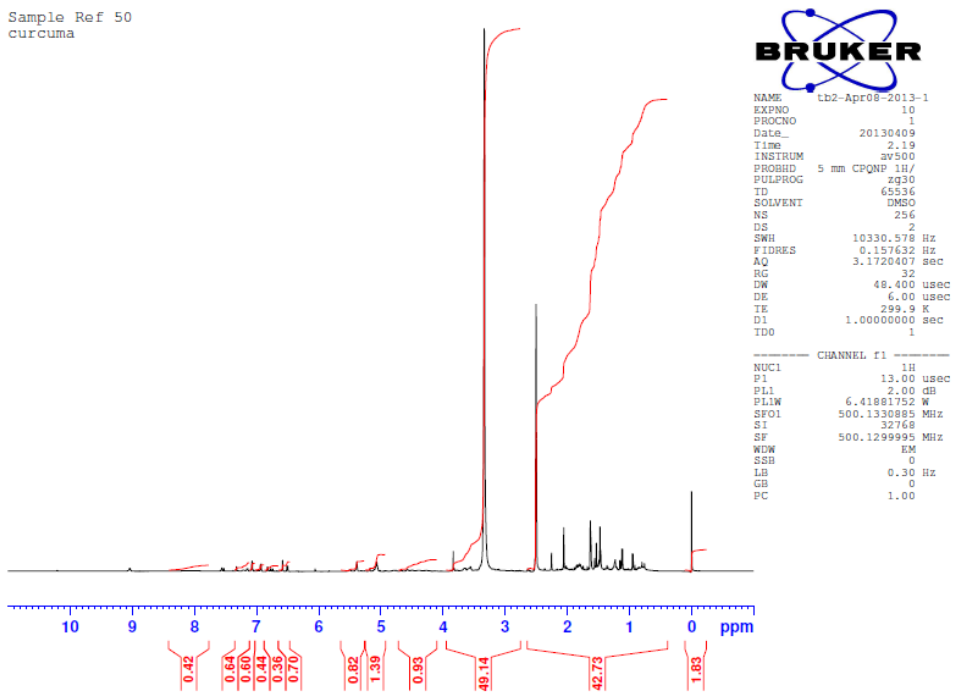
Sample Ref s36

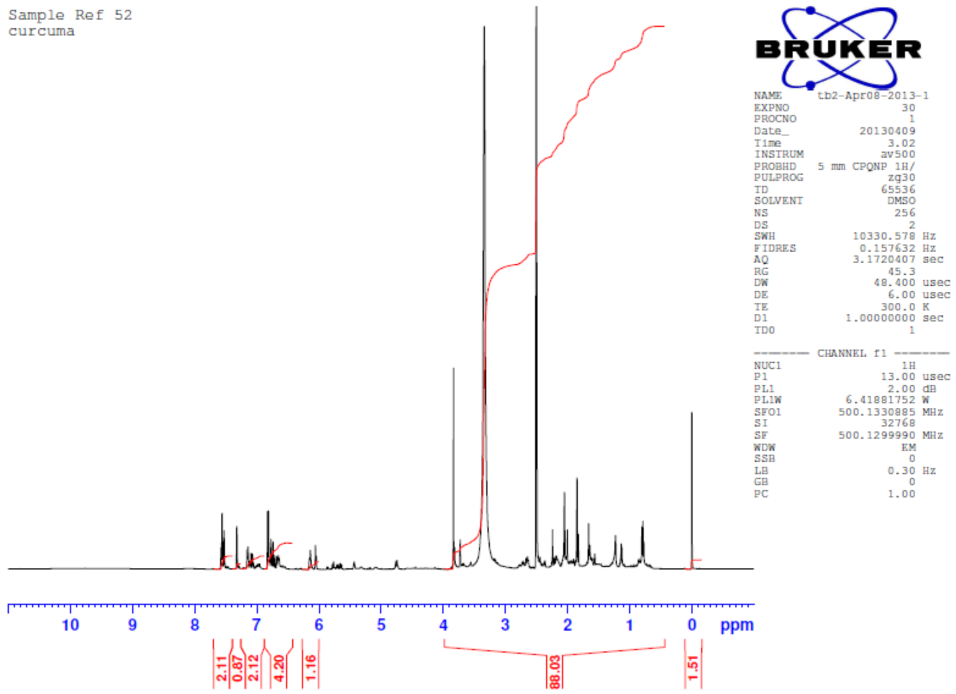


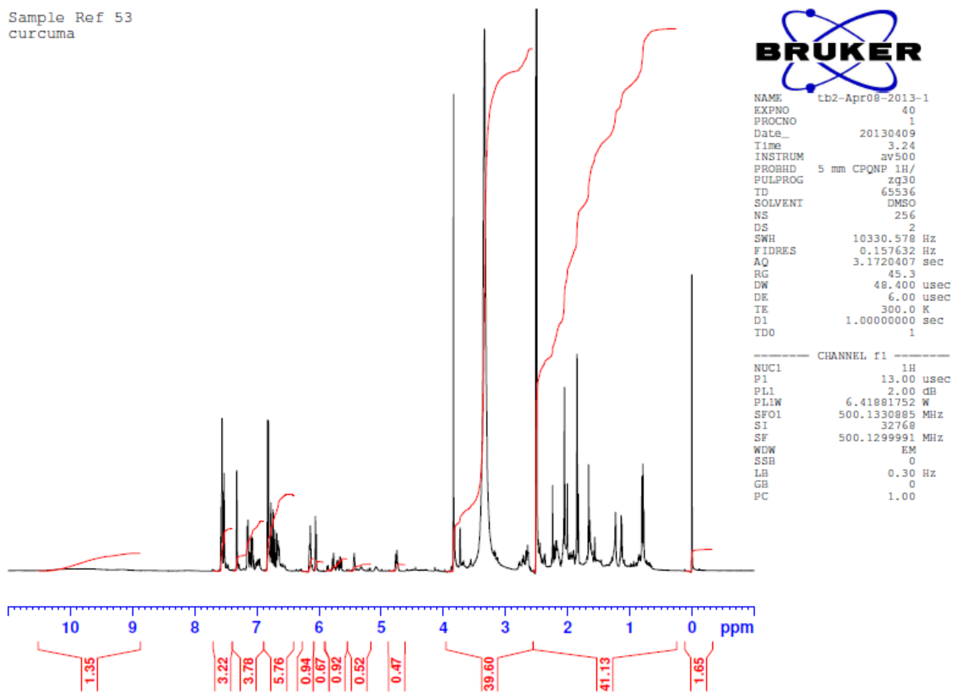

Sample Ref s37
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 350
PROCNO 1
Date_ 20120721
Time 6.37
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 32
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300023 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
15 14 13 12 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
6.84
37.15
3.20
43.56
7.80

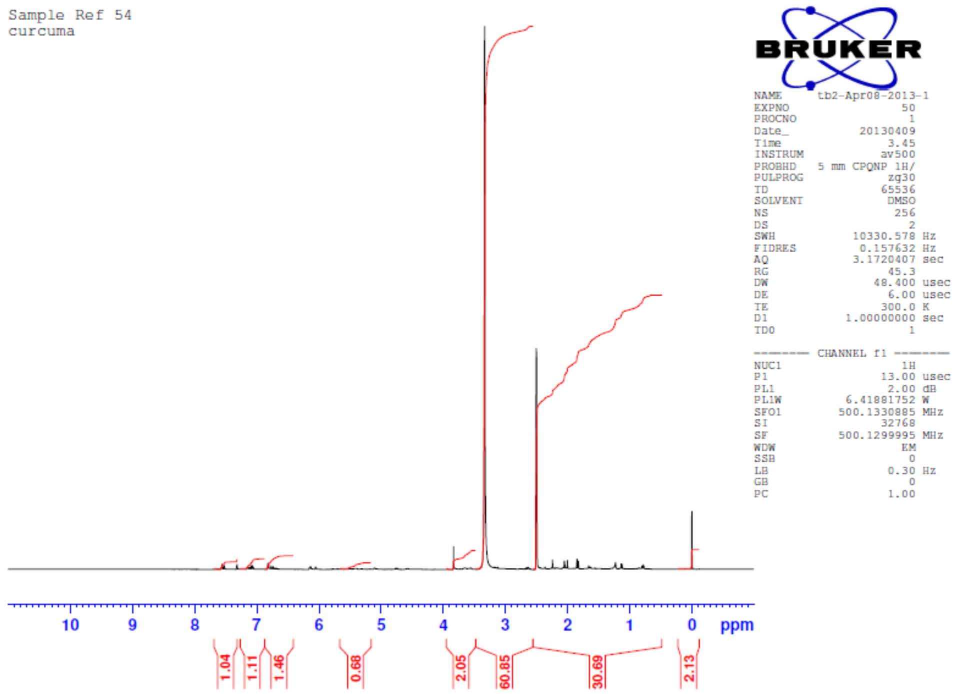

Sample Ref s38
BRUKER
NAME tb2-Jul20-2012-25
EXPNO 360
PROCNO 1
Date_ 20120721
Time 6.59
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 35.9
DW 48.400 usec
DE 6.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300039 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.81
1.17
1.22
76.42
9.63
10.13
0.61

