Parameters for apple quality and an outline for a new concept of quality

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ABSTRACT

The commonly used concept of quality in relation to food, with its emphasis on external appearance and nutritional content is not sufficient for organic products and their market. In response a quality concept known as 'vital quality' has been developed based on the life processes (growth and differentiation) and corresponding product attributes (vitality, structure and coherence). The research project presented is based on the evaluation of the quality of apples, specifically cultivated for the research project with variation in picking date, bearing, sun exposure, bio-dynamic preparations and ageing after storage. Quality measurements included traditional methods used routinely to assess apple quality and also experimental parameters which are expected to be relevant for vital quality. The experimental parameters appeared to supplement the traditional parameters in a consideration of quality. The concept of 'vital quality' is a valuable one for the consideration of wider aspects of quality within organic farming systems and should be further developed.

Keywords: food quality, vitality, structure, coherence

INTRODUCTION

The commonly used concept of food quality, with its emphasis on external appearance and nutritional content is not sufficient for organic products and their market. The objective of the international 'Food Quality and Health Programme' started by the Louis Bolk Instituut in 2000 is to develop a contextual quality concept with appropriate measurable parameters, which correspond to the needs of organic producers, also defined.

In developing a quality concept for organic agriculture, the concept of quality must be related to the central paradigm of organic agriculture, which is to sustain life processes. Growth and differentiation can be considered the two basic processes of life and consequently a consideration of the integration and balance of growth and differentiation processes is central to the definition of the quality concept. Secondly the quality concept must be able to be communicated both to producer and consumer, who operate with different internal references. Producers who work with growing plants think in terms of life processes, which can be stimulated, restrained and balanced. However, the consumer and retailer think in terms of controllable and recognisable product attributes. Therefore the quality concept has two sides: life processes and product aspects; both are related. Additionally the quality concept must relate to the holistic health view of physicians and dieticians to enable the impact of organic products on health to be assessed.

All of these requirements have resulted in the development of a concept of 'vital quality' based on the life processes (growth and differentiation) and corresponding product attributes (vitality, structure and coherence). In this context vitality has been defined as resulting from growth processes, corresponding to the common use of the word to mean growth-full, young and lively. The more integrated use of the term 'vitality' in relation to health, in the sense of a harmonious balance between growth and differentiation and strong resistance and self-regulating abilities, has been incorporated within the integrated or contextual aspect of vital quality.

The aim of the programme is to develop a coherent quality concept for organic agriculture including the definition of measurable parameters. In the first instance the project therefore has not considered whether organic products are better than conventionally produced goods, and indeed what may be considered as 'better'. The apple was chosen as the first crop for study as the processes of growth and differentiation are well-known phenomena amongst fruit growers and the institute has experience with the crop.

MATERIALS AND METHODS

The research is based on analyses of apples (variety Elstar), specifically cultivated for the research project. We attempted to grow the apples in such a way that only one of the life processes would be affected between the two extremes within each series, while all other factors were standardised as much as possible. World wide research on apple quality was used to determine which aspects should be standardised to reduce unwanted variation. The series differed in picking date, bearing level, sun exposure, bio-dynamic preparations and ageing after storage.

Samples of 120 apples were collected (originating from at least 10 trees) and these were randomly divided into sub-samples (20 apples) for each laboratory undertaking analysis. Replicate field samples were not taken to reduce cost in the preliminary phase. To some extent the treatment series compensate for the lack of independent replication. Parameters included traditional measurements used to assess apple quality and also experimental parameters which are expected to be relevant for vital quality:

- Crop: soil, growth, bearing, diseases and plagues, leaf series, next years budding;
- Traditional: crop size, ground colour, blush colour, shine, firmness, starch, Brix, acid, N, P, K, Mg, Ca and dry matter;
- Vitamin C, phenolic compounds, amino acids and protein;
- Self-disintegration, taste, copper chloride crystallisation, capillary pictures;
- Two methods using biophotons;
- Electrochemical parameters: pH, redox potential, electrical resistance;
- Bovis value, determined using an observational technique.

Replicate measurements were made within sub-samples to investigate method variability. Problems due to high variability within the methods were only found with the self-disintegration test and the analysis of vitamin C, these analyses might be improved in the near future to enable their more routine use.

The risk of circular reasoning in our approach cannot be avoided completely. Our strategy was as follows: we attempted to cultivate apples in such a way that only one of the life processes would be affected per series. In this way we drew out the experimental parameters that seemed to be relevant for these life processes. The results were compared to the outcome of the traditional parameters and with the literature, to illustrate the relevance of our series. We also determined the relationships between the parameters. Finally all parameters were reviewed for their relation with the life processes and therefore with the concept of 'vital quality'.