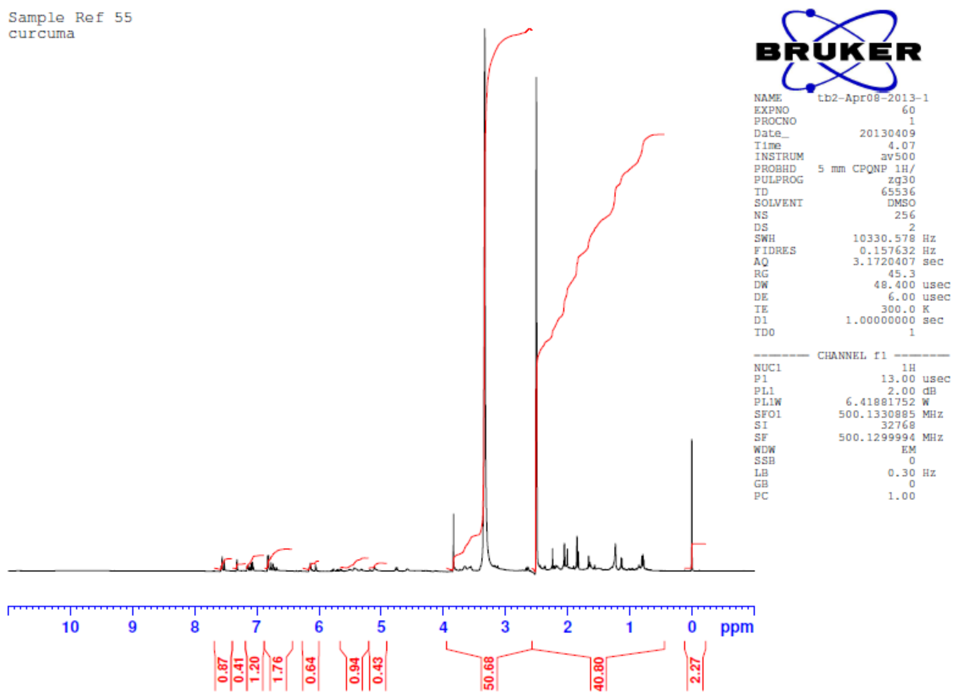


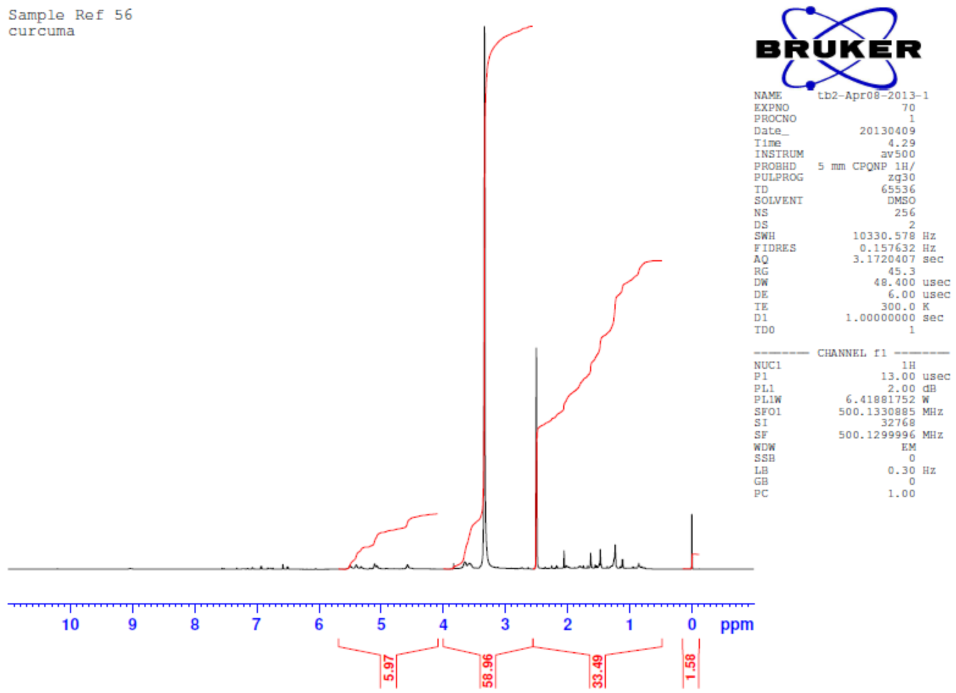

Sample Ref 50
curcuma

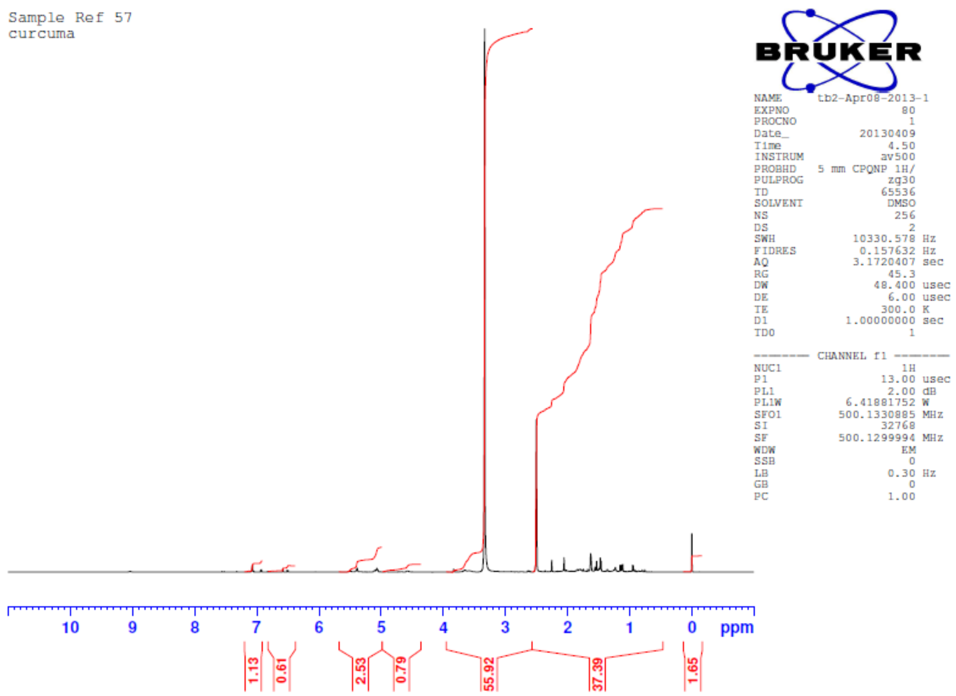


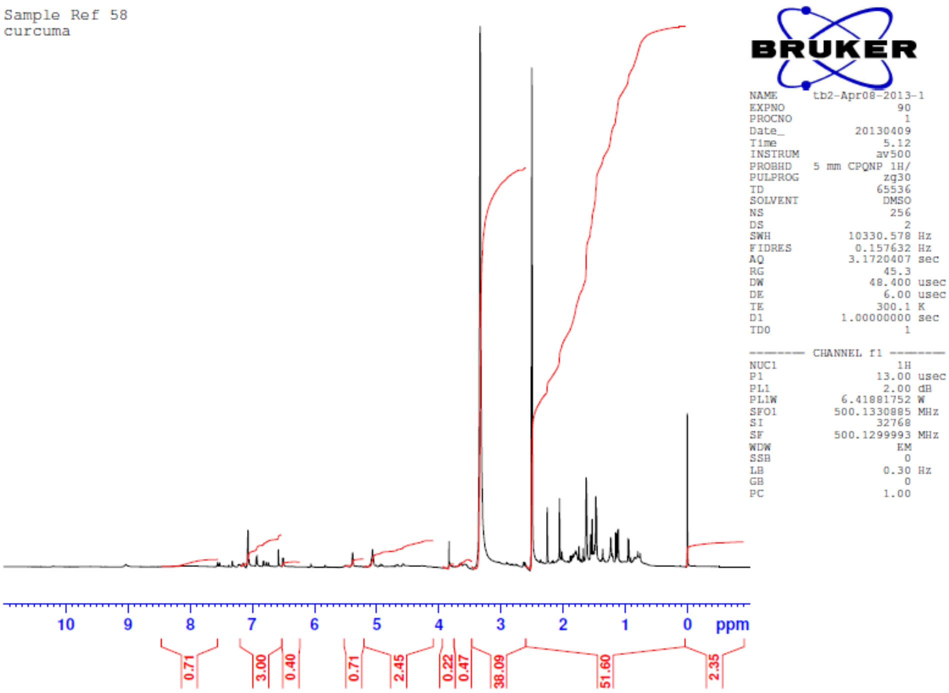



Sample Ref 54
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 50
PROCNO 1
Date_ 20130409
Time 3.45
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299995 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.04 1.11 1.46 0.68 2.05 60.85 30.69 2.13

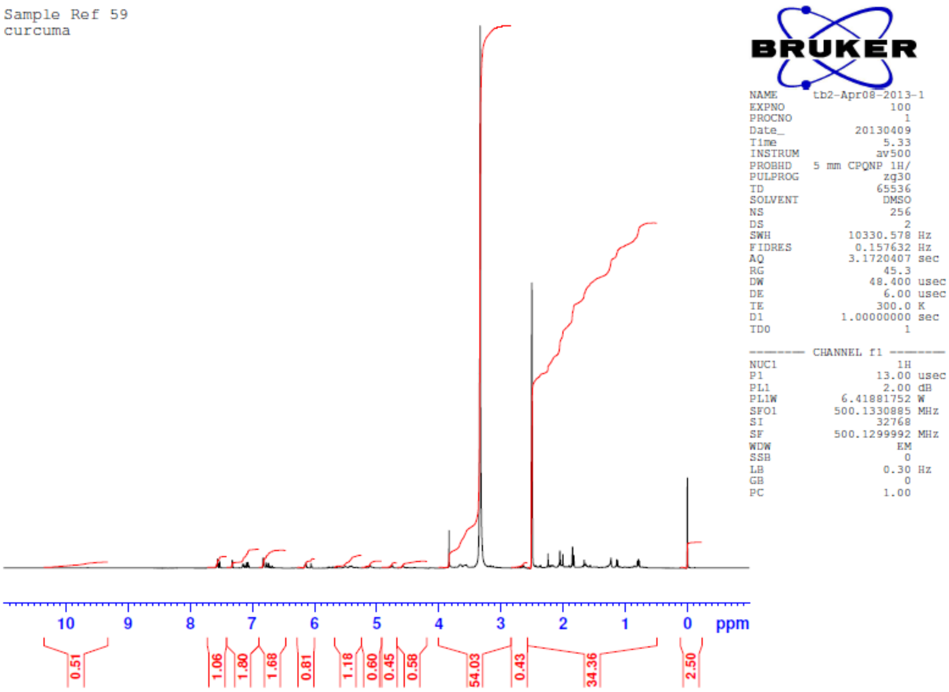

Sample Ref 55
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 60
PROCNO 1
Date_ 20130409
Time 4.07
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299994 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.87 0.41 1.20 1.76 0.64 0.94 0.43 50.68 40.80 2.27


Sample Ref 56
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 70
PROCNO 1
Date_ 20130409
Time 4.29
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299996 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
5.97
58.96
33.49
1.58

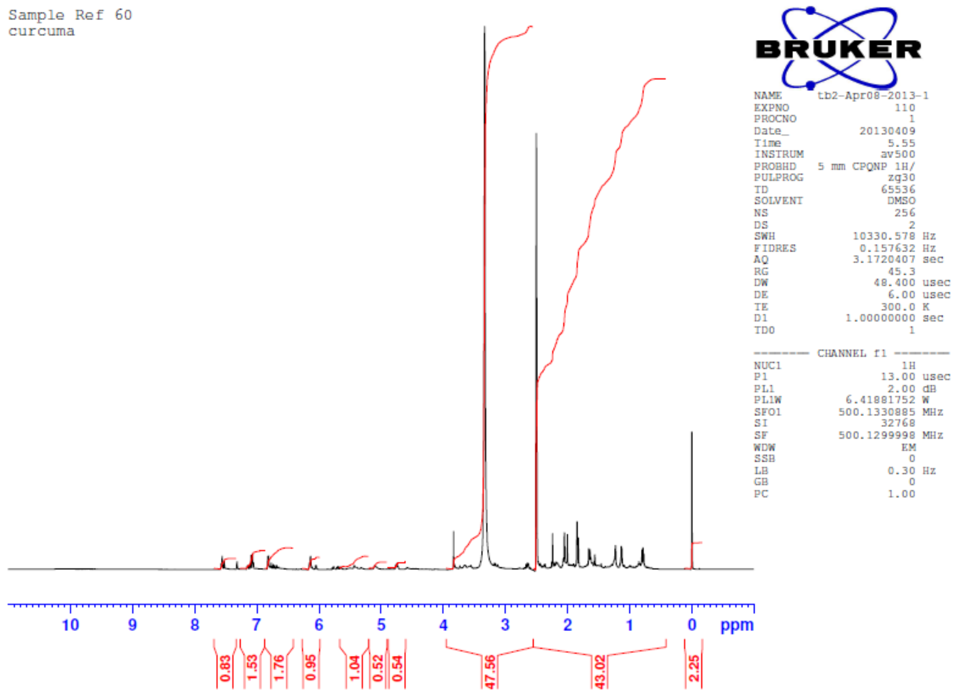

Sample Ref 57
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 80
PROCNO 1
Date_ 20130409
Time 4.50
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299994 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.13
0.61
2.53
0.79
55.92
37.39
1.65



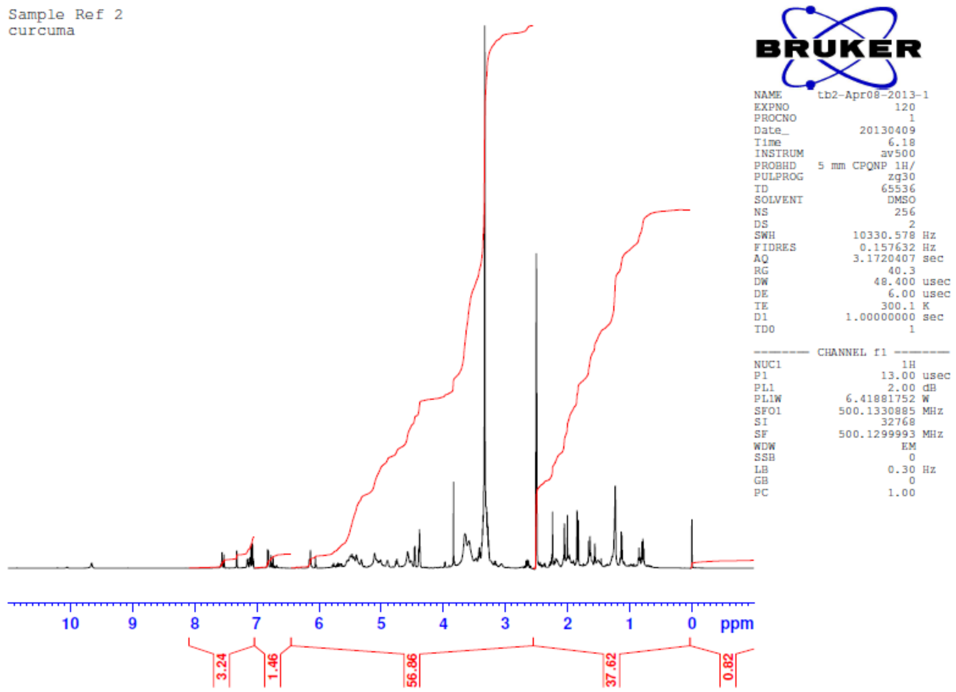
Sample Ref 58
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 90
PROCNO 1
Date_ 20130409
Time 5.12
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.1 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299993 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.71 3.00 0.40 0.71 2.45 0.22 0.47 38.09 51.60 2.35



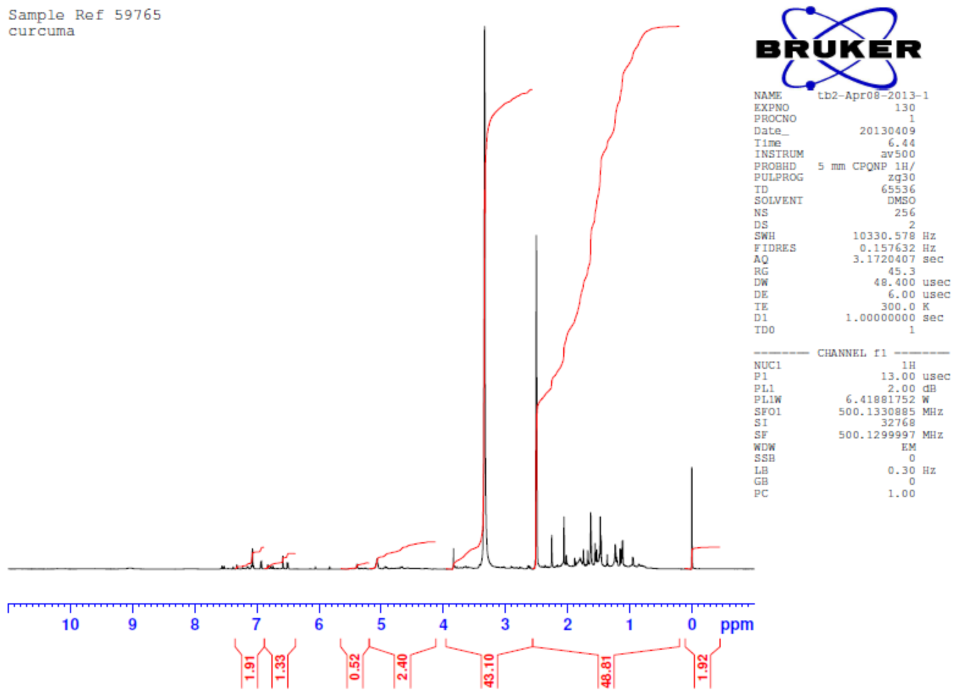
Sample Ref 59
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 100
PROCNO 1
Date_ 20130409
Time 5.33
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299992 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.51 1.06 1.80 1.68 0.81 1.18 0.60 0.45 0.58 54.03 0.43 34.36 2.50

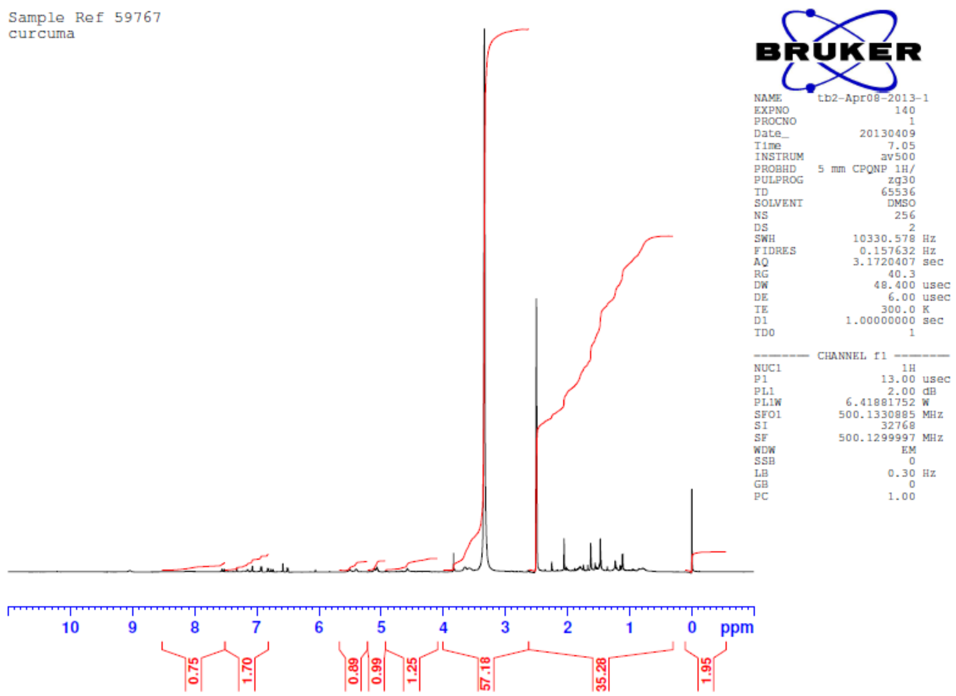


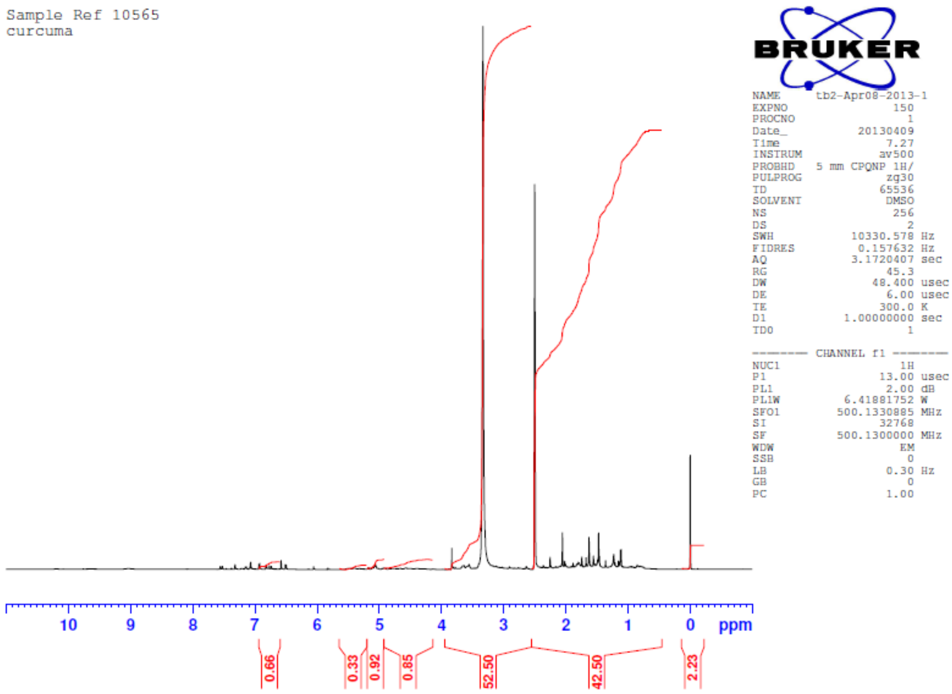
Sample Ref 60
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 110
PROCNO 1
Date_ 20130409
Time 5.55
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299998 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.83 1.53 1.76 0.95 1.04 0.52 0.54 47.56 43.02 2.25

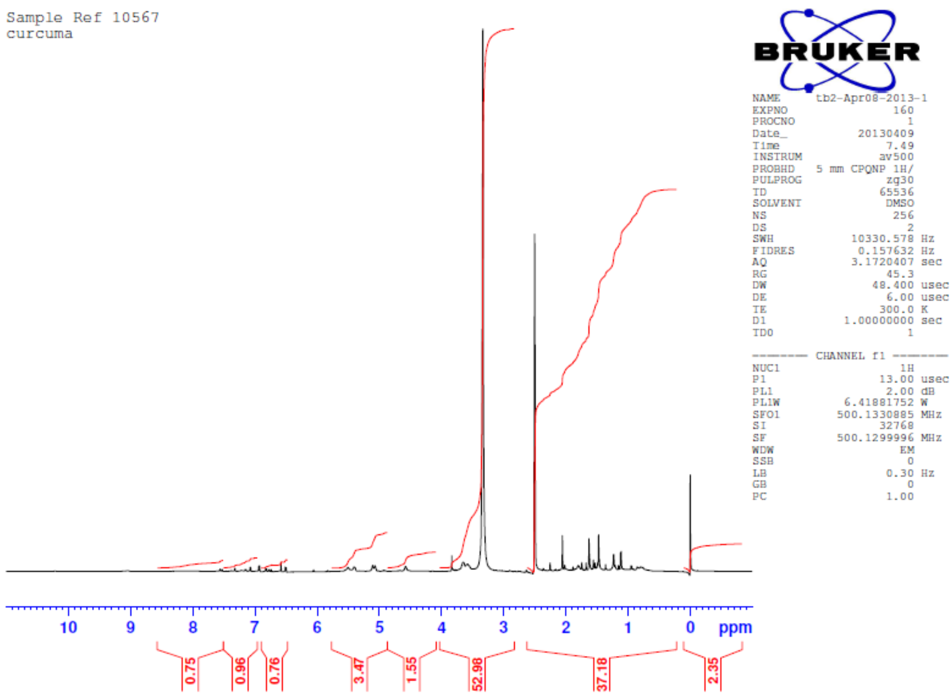


Sample Ref 2
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 120
PROCNO 1
Date_ 20130409
Time 6.18
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 40.3
DW 48.400 usec
DE 6.00 usec
TE 300.1 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299993 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
3.24 1.46 56.86 37.62 0.82


Sample Ref 59765
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 130
PROCNO 1
Date_ 20130409
Time 6.44
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299997 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
1.91
1.33
0.52
2.40
43.10
48.81
1.92


Sample Ref 59767
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 140
PROCNO 1
Date_ 20130409
Time 7.05
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 40.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======= CHANNEL f1 =======
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299997 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.75
1.70
0.89
0.99
1.25
57.18
35.28
1.95


Sample Ref 10565
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 150
PROCNO 1
Date_ 20130409
Time 7.27
INSTRUM av500
PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1300000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.66 0.33 0.92 0.85 52.50 42.50 2.23


Sample Ref 10567
curcuma
BRUKER
NAME tb2-Apr08-2013-1
EXPNO 160
PROCNO 1
Date_ 20130409
Time 7.49
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PROBHD 5 mm CPQNP 1H/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 256
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1720407 sec
RG 45.3
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 13.00 usec
PL1 2.00 dB
PL1W 6.41881752 W
SFO1 500.1330885 MHz
SI 32768
SF 500.1299996 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10 9 8 7 6 5 4 3 2 1 0 ppm
0.75 0.96 0.76 3.47 1.55 52.98 37.18 2.35

13.7 Appendix 7

Project P399-01 HPTLC Worksheet Curcuma (AB and DAF)

CAMAG Laboratories, Muttenz, Switzerland, March 2013

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Worksheet

Project No.: P399-01 **Analyst:** DAF; AB

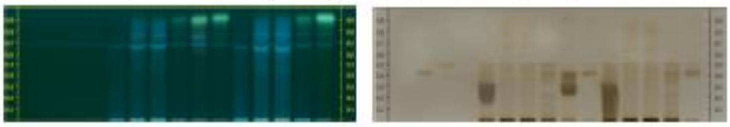
Project objective: Collaborative work

Date: 12.03.2013 **Lab Temperature:** 24 °C **Humidity:** 32%

Sumary

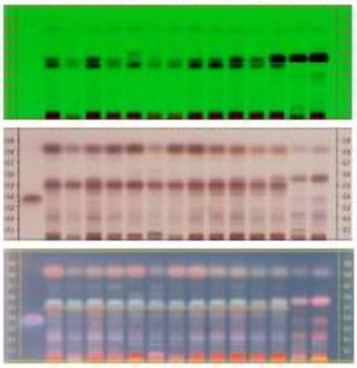
Sugars fingerprints: 0.2 g of the powder in 4 mL of water

1) ACN, acetone, water (40:40:20) **test 14 (Aniline-diphenylamine-phosphoric acid)**

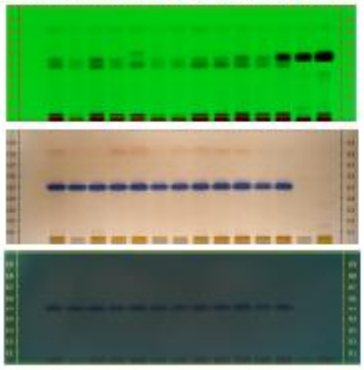


Essential oils fingerprints: 0.2 g of the powder in 4 mL of toluene

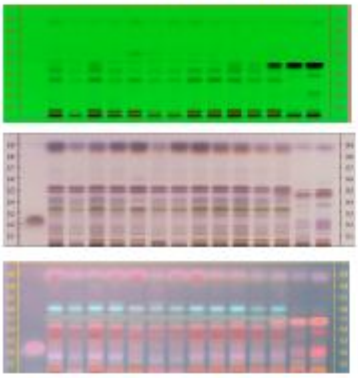
1) Toluene, ethyl acetate (95:05) **test 3 (anis)**



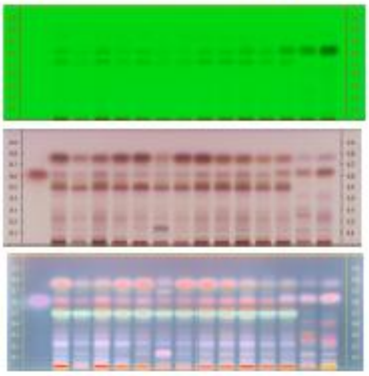
2) Toluene, ethyl acetate (95:05) **test 4 (Gibbs)**



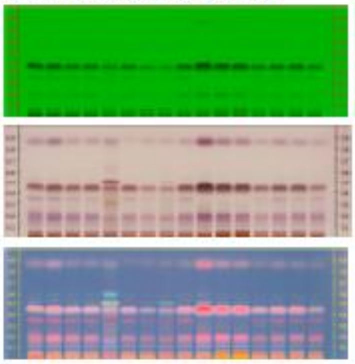
3) DCM + cineol **test 6 (anisaldehyde)**



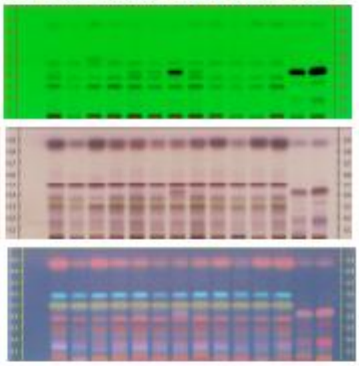
4) MTBE:Cyclohexane 20:80 **test 8 (anis)**



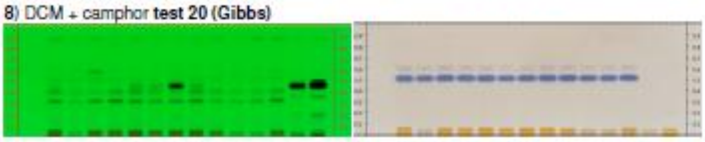
5) DCM for C. longa specie **test 13**



6) DCM + camphor **test 19 (anisaldehyde**

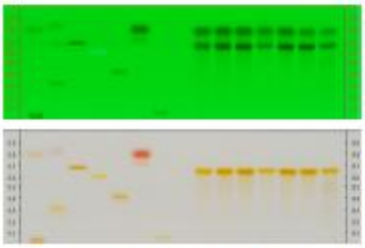


8) DCM + camphor **test 20 (Gibbs)**

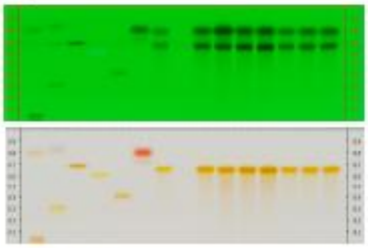


Illegal dyes test: 0.2 g of the powder in 4 mL methanol. MP = toluene, MeOH, acetic acid (32:8:10)

1) test 9

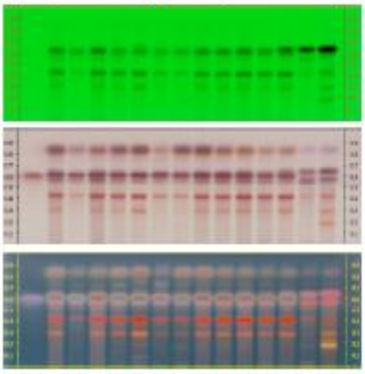


2) test 10

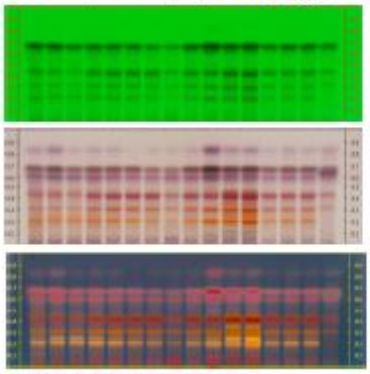


Curcuminoids fingerprint: 0.2 g of the powder in 4 mL methanol.

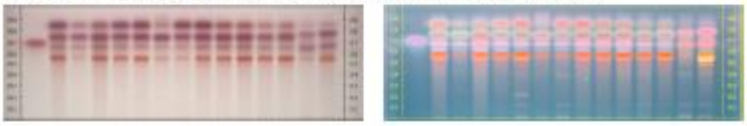
1) Tol., acetic ac. (4:1) **test 5 (xant. + arom.)**



2) Toluene, acetic ac. (4:1) **test 17 (longa)**



3) Toluene, ethyl acetate, acetic ac. (32:6:10) **test 7 (xanthorriza + aromatica)**



Samples and standards identification

Sample Number	Sample Description	Source and Batch
S10273	C. xanthorriza	S3
S10274	C. xanthorriza plus	S6
S10292	C. longa	S8
S10310	C. longa	S14
S10295	C. longa	S15
S10296	C. longa	S16
S10277	Mixture of species (xanthorriza +)	S21
S10312	Aqueous extract	S23
S10288	Aqueous extract	S24
S10281	Aqueous extract	S25
S10280	C. longa	S26
S10282	C. aromatica	S27
S10289	Aqueous extract	S28
S10278	C. aromatica	S29
S10301	C. longa	S30
S10305	C. longa	S34
S10284	C. longa??	S36
S10302	C. longa	S38
S10609	C. xanthorriza tropilab	S50
S10610	C. longa	S51
S10611	C. longa	S52
S10612	C. longa	S53
S10613	C. longa	S54
S10614	C. longa	S55
S10615	C. aromatica	S56
S10616	C. aromatica	S57
S10617	C. aromatica	S58
S10618	C. longa	S59
S10619	C. longa	S60
S9767	C. xanthorriza	
S10565	C. xanthorriza	
S10566	C. xanthorriza	
S10567	C. xanthorriza	

Standard Number	Standard Description	Source and Batch
	Camphor	
	1,8 Cineol	
	Saccharose	
	Fructose	

Plates used

	Manufacturer	Batch
HPTLC glass 20x10 cm, Si 60 F_{254}	Merck	

Material used

Name, article	Manufacturer
Automatic TLC Sampler 4	CAMAG

Twin Trough Chamber 20x10 cm / 10x10 cm	CAMAG
Chromatogram Immersion Device III	CAMAG
TLC Plate Heater III	CAMAG
Automatic Development Chamber ADC 2	CAMAG
Visualizer	CAMAG
Filter paper for chamber saturation	CAMAG
Mill KB5/10	IKA
Ultra Centrifugal Mill ZM200	Retsch
Centrifuge EBA21	Hettich
Ultrasonic Bath SW 3H	Sono Swiss
Analytical Balance AG245	Mettler-Toledo
Balance DC4400	Mettler-Toledo
Orbital Shaking Platform POS-300	Grand-Bio
UV/VIS spectrophotometer 6715	Jenway

Test 1, Plate No. P399-01_130312_01

A Objective:
Essential oils analysis. Try to detect differences between *C. xanthorriza* and *C. aromatica*