RESULTS AND DISCUSSION

Ripening

For comparison within one treatment series, we chose to perform the analyses on the same day. For the series with 5 different picking dates (between September 1 and October 9) this means that early picking leads to a longer period of cold storage. This series therefore contrasts ripening on the tree with ripening in storage. The conversion of starch to sugar and loss of firmness occur both on the tree and during cold storage. Hence the process of ripening changes fruit with starch, acid and phenolic compounds into juicy fruit with soluble sugars and aromatic compounds. However, other aspects of ripening affecting colour, size and taste occur differently in storage or on the tree. The holistic methods show an increase in openness and 'facing outwards' during ripening on the tree. Ripening can be seen as a transition from vitality into structure and coherence. In contrast in cold storage, vitality is lost, but without an increase in structure and coherence, this is more an ageing than a true ripening process.

Bearing level

In June the trees were pruned to the desired bearing level 35, 75, 100, 125 and 140 fruit per tree (corresponding to 14, 30, 40, 50 and 60 tonnes apples per hectare). Due to the favourable season for apple production both the 100 and 125 fruit per tree levels showed optimal taste and flowerbud formation. As widely observed there is a strong relationship between higher bearing and decreased twig onset, lower leaf/fruit ratios and reduced flowerbud formation for the next season. The impact of high bearing on fruit quality was shown by the dilution of all parameters associated with assimilation and mineral uptake: dry matter sugar, sourness, aroma and mineral uptake were all reduced. However, Ca levels and the Ca/K ratio, which indicate storage potential also increased at high bearing, this is also commonly found.

The copper chloride images of apples from low bearing trees gave a powerless and vegetative impression, while apples from high bearing trees gave poor sharply outlined impressions. Average bearing gave rise to the most vital and differentiated images. The capillary pictures were sharper at high bearing. The biophoton level decreased directly after excitation (a measure of vitality) and the hyperbolicallity increased (a measure of the differentiation/growth ratio) in the high bearing trees. High bearing therefore resulted in a decrease in vitality and an increase in structure.

Sun exposure

During harvest, separate apples were picked hanging either in full sunlight, complete shadow or between these extremes. We harvested two sunlight series, one with and one without biodynamic preparations. The sun exposure levels of both series were comparable. Apples grown in the sun gave rise to increased colour, phenolic compounds and biophotons (all which measure the differentiation/growth ratio), a broader colour spectrum with biophotons (a measure for fruit typicality), higher protein/amino acid ratios, more coherence and transparency in copper chloride crystallisation images and more round open shapes in the capillary pictures (all measures for increased integration). Surprisingly no difference was found in taste, firmness, calcium or acidity. However, of interest and a new finding were the much higher levels of N, P, K, amino acids and proteins in the shade grown fruit. This resulted in a higher Ca/K ratio for the sun-exposed fruit which corresponds with the experience that sun-exposed fruit stores better. It seems that sun-exposure stimulates differentiation resulting in an increase in structure and coherence.

Biodynamic preparations

One part of the orchard received no biodynamic preparations, the other half was treated twice with a cow manure preparation and twice with a silica preparation. The sunlight series was gathered from both parts of the orchard. Traditional parameters like colour, taste, firmness, minerals, starch, acid and pH revealed no difference between apples with and without preparations. However, a couple of experimental parameters linked to either differentiation or integration did reveal differences e.g. phenolic compounds, protein/amino acid ratio, electrical resistance, broader colour spectrum with biophotons, increased transparent copper chloride crystallisation mages and Bovis-value. These effects were not however observed at all levels of sun exposure, making it hard to draw firm conclusions. The light and preparation series are combined as we expected preparations to have an effect similar to that of sun exposure and would enhance the integration process. These results are not sufficient to evaluate this hypothesis and further work is needed.

Shelf life

The apples of the fourth picking date remained in cold storage for three months and were taken out at different time intervals. This resulted in a shelf life series of 1, 4, 8 and 12 days. As is commonly known and was found here too, firmness and acidity clearly decrease during ageing while the sugar level remains constant for some time due to remobilisation. Practically all parameters indicated a limited ageing, but not as severe as we had anticipated. The series was not extreme enough and, in retrospect, we should have included longer shelf-lives to obtain a real image of decay. As the apples grew older the needle structure of the crystallisation images developed more and more towards the periphery. Surprisingly apples only one day out of cold storage were judged by a lot of parameters to be less good than those 4 days out of cold storage. Apples seem to need to acclimatise to altered conditions after cold storage (and/or transport) for a

couple of days. This series did not enable the quality concept to be considered as all the parameters vitality, differentiation and integration decreased. These change in life processes are not distinguishable in shelf-life series.

CONCLUSION

Research indicates that as well as the two life processes (growth and differentiation) it is meaningful to consider integration as a third aspect alongside these two processes. Using measurements of the quality of apples grown in particular ways, this work has shown that the experimental parameters appeared to supplement the traditional parameters in a consideration of quality and enrich our vision. The concept of 'vital quality' is a valuable one for the consideration of wider aspects of quality within organic farming systems and should be further developed.

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REFERENCES

Further information and reference for all the methods discussed can be obtained from the report:

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