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1					
2	R9712	cineol 1,8	2.0	A1	Reference
3	S3	c.xanthorhiza	4.0	A2	Sample
4	S6	c.xanthorhiza plus	4.0	A3	Sample
5	S27	c.aromatica	4.0	A4	Sample
6	S29	c.aromatica	4.0	A5	Sample
7	S50	c.aromatica tropilab	4.0	A6	Sample
8	S56	c.aromatica	4.0	A7	Sample
9	S57	c.aromatica	4.0	A8	Sample
10	S58	c.aromatica	4.0	A9	Sample
11	S3	c.xanthorhiza	2.0	A2	Sample
12	S6	c.xanthorhiza plus	2.0	A3	Sample
13	S29	c.aromatica	2.0	A5	Sample
14	S50	c.aromatica tropilab	2.0	A6	Sample
15	S57	c.aromatica	2.0	A8	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Toluene, ethyl acetate (95:05)

Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added.
25.02.13
Reagent use: Dip (speed: 5; time: 0), heated for 3 minutes at 100°C

Results
Image under white light

Image under UV 254 nm

(enhanced image)

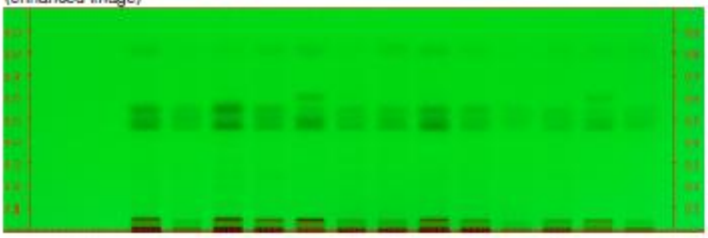
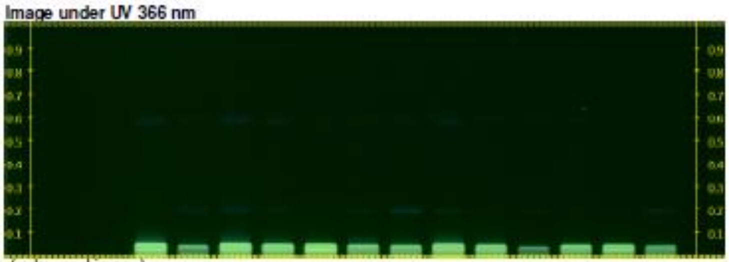


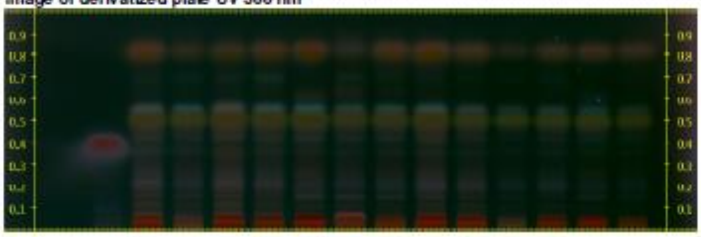
Image under UV 366 nm



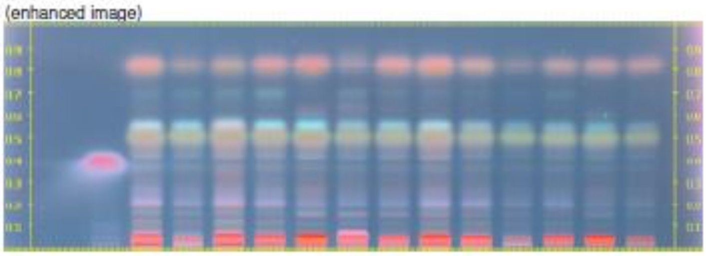
(enhanced image)

Image of derivatized plate WRT

Image of derivatized plate UV 366 nm



(enhanced image)



C Conclusions:
No difference was observed between aromatica and xathorriza

Test 2, Plate No. P399-01 130312 02

A Objective:
Sugars analysis

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of water and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
1 mg each of succharose and fructose was dissolved in 1 mL of water

Application

Track	Vial ID	Desc	Volume	Position	Type
1					
2	R308_01	Saccharose	2.0	C1	Reference
3	R308_02	Fructose	2.0	C2	Reference
4	Rxxxx	Rutin	2.0	C3	Sample
5	S23	aq. extract	2.0	C4	Sample
6	S28	aq. extract	2.0	C5	Sample
7	S24	aq. extract	2.0	C6	Sample
8	S25	aq. extract	2.0	C7	Sample
9	S8	aq. extract	2.0	C8	Sample
10	S23	aq. extract	4.0	C4	Sample
11	S28	aq. extract	4.0	C5	Sample
12	S24	aq. extract	4.0	C6	Sample
13	S25	aq. extract	4.0	C7	Sample
14	S8	aq. extract	4.0	C8	Sample
15					

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Acetonitrile, acetone, water (40:40:20)

Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Aniline-diphenylamine-phosphoric acid
Preparation: Weigh 4 g of diphenylamine in a glass bottle and dissolve 160 mL of acetone, add 4 mL of aniline, and carefully add 30 mL of o-phosphoric acid. Shake well to dissolve the initially formed precipitate.
Use: dip (speed: 5; time:0), heat at 120°C for 10 min

Results
Image under white light

Image under UV 254 nm

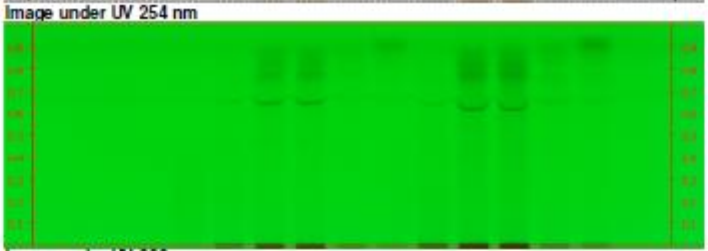


Image under UV 366 nm

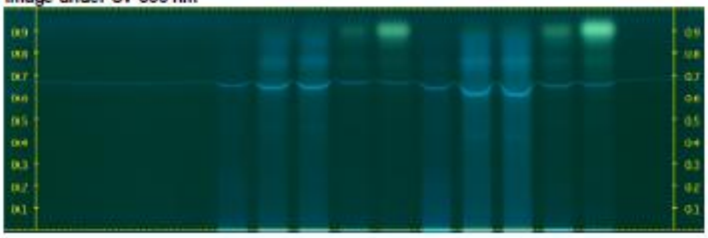
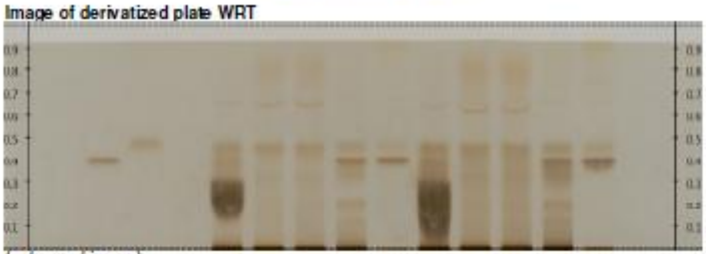
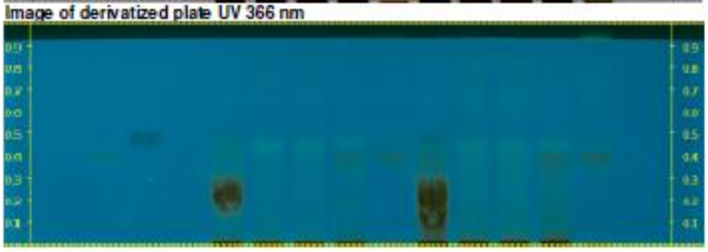


Image of derivatized plate WRT



(enhanced image)

Image of derivatized plate UV 366 nm



C Conclusions:

In the NMR the sample S6 is grouped closer to the aqueous extract, probably due to the presence of the sugars. Repeat this plate and include the sample S6 and spray.

Test 3, Plate No. P399-01_130312_03

A Objective:

Essential oils analysis. Try to detect differences between *C. xanthorriza* and *C. aromatica*. Add more xanthorriza and longa samples.

B Experimental:

Sample preparation

0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation

50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S27	c.aromatica	4.0	A4	Sample
5	S29	c.aromatica	4.0	A5	Sample
6	S30	c.aromatica [illegible]	4.0	A6	Sample
7	S56	c.aromatica	4.0	A7	Sample
8	S57	c.aromatica	4.0	A8	Sample
9	S58	c.aromatica	4.0	A9	Sample
10	S10567	c.xanthorhiza	4.0	A10	Sample
11	S10566	c.xanthorhiza	4.0	A11	Sample
12	S10565	c.xanthorhiza	4.0	B1	Sample
13	S9767	c.xanthorhiza	4.0	B2	Sample
14	S36		4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development

Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Toluene, ethyl acetate (95:05)
Developing time:
Plate drying: 5 minutes

Derivatization reagent

Reagent name: Anisaldehyde
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 25.02.13
Reagent use: Dip (speed: 5; time: 0), heated for 3 minutes at 100°C

Results

Image under white light

Image under UV 254 nm

(enhanced image)

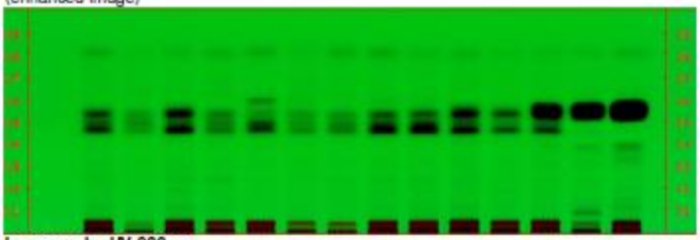


Image under UV 366 nm

(enhanced image)

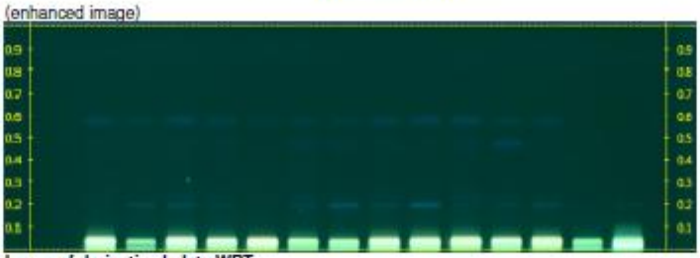
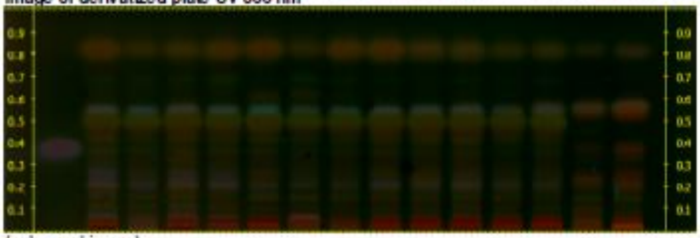
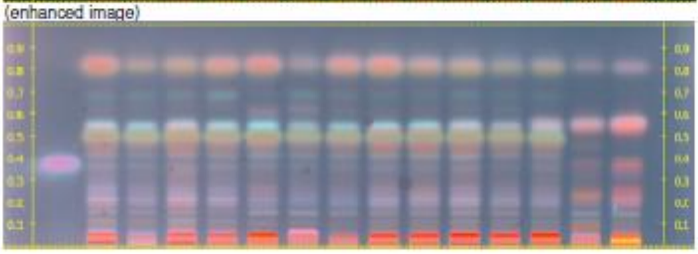


Image of derivatized plate WRT

Image of derivatized plate UV 366 nm



(enhanced image)



C Conclusions:
No difference was observed between aromatica and xathorriza. The two last tracks could be well differenciate from C. xanthorriza and C. aromatica.

Test 4, Plate No. P399-01_130312_04

A Objective:
Essential oils analysis. Try to detect differences between *C. xanthorriza* and *C. aromatica*. Add more xanthorriza samples. Derivatize with Gibbs reagent.

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S27	c.aromatica	4.0	A4	Sample
5	S29	c.aromatica	4.0	A5	Sample
6	S50	c.aromatica troplab	4.0	A6	Sample
7	S56	c.aromatica	4.0	A7	Sample
8	S57	c.aromatica	4.0	A8	Sample
9	S58	c.aromatica	4.0	A9	Sample
10	S10567	c.xanthorhiza	4.0	A10	Sample
11	S10566	c.xanthorhiza	4.0	A11	Sample
12	S10565	c.xanthorhiza	4.0	B1	Sample
13	S9767	c.xanthorhiza	4.0	B2	Sample
14	S36		4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Toluene, ethyl acetate (95:05)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Gibbs reagent
Reagent preparation: Dissolve 8 mg of DCCL in 20 mL 2-propanol
Reagent use: spray with DCCL solution, than place chromatogram in a chamber with vapor from 32% ammonia solution, making sure that the layer does not contact the liquid

Results

Image under white light

Image under UV 254 nm

(enhanced image)

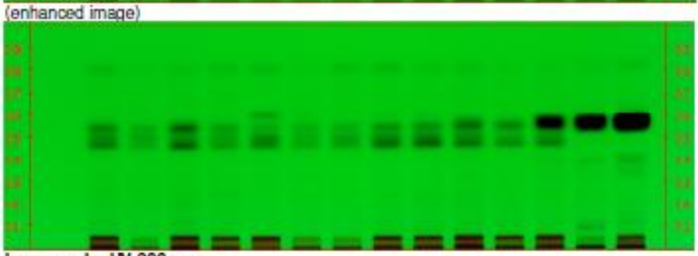


Image under UV 366 nm

(enhanced image)

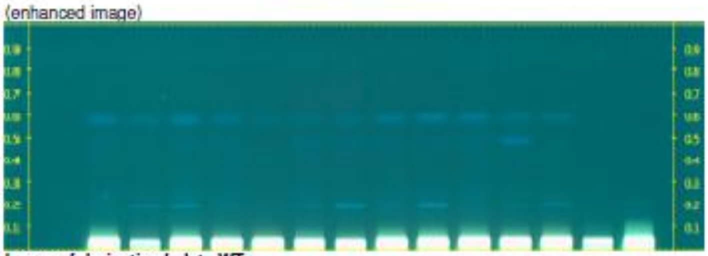


Image of derivatized plate WT

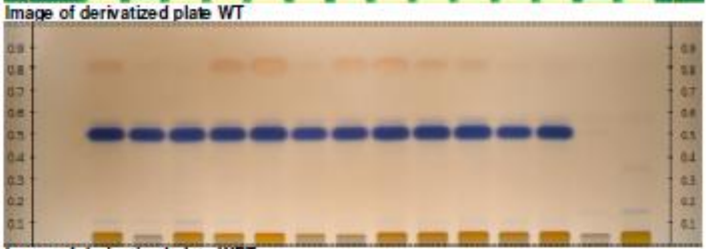


Image of derivatized plate WRT

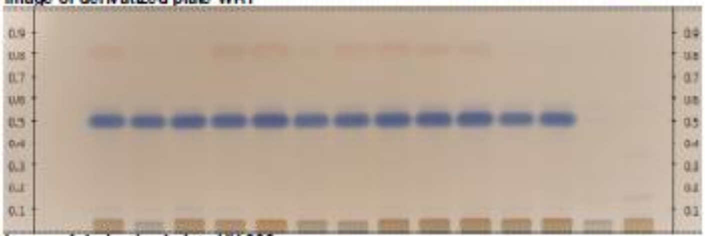


Image of derivatized plate UV 366 nm

C Conclusions:
No difference was observed between aromatica and xathorriza. The two last tracks could be well differenciate from those species.

Test 5, Plate No. P399-01 130312 05

A Objective:
Try to detect differences between *C. xanthorriza* and *C. aromatica*. Add more xanthorriza samples.

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S27	c.aromatica	4.0	A4	Sample
5	S29	c.aromatica	4.0	A5	Sample
6	S50	c.aromatica tropilab	4.0	A6	Sample
7	S56	c.aromatica	4.0	A7	Sample
8	S57	c.aromatica	4.0	A8	Sample
9	S58	c.aromatica	4.0	A9	Sample
10	S10567	c.xanthorhiza	4.0	A10	Sample
11	S10566	c.xanthorhiza	4.0	A11	Sample
12	S10565	c.xanthorhiza	4.0	B1	Sample
13	S9767	c.xanthorhiza	4.0	B2	Sample
14	S36		4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Toluene, acetic acid (4:1)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added.
25.02.13
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results

Image under white light

Image under UV 254 nm

(enhanced image)

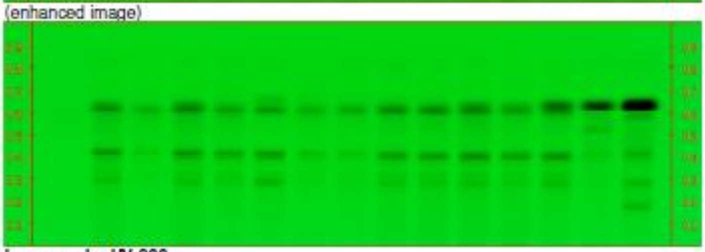


Image under UV 366 nm

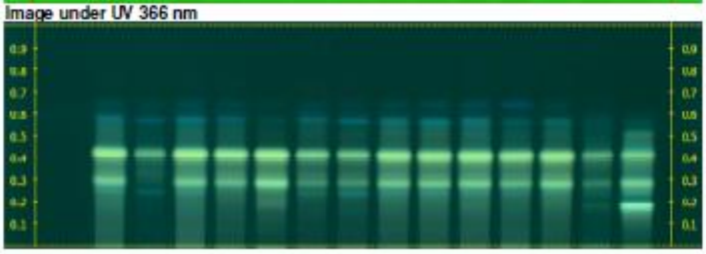


Image of derivatized plate WRT

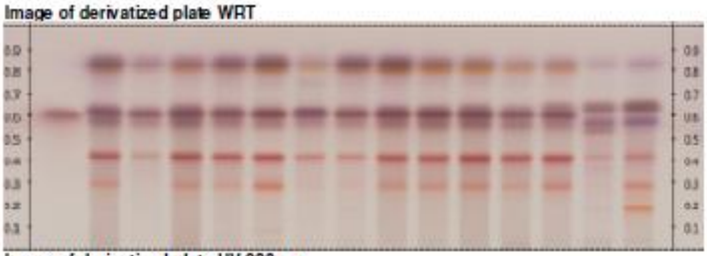
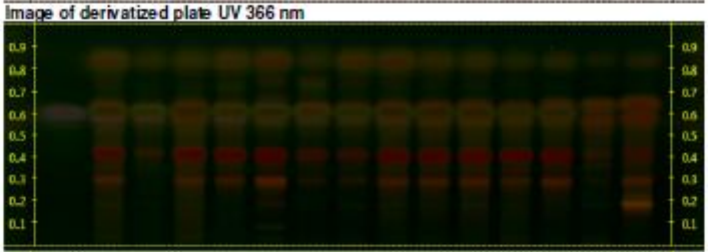


Image of derivatized plate UV 366 nm



C Conclusions:

No difference was observed between aromatica and xathorriza. The track 14 isnt C. xanthorhiza/aromatica or longa either.

Test 6, Plate No. P399-01 130313 01

A Objective:

Try to detect differences between *C. xanthorriza* and *C. aromatica*. Add more xanthorriza samples. Test new MP.

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S27	c.aromatica	4.0	A4	Sample
5	S29	c.aromatica	4.0	A5	Sample
6	S50	c.aromatica tropilab	4.0	A6	Sample
7	S56	c.aromatica	4.0	A7	Sample
8	S57	c.aromatica	4.0	A8	Sample
9	S58	c.aromatica	4.0	A9	Sample
10	S10567	c.xanthorhiza	4.0	A10	Sample
11	S10566	c.xanthorhiza	4.0	A11	Sample
12	S10565	c.xanthorhiza	4.0	B1	Sample
13	S9767	c.xanthorhiza	4.0	B2	Sample
14	S36		4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: DCM
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 25.02.13
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results
Image under white light

Image under UV 254 nm (enhanced image)

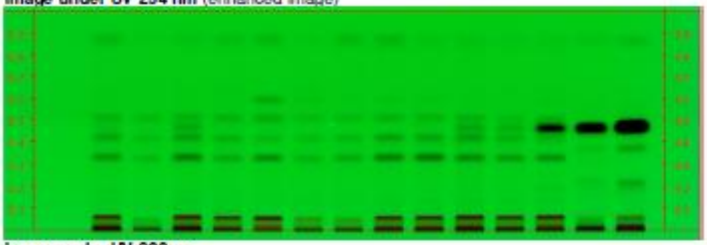
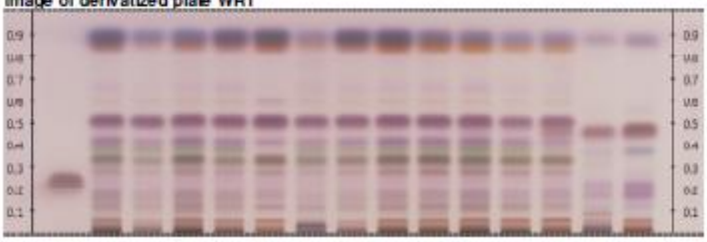


Image under UV 366 nm

Image of derivatized plate WRT



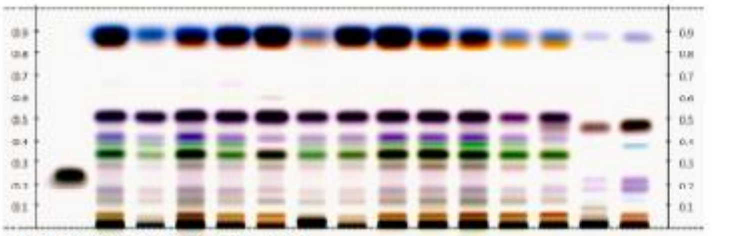
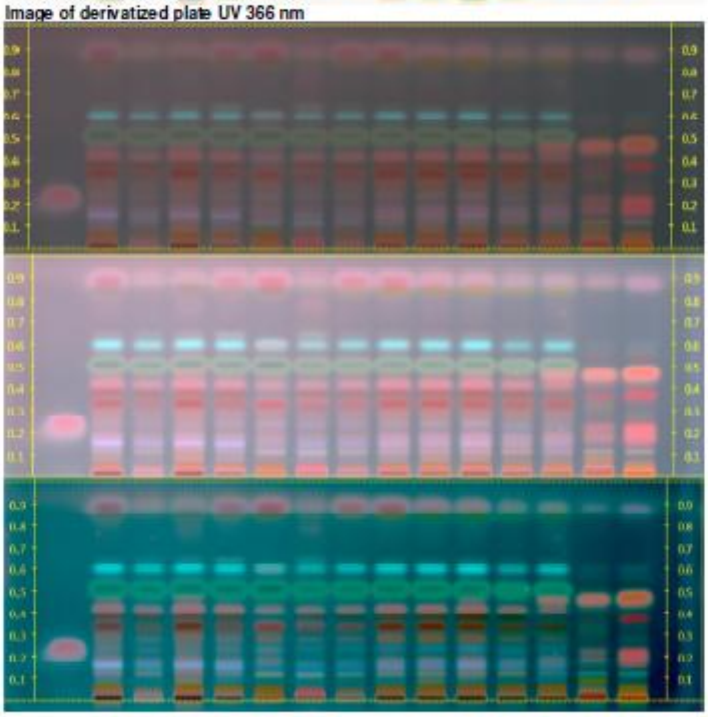


Image of derivatized plate UV 366 nm



C Conclusions:
No difference was observed between aromatica and xanthorhiza. The track 14 isnt C. xanthorriza/aromatica or longa either. It may be kwangsiensis. No sample seems to contain cineol.

Test 7, Plate No. P399-01_130313_02

A Objective:
Try to detect differences between *C. xanthorhiza* and *C. aromatica*. Add more xanthorhiza samples. Test new MP.

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S27	c.aromatica	4.0	A4	Sample
5	S29	c.aromatica	4.0	A5	Sample
6	S30	c.aromatica tropilab	4.0	A6	Sample
7	S56	c.aromatica	4.0	A7	Sample
8	S57	c.aromatica	4.0	A8	Sample
9	S58	c.aromatica	4.0	A9	Sample
10	S10567	c.xanthorhiza	4.0	A10	Sample
11	S10566	c.xanthorhiza	4.0	A11	Sample
12	S10565	c.xanthorhiza	4.0	B1	Sample
13	S9767	c.xanthorhiza	4.0	B2	Sample
14	S36		4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Toluene: ethyl acetate: acetic acid 32:6:10
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 25.02.13
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results
Image under white light

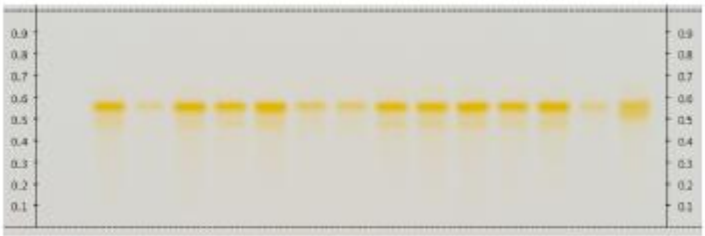


Image under UV 254 nm (enhanced image)

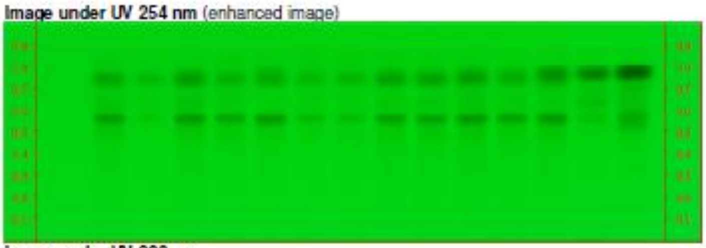


Image under UV 366 nm

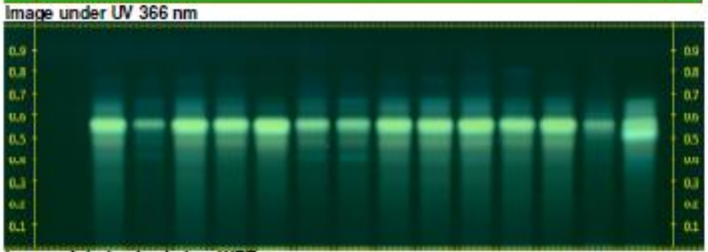


Image of derivatized plate WRT

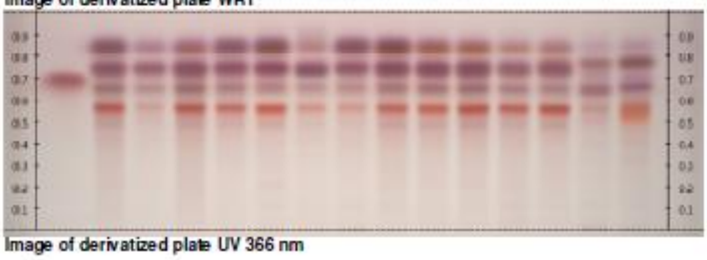
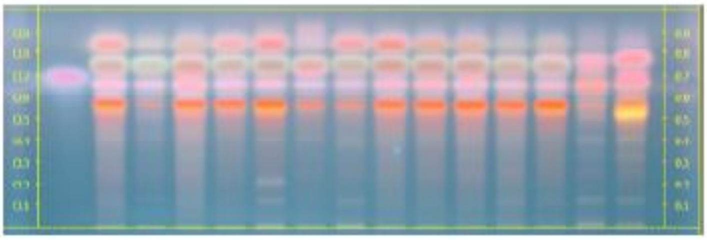


Image of derivatized plate UV 366 nm



C Conclusions:
No difference was observed between aromatica and xanthorhiza. The track 14 isnt C. xanthorriza/aromatica or longa either. It may be kwangsiensis. Track 15, UV366, has a bright yellow zone at Rf 0.53. This mobile phase is too strong.

Test 8, Plate No. P399-01_130313_03

A Objective:
Try to detect differences between *C. xanthorhiza* and *C. aromatica*. Add more xanthorhiza samples. Test new MP.

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and sonicated for 10 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S27	c.aromatica	4.0	A4	Sample
5	S29	c.aromatica	4.0	A5	Sample
6	S50	c.aromatica tropilab	4.0	A6	Sample
7	S56	c.aromatica	4.0	A7	Sample
8	S57	c.aromatica	4.0	A8	Sample
9	S58	c.aromatica	4.0	A9	Sample
10	S10567	c.xanthorhiza	4.0	A10	Sample
11	S10566	c.xanthorhiza	4.0	A11	Sample
12	S10565	c.xanthorhiza	4.0	B1	Sample
13	S9767	c.xanthorhiza	4.0	B2	Sample
14	S36		4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

S50 was wrong labeled (C. xanthorriza instead C. aromatica)

Development
Chamber: ADC2

Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: MtBE:Cyclohexane 20:80
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 25.02.13
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results

Image under white light

Image under UV 254 nm (enhanced image)

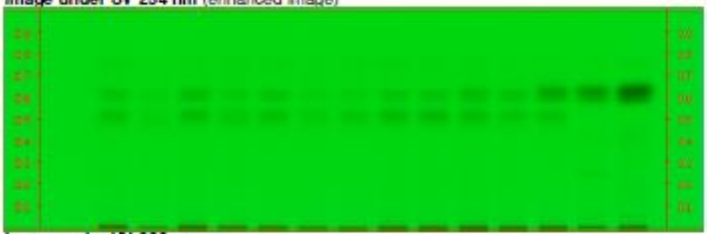


Image under UV 366 nm

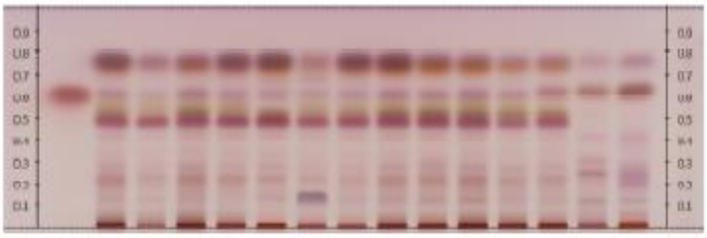
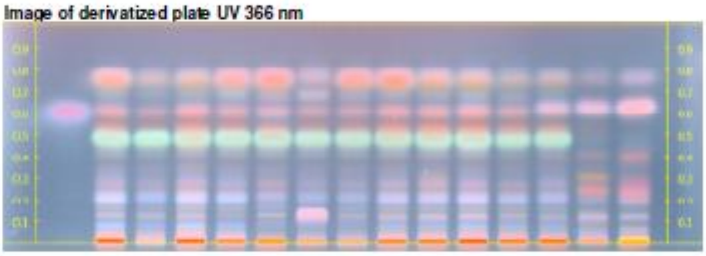


Image of derivatized plate UV 366 nm



C Conclusions:

No difference was observed between aromatica and xanthorhiza. The track 14 isnt C. xanthorriza/aromatica or longa either. It may be kwangsiensis. Track 7 had an intense zone at Rf 0.13, UV366. The selectivity modified with this mobile phase. DCM as mobile phase is preferred.

Test 9, Plate No. P399-01 130314 01

A Objective:

Test for detection of illegal dyes in curcuma

B Experimental:

Sample preparation

0.2g of powdered turmeric are solved in 4 mL of methanol and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation

0.2 mg of each in 1 mL of methanol

Application

Track	Vial ID	Desc	Volume	Position	Type
1	S2674	Sudan I (upper)	2.0	D1	Reference
1	S1910	Sunset yellow (lower)	2.0	D2	Reference
2	S395	Sudan IV (upper)	2.0	D3	Reference
2	S2666	Auramine O (lower)	2.0	D4	Reference
3	S9784	Aniline	2.0	D5	Reference
4	S9786	Fluorescin	2.0	D6	Reference
5	S3231	Metanil yellow	2.0	D7	Reference
6	S2668	Menthyl yellow	2.0	D8	Sample
7	S9785	Xylene 2G	2.0	D9	Sample
8					
9	S14		4.0	D10	Sample
10	S15		4.0	D11	Sample
11	S16		4.0	E1	Sample
12	S21		4.0	E2	Sample
13	S26		4.0	E3	Sample
14	S30		4.0	E4	Sample
15	S34		4.0	E5	Sample

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: toluene, methanol, acetic acid (32:8:10)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
N/A

Results
Image under white light

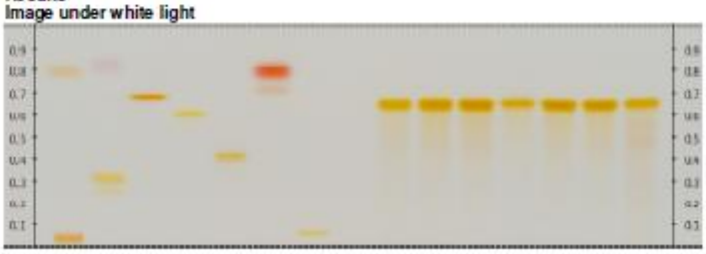
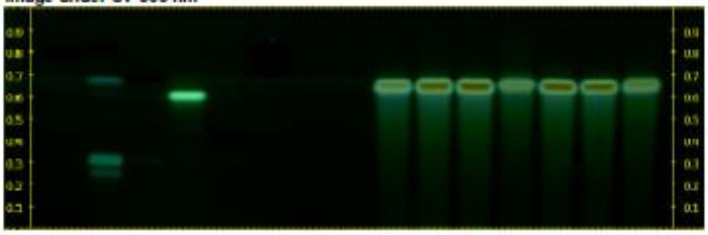


Image under UV 254 nm

Image under UV 366 nm



C Conclusions:

No adulteration

Test 10, Plate No. P399-01 130314 02

A Objective:

Test for detection of illegal dyes in curcuma

B Experimental:

Sample preparation

0.2g of powdered turmeric are solved in 4 mL of methanol and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation

0.2 mg of each in 1 mL of methanol

Application

Track	Vial ID	Desc	Volume	Position	Type
1	S2674	Sudan I (upper)	2.0	D1	Reference
1	S1910	Sunset yellow (lower)	2.0	D2	Reference
2	S395	Sudan IV (upper)	2.0	D3	Reference
2	S2666	Auramine O (lower)	2.0	D4	Reference
3	S9784	Aniline	2.0	D5	Reference
4	S9786	Fluorescin	2.0	D6	Reference
5	S3231	Metanil yellow	2.0	D7	Reference
6	S2668	Menthyl yellow	2.0	D8	Reference
7	S9785	Xylene 2G	2.0	D10	Reference
8					
9	S38	longa	4.0	E6	Sample
10	S51	longa	4.0	E7	Sample
11	S52	longa	4.0	E8	Sample
12	S53	longa	4.0	E9	Sample
13	S54	longa	4.0	E10	Sample
14	S55	longa	4.0	E11	Sample
15	S59	longa	4.0	F1	Sample

Track 7 isn't xylene 2G (probably curcuma sample)

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: toluene, methanol, acetic acid (32:8:10)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
N/A

Results
Image under white light

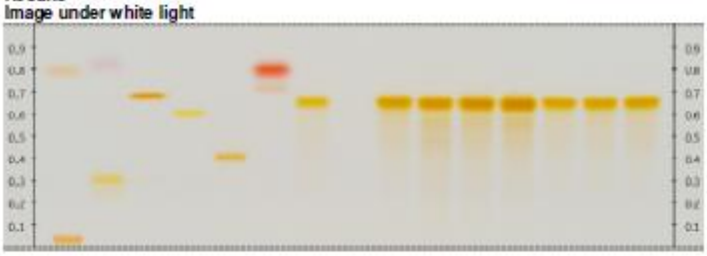
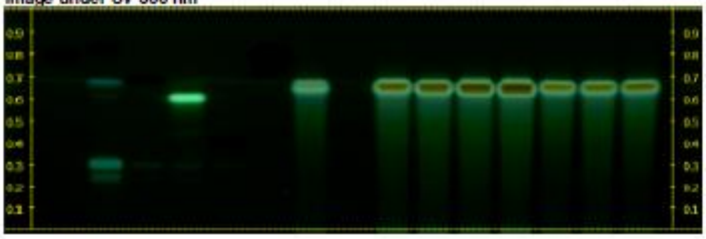


Image under UV 254 nm

Image under UV 366 nm



C Conclusions:
No adulteration

Test 11, Plate No. P399-01_130314_03

A Objective:
Analyze the other C. longa samples with essential oils mobile phase (DCM)

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S14	C.longa	4.0	A2	Sample
3	S15	C.longa	4.0	A3	Sample
4	S16	C.longa	4.0	A4	Sample
5	S21	C.longa	4.0	A5	Sample
6	S26	C.longa	4.0	A6	Sample
7	S30	C.longa	4.0	A7	Sample
8	S34	C.longa	4.0	A8	Sample
9	S38	C.longa	4.0	A9	Sample
10	S51	C.longa	4.0	A10	Sample
11	S52	C.longa	4.0	A11	Sample
12	S53	C.longa	4.0	B1	Sample
13	S54	C.longa	4.0	B2	Sample
14	S55	C.longa	4.0	B3	Sample
15	S59	C.longa	4.0	B4	Sample

Development

Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: DCM
Developing time:
Plate drying: 5 minutes

Derivatization reagent

Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results

Image under white light

Image under UV 254 nm

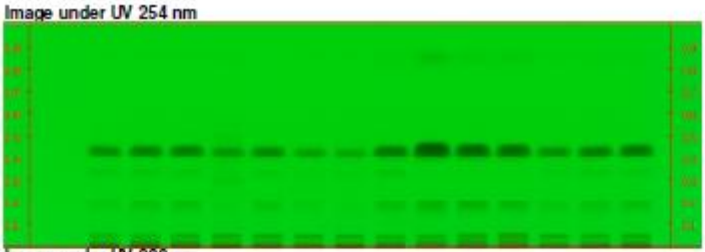


Image under UV 366 nm

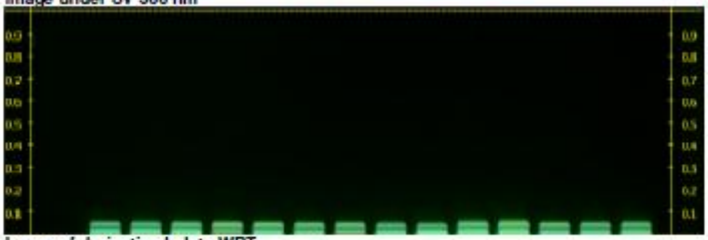


Image of derivatized plate WRT

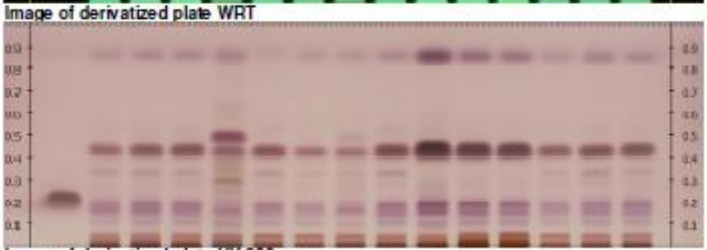
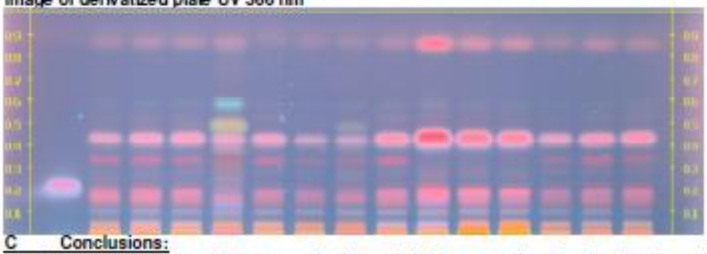


Image of derivatized plate UV 366 nm



C Conclusions:

No difference was observed between sonication and shaking extraction. Sample S21 showed a different fingerprint (C. xanthorriza/aromatic). The samples on tracks 10-12 showed an intense purple zone at Rf 0.43 and no purple zone at Rf 0.32, UV366 (those samples are fresh). Repeat the test and include new C. longa samples.

Test 12, Plate No. P399-01_130314_04

A Objective:
Analyze other C. longa samples with curcuminoids mobile phase (toluene, acetic acid 4:1)

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
50 µL of 1,8,cineole in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R9712	cineol 1,8	0.5	A1	Reference
2	S14	C.longa	4.0	A2	Sample
3	S15	C.longa	4.0	A3	Sample
4	S16	C.longa	4.0	A4	Sample
5	S21	C.longa	4.0	A5	Sample
6	S26	C.longa	4.0	A6	Sample
7	S30	C.longa	4.0	A7	Sample
8	S34	C.longa	4.0	A8	Sample
9	S38	C.longa	4.0	A9	Sample
10	S51	C.longa	4.0	A10	Sample
11	S52	C.longa	4.0	A11	Sample
12	S53	C.longa	4.0	B1	Sample
13	S54	C.longa	4.0	B2	Sample
14	S55	C.longa	4.0	B3	Sample
15	S59	C.longa	4.0	B4	Sample

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: toluene, acetic acid (4:1)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results

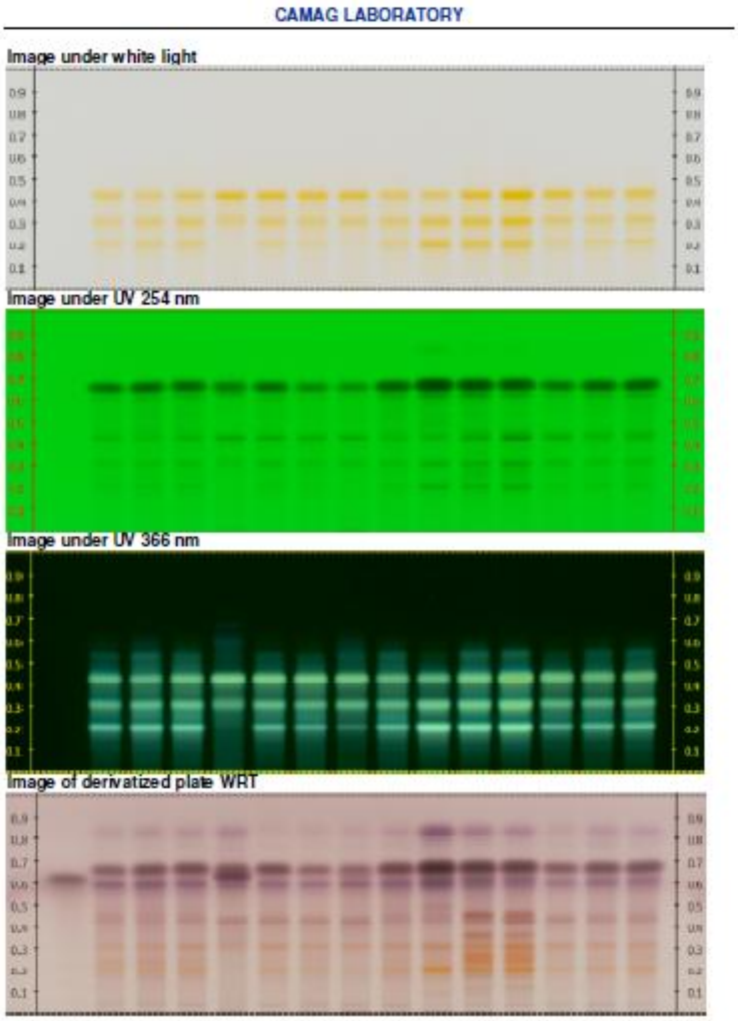
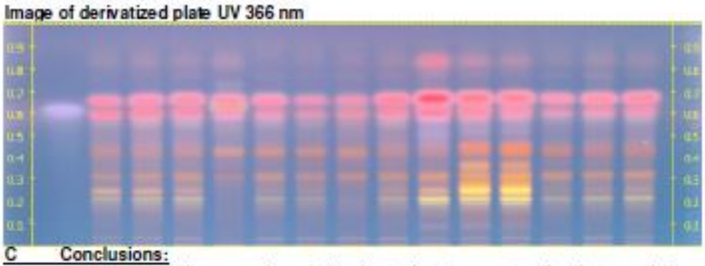

CAMAG LABORATORY
Image under white light
Image under UV 254 nm
Image under UV 366 nm
Image of derivatized plate WRT

Image of derivatized plate UV 366 nm



C Conclusions:
Curcuminoids zones look very weak, probably due to the toluene extraction that was shaken (should be methanolic extraction/sonication). Repeat the test, include new samples (all extracted with methanol by shake)

Test 13, Plate No. P399-01 130314 05

A Objective:
Analyze the other C. longa samples with essential oils mobile phase (DCM)

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
N/A

Application

Track	Vial ID	Desc	Volume	Position	Type
1	S4	C.longa	4.0	A1	Reference
2	S60	C.longa	4.0	A2	Sample
3	S15	C.longa	4.0	A3	Sample
4	S16	C.longa	4.0	A4	Sample
5	S21	C.longa	4.0	A5	Sample
6	S26	C.longa	4.0	A6	Sample
7	S30	C.longa	4.0	A7	Sample
8	S34	C.longa	4.0	A8	Sample
9	S38	C.longa	4.0	A9	Sample
10	S51	C.longa	4.0	A10	Sample
11	S52	C.longa	4.0	A11	Sample
12	S53	C.longa	4.0	B1	Sample
13	S54	C.longa	4.0	B2	Sample
14	S55	C.longa	4.0	B3	Sample
15	S59	C.longa	4.0	B4	Sample
16	S14	C.longa	4.0	B5	Sample

track 1 inst reference but sample.

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$

Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: DCM
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added.
14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results
Image under white light

Image under UV 254 nm

Image under UV 366 nm

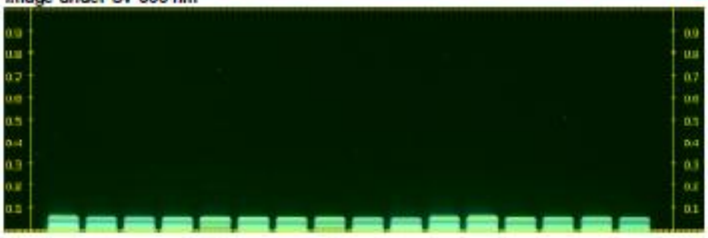


Image of derivatized plate WRT

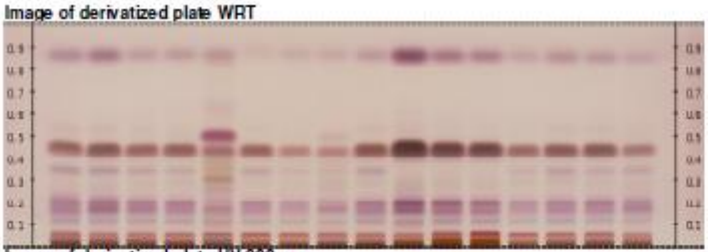
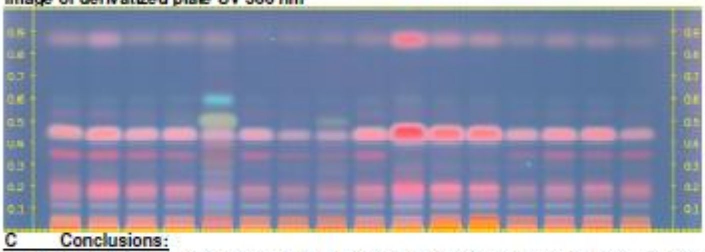


Image of derivatized plate UV 366 nm



C Conclusions:

Sample S21 (track 5) looks different from C. longa. The sample S34 (track 8) showed similar zones as track 5, but less intense (maybe spiked?).

Test 14, Plate No. P399-01_130314_06

A Objective:

Analyze the aqueous extract with the sugar system. Include the sample S6 (in NMR analysis this sample was grouped together with the aqueous extract→ high content of sugars). Spray with anilin reagent

B Experimental:

Sample preparation

0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation

1 mg each of succharose and fructose was dissolved in 1 mL of water

Application

Track	Vial ID	Desc	Volume	Position	Type
1					
2	R308_01	Saccharose	2.0	D1	Reference
3	R308_02	Fructose	2.0	D2	Reference
4	Rxxxx	Rutin	2.0	D3	Sample
5	S23	aq. extract	2.0	D4	Sample
6	S26	aq. extract	2.0	D5	Sample
7	S24	aq. extract	2.0	D6	Sample
8	S25	aq. extract	2.0	D7	Sample
9	S5	aq. extract	2.0	D8	Sample
10	S8	aq. extract	2.0	D9	Sample
11	S23	aq. extract	4.0	D4	Sample
12	S26	aq. extract	4.0	D5	Sample
13	S24	aq. extract	4.0	D6	Sample
14	S25	aq. extract	4.0	D7	Sample
15	S8	aq. extract	4.0	D9	Sample

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: Acetonitrile, acetone, water (40:40:20)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Aniline-diphenylamine-phosphoric acid
Preparation: Weigh 4 g of diphenylamine in a glass bottle and dissolve 160 mL of acetone, add 4 mL of aniline, and carefully add 30 mL of o-phosphoric acid. Shake well to dissolve the initially formed precipitate.
Use: dip (speed: 5; time:0), heat at 120°C for 10 min

Results
Image under UV 254 nm

Image under UV 366 nm

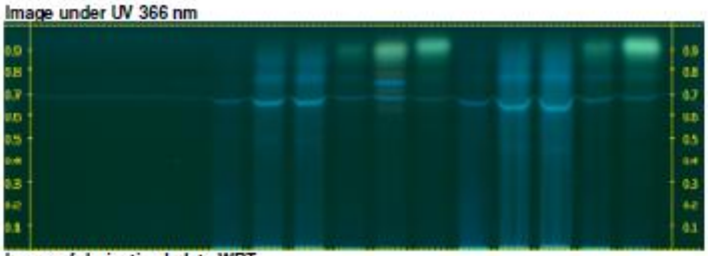


Image of derivatized plate WRT

Image of derivatized plate UV 366 nm

C Conclusions:

The sample S6 contain a large amount of sugar, and also the curcuminoids. This sample is grouped with the Xanthorriza and aromatic in group 1.

Test 15, Plate No. P399-01 130314 07

A Objective:

Repeat the test 12 with samples extracted with methanol by saken. Analyze other C. longa samples with curcuminoids mobile phase (toluene, acetic acid 4:1)

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of methanol and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
N/A

Application

Track	Vial ID	Desc	Volume	Position	Type
1	S4	C.longa	4.0	E1	Sample
2	S60	C.longa	4.0	E2	Sample
3	S15	C.longa	4.0	E3	Sample
4	S16	C.longa	4.0	E4	Sample
5	S21	C.longa	4.0	E5	Sample
6	S26	C.longa	4.0	E6	Sample
7	S30	C.longa	4.0	E7	Sample
8	S34	C.longa	4.0	E8	Sample
9	S38	C.longa	4.0	E9	Sample
10	S51	C.longa	4.0	E10	Sample
11	S52	C.longa	4.0	E11	Sample
12	S53	C.longa	4.0	F1	Sample
13	S54	C.longa	4.0	F2	Sample
14	S55	C.longa	4.0	F3	Sample
15	S59	C.longa	4.0	F4	Sample
16	S14	C.longa	4.0	F5	Sample

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: toluene, acetic acid (4:1)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results

Image under white RT light

Image under UV 254 nm

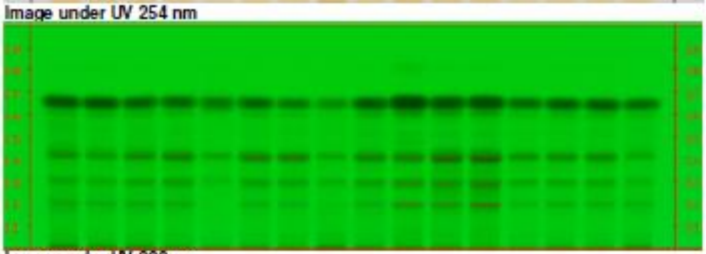


Image under UV 366 nm

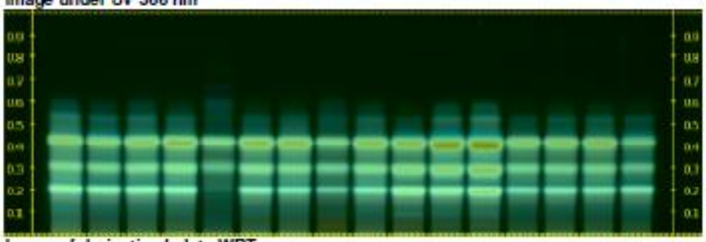


Image of derivatized plate WRT

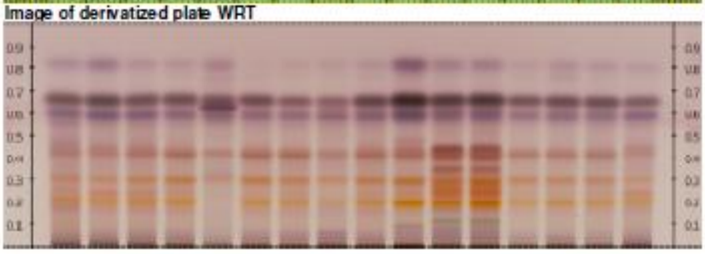
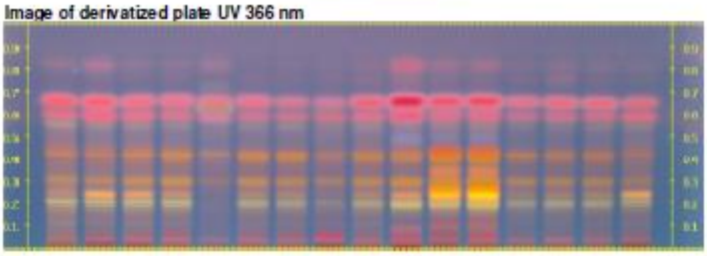


Image of derivatized plate UV 366 nm



C **Conclusions:**
The sample S21 contains no bisdemethoxycurcumin (lower curcuminoid). This sample is grouped with the Xanthorriza and aromatic in group 1. The samples on track 11 and 12 showed additional zones between the curcuminoids, and an intense pink/ brown zone at Rf ~ 0.67. those samples are fresh tumeric
The colors look different probably due to the mobile phase not dried from the plate. The curcuminoids zones look more orange then pink under white light. Repeat the test to check if the problem is the plate, the extraction method, the derivatization reagent or the mobile not dried after development.

Test 16, Plate No. P399-01_130315_01

A **Objective:**
Repeat the test 15 with samples extracted with methanol by saken. Analyze other C. longa samples with curcuminoids mobile phase (toluene, acetic acid 4:1).

B **Experimental:**

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of methanol and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
N/A

Application

Track	Vial ID	Desc	Volume	Position	Type
1	S4	C.longa	4.0	E1	Sample
2	S60	C.longa	4.0	E2	Sample
3	S15	C.longa	4.0	E3	Sample
4	S16	C.longa	4.0	E4	Sample
5	T1	indonesia samples	4.0	F6	Sample
6	T2	indonesia samples	4.0	F7	Sample
7	T3	indonesia samples	4.0	F8	Sample
8					
9	S4	C.longa	2.0	E1	Sample
10	S60	C.longa	4.0	E2	Sample
11	S15	C.longa	4.0	E3	Sample
12	S16	C.longa	4.0	E4	Sample
13	T1	indonesia samples	4.0	F6	Sample
14	T2	indonesia samples	4.0	F7	Sample
15	T3	indonesia samples	4.0	F8	Sample

Development
Chamber: ADC2
Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: toluene, acetic acid (4:1)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added.
14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results
Image under white RT light

Image under UV 254 nm

Image under UV 366 nm

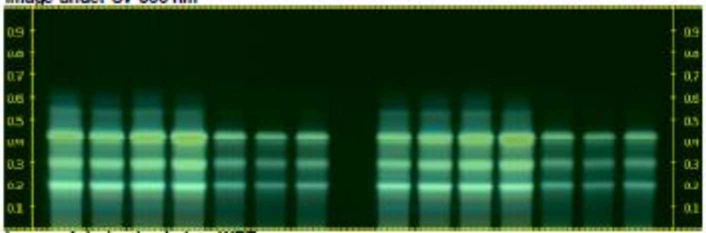
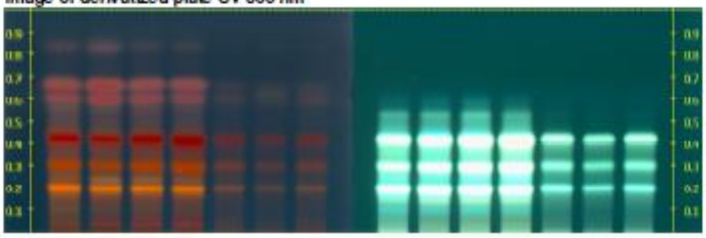


Image of derivatized plate WRT

Image of derivatized plate UV 366 nm



C Conclusions:
This test shows that the previous test problem was actually with the drying time after developing (solvent residue in the plate) which changed the colors of the curcuminoids zones after derivatization.

Test 17, Plate No. P399-01_130315_03

A Objective:
Repeat the test 16 with samples extracted with methanol by saken. Analyze other C. longa samples with curcuminoids mobile phase (toluene, acetic acid 4:1).

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of methanol and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
N/A

Application

Track	Vial ID	Desc	Volume	Position	Type
1	S4	C.longa	4.0	E1	Sample
2	S60	C.longa	4.0	E2	Sample
3	S14	C.longa	4.0	E3	Sample
4	S15	C.longa	4.0	E4	Sample
5	S16	C.longa	4.0	E5	Sample
6	S26	C.longa	4.0	E6	Sample
7	S30	C.longa	4.0	E7	Sample
8	S34	C.longa	4.0	E8	Sample
9	S38	C.longa	4.0	E9	Sample
10	S51	C.longa	4.0	E10	Sample
11	S52	C.longa	4.0	E11	Sample
12	S53	C.longa	4.0	F1	Sample
13	S54	C.longa	4.0	F2	Sample
14	S55	C.longa	4.0	F3	Sample
15	S59	C.longa	4.0	F4	Sample
16	S21	Unknown	4.0	F5	Sample

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: toluene, acetic acid (4:1)
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results

Image under white RT light

Image under UV 254 nm

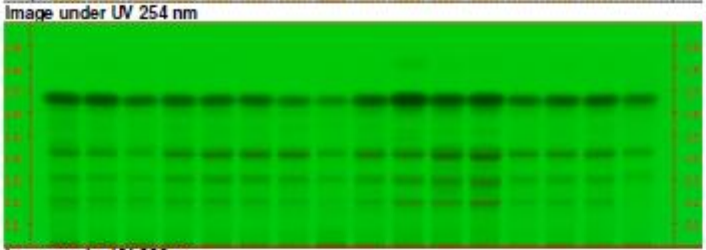


Image under UV 366 nm

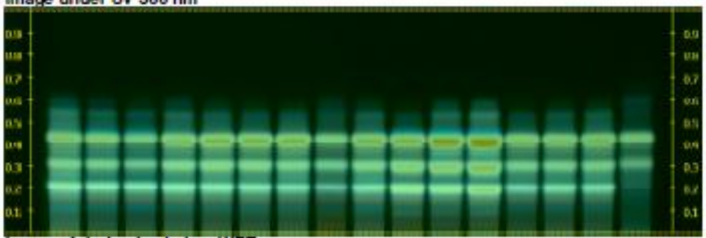


Image of derivatized plate WRT

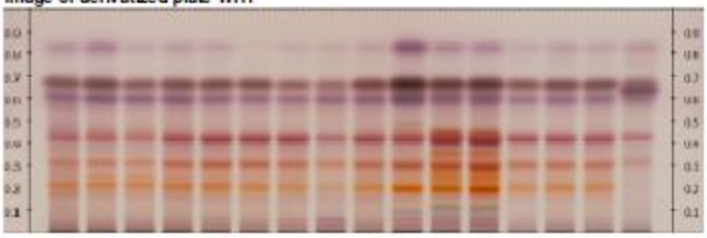
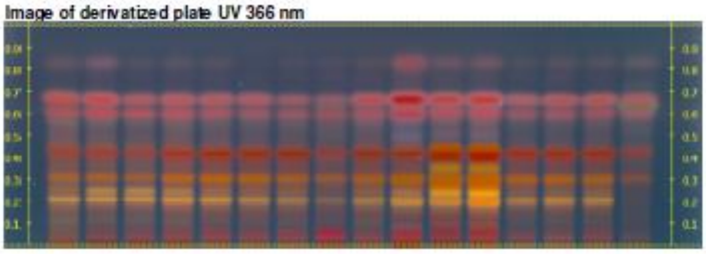


Image of derivatized plate UV 366 nm



C Conclusions:

Good results. Maybe the toluene extract is not stable after 2 days. Some zones seems to be weaker, but it is still possible to see additional zones between the curcuminoids in the fresh samples extract.

Test 18, Plate No. P399-01 130315 02

A Objective:

Repeat the essential oils analysis developed with DCM and add camphor as reference. According to the paper "essential oils from therr curcuma species collected in thailand", the *C. aromatica* presents ~10 times more camphor than *C. xanthorriza*

B Experimental:

Sample preparation

0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation

1 mg of camphor in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R468	Camphor	0.2	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S50	c.xanthorhiza Tropilab	4.0	A4	Sample
5	S10567	c.xanthorhiza	4.0	A5	Sample
6	S10566	c.xanthorhiza	4.0	A6	Sample
7	S10565	c.xanthorhiza	4.0	A7	Sample
8	S9767	c.xanthorhiza	4.0	A8	Sample
9	S27	c.aromatica	4.0	A9	Sample
10	S29	c.aromatica	4.0	A10	Sample
11	S56	c.aromatica	4.0	A11	Sample
12	S57	c.aromatica	4.0	B1	Sample
13	S58	c.aromatica	4.0	B2	Sample
14	S36	Unknown	4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

Development

Chamber: ADC2

Humidity control: 33% $MgCl_2$
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: DCM
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added.
14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results
Image under white RT light

Image under UV 254 nm (enhanced)

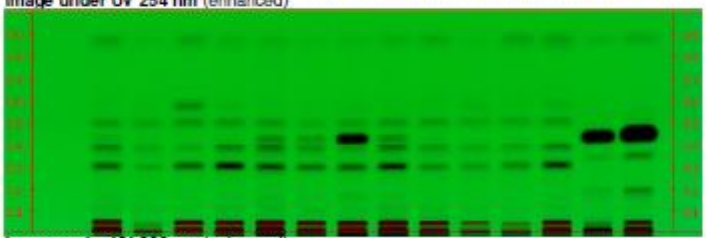


Image under UV 366 nm (enhanced)

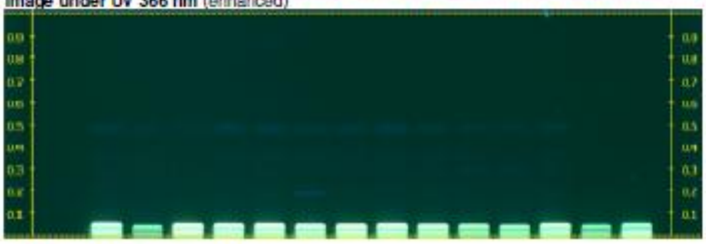


Image of derivatized plate WRT

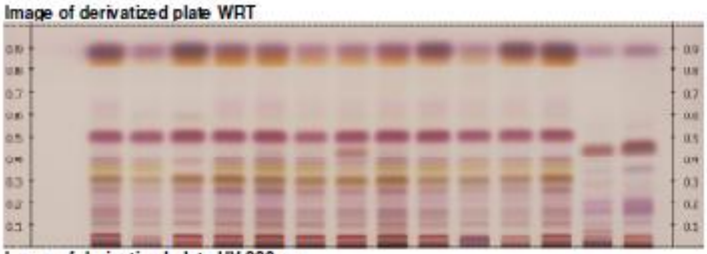
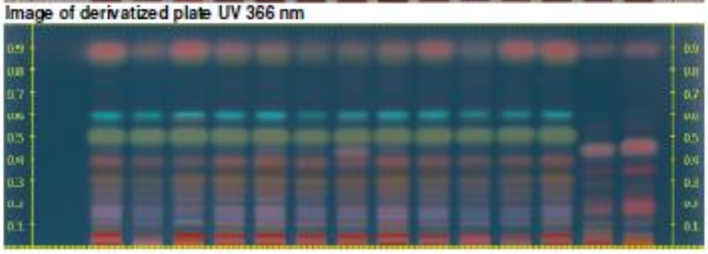


Image of derivatized plate UV 366 nm



C Conclusions:

The amount of camphor applied was very low. Repeat the test

Test 19, Plate No. P399-01_130315_04

A Objective:

Repeat the test 18 with correct application volume of camphor.

B Experimental:

Sample preparation

0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation

1 mg of camphor in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R468	Camphor	5.0	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S50	c.xanthorhiza Tropilab	4.0	A4	Sample
5	S10567	c.xanthorhiza	4.0	A5	Sample
6	S10566	c.xanthorhiza	4.0	A6	Sample
7	S10565	c.xanthorhiza	4.0	A7	Sample
8	S9767	c.xanthorhiza	4.0	A8	Sample
9	S27	c.aromatica	4.0	A9	Sample
10	S29	c.aromatica	4.0	A10	Sample
11	S56	c.aromatica	4.0	A11	Sample
12	S57	c.aromatica	4.0	B1	Sample
13	S58	c.aromatica	4.0	B2	Sample
14	S36	Unknown	4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: DCM
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Anisaldehyde reagent
Reagent preparation: 10 mL of sulfuric acid are carefully added to an ice-cooled mixture of 170 mL of methanol and 20 mL of acetic acid. To this solution, 1 mL of anisaldehyde is added. 14.03.2013
Reagent use: Dip (speed:5; time: 0), heated for 3 minutes at 100°C

Results
Image under white RT light

Image under UV 254 nm (enhanced)

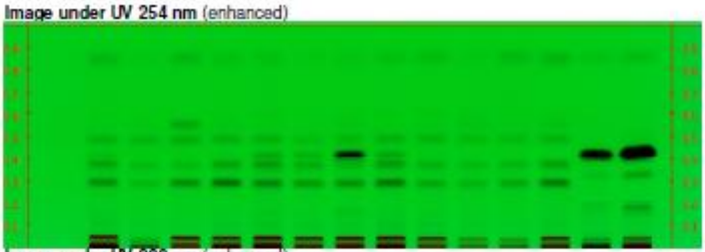


Image under UV 366 nm (enhanced)

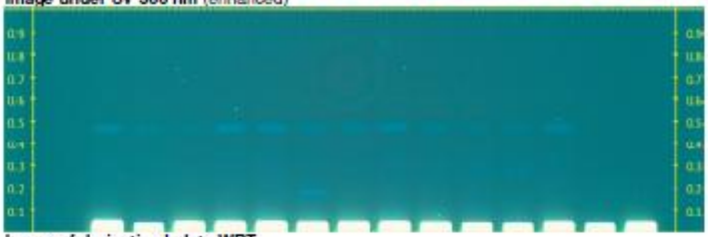


Image of derivatized plate WRT

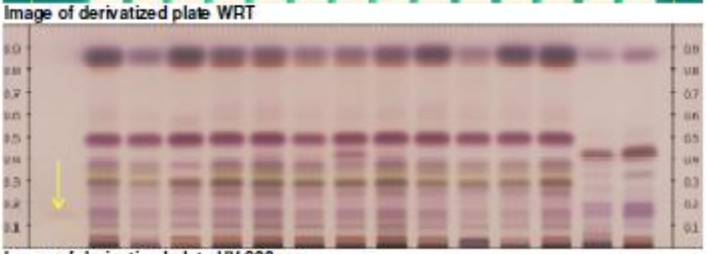
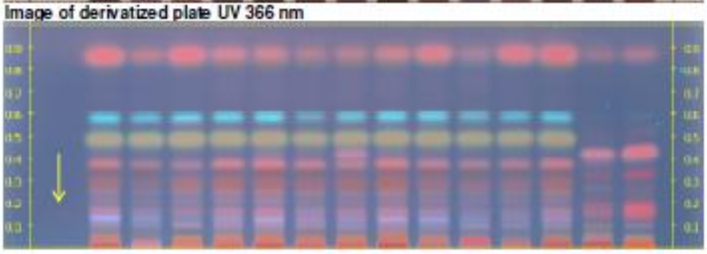


Image of derivatized plate UV 366 nm



C Conclusions:
It is very hard to detect even higher amount of pure camphor in the plate

Test 20, Plate No. P399-01_130315_05

A Objective:
Repeat test 19 and derivatize with gibbs reagent. Check which zone in 254 correspond to the blue zone after derivatization.

B Experimental:

Sample preparation
0.2g of powdered turmeric are solved in 4 mL of toluene and shaked for 20 min. Then centrifuged for 5 minutes. Using the supernatant as test solution.

Standard preparation
1 mg of camphor in 1 mL of toluene

Application

Track	Vial ID	Desc	Volume	Position	Type
1	R468	Camphor	5.0	A1	Reference
2	S3	c.xanthorhiza	4.0	A2	Sample
3	S6	c.xanthorhiza plus	4.0	A3	Sample
4	S50	c.xanthorhiza Tropilab	4.0	A4	Sample
5	S10567	c.xanthorhiza	4.0	A5	Sample
6	S10566	c.xanthorhiza	4.0	A6	Sample
7	S10565	c.xanthorhiza	4.0	A7	Sample
8	S9767	c.xanthorhiza	4.0	A8	Sample
9	S27	c.aromatica	4.0	A9	Sample
10	S29	c.aromatica	4.0	A10	Sample
11	S56	c.aromatica	4.0	A11	Sample
12	S57	c.aromatica	4.0	B1	Sample
13	S58	c.aromatica	4.0	B2	Sample
14	S36	Unknown	4.0	B3	Sample
15	S60	c.longa	4.0	B4	Sample

Development
Chamber: ADC2
Humidity control: 33% MgCl2
Saturation: 20 minutes with filter paper
Developing distance from lower edge: 70 mm
Developing solvent: DCM
Developing time:
Plate drying: 5 minutes

Derivatization reagent
Reagent name: Gibbs reagent
Reagent preparation: Dissolve 8 mg of DCCL in 20 mL 2-propanol
Reagent use: spray with DCCL solution, than place chromatogram in a chamber with vapor from 32% ammonia solution, making sure that the layer does not contact the liquid

Results

Image under white RT light

Image under UV 254 nm (enhanced)

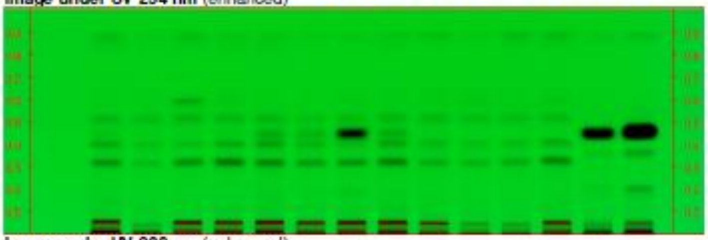


Image under UV 366 nm (enhanced)

Image of derivatized plate WRT

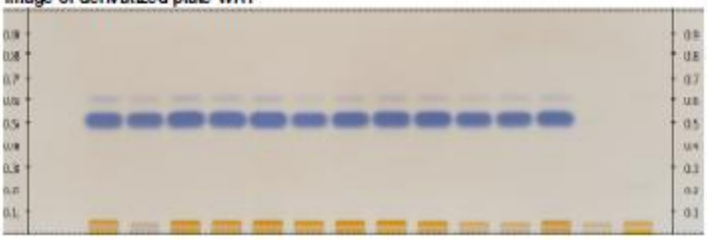
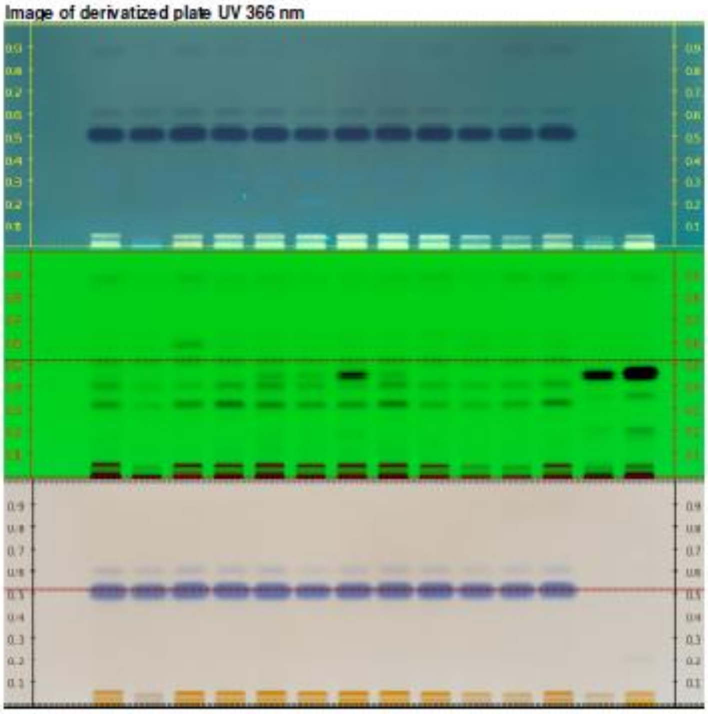


Image of derivatized plate UV 366 nm



C Conclusions:

The blue zone corresponding to the quenching zone at Rf ~ 0.51(UV 254 nm). The DCM system differentiate this zone better than toluene, ethyl acetate (95:05) system.