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# Presence of metals in herbal extracts

Do metals from raw herbs transport into herbal preparations during manufacture?

Amira Guirguis, Jade D. Owen and Jacqueline I. Stair

Do metals from raw herbs transport into herbal preparations during manufacture? **Amira Guirguis** and colleagues take a look at the issue using St John's wort as an example

Herbs have been in use for a variety of therapeutic purposes since antiquity. Despite enormous progress in medicinal science, the popularity of herbal remedies remains high. In the UK, sales of natural medicinal products, including herbal remedies, are expected to reach £780m by 2016.<sup>1</sup> Herbal medicines are chemically complex, containing numerous active ingredients with often synergistic properties, making them difficult to characterise and study. However, sustained interest in herbal medicines is, in part, due to the widespread belief that "natural" products are safer. One area of concern has been the contamination of herbal products from toxic heavy metals such as arsenic, cadmium, lead and mercury. A study of 260 Asian patent medicines obtained from California herbal retailers showed that products had concentrations up to 114,000ppm of arsenic, and 5,070ppm of mercury.<sup>2</sup> Although some metals are added to products through adulteration, many herbs are metal accumulators and take up both essential and non-essential metals from the environment during growth.

## Metals in St John's wort

One herbal medicine that is a well known metal accumulator is *Hypericum perforatum*, commonly known as St John's wort, which is in widespread use for the treatment of mild to moderate depression. Currently, St John's wort is standardised according to the pharmacologically active ingredients: hypericins, hyperforin and flavonoids (eg, rutin). Metals can bind to these active ingredients forming complexes, which can alter their medicinal properties. For example, iron can cause the oxidation of hypericin.<sup>3</sup>

Also, the antioxidant properties of rutin were shown to increase when complexed with iron and copper.<sup>4</sup> In summary, the metal composition can potentially alter the therapeutic effect of St John's wort and other herbal medicines. This is important for pharmacists in their role to provide patients and customers with medicinal products that have consistent therapeutic margins. Because many herbal products contain an extract, this study aimed to investigate changes in metal content when an extract is prepared from St John's wort using different solvents.

## Method

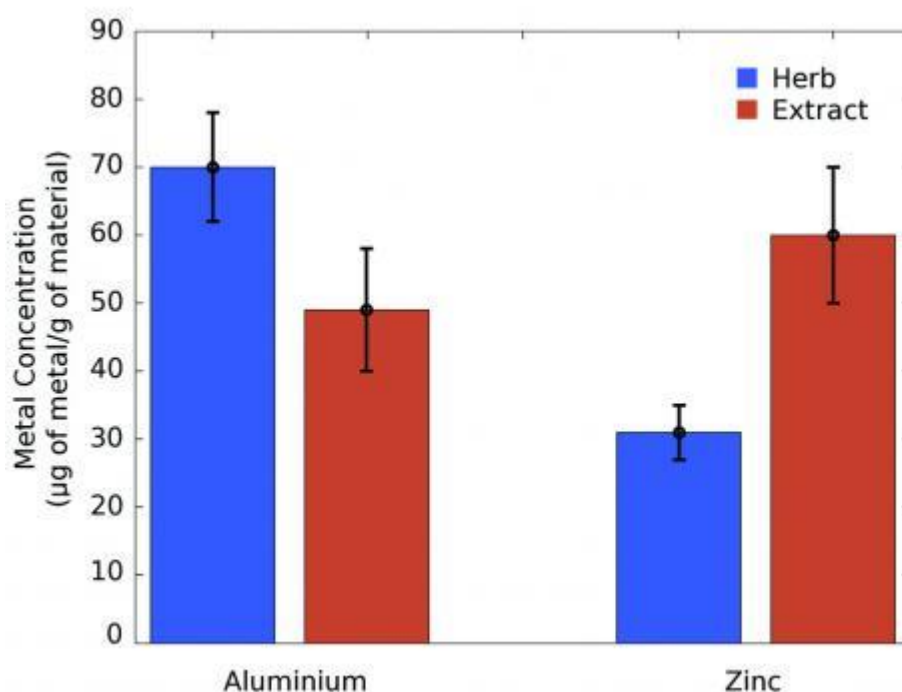
The extracts were prepared from St John's wort (sourced from Hungary and Spain) using three solvents: water, 50:50 methanol:water, and methanol. The herbs were soaked, macerated using ultrasonication, filtered and then re-extracted. The resulting liquid extracts were then evaporated to dryness and the organic material digested using concentrated nitric acid. The herbs themselves were also digested for comparison. The samples were then analysed for 11 metals (aluminium, barium, calcium, copper, iron, magnesium, manganese, nickel, strontium,

titanium and zinc) using inductively coupled plasma-optical emission spectroscopy (ICP-OES). All measurements were in triplicate; mean and standard deviation (SD) are reported.

## Results and discussion

The concentrations of the 11 metals monitored ranged from 1.7–4,200 and 5.3–7,700 $\mu\text{g}$  of metal per gram of herb for the Hungarian and Spanish St John's wort, respectively. The metal content transferred from the herb to the final extract was between 5 and 24 per cent. For example, the metal content transferred from the Hungarian herb to water, 50:50 methanol:water and methanol was 24 per cent (SD 8), 20 per cent (SD 1), and 14 per cent (SD 17), respectively. The metal content transferred from the Spanish herb to water, 50:50 methanol:water and methanol was 5 per cent (SD 3), 13 per cent (SD 4) and 22 per cent (SD 3), respectively.

The resulting metal concentrations in the extract decreased or increased in comparison with the dry herb, depending upon the metal and herb sample. For example the Hungarian herb concentration of aluminium decreased ( $t[4]=3.02$ ,  $P<0.05$  [two-tailed]), whereas that of zinc increased ( $t[4]=4.66$ ,  $P<0.05$  [two-tailed]) (Figure 1). Furthermore, metal selectivity was influenced by the extraction solvent and herb sample; manganese/copper selectivity of Spanish herb extracts increased from 5 (SD 3) for water to 18 (SD 6) for methanol ( $t[4]=3.36$ ,  $P<0.05$  [two-tailed]).



Processes such as liberation from the plant matrix and solubility contribute to the transfer of metals from the plant into the extraction solvent. Solubility depends on the form of the metal (ie, whether the metal exists in a free or complexed form). For example, hypericin has been shown to complex iron, and rutin has been shown to complex copper, iron and lead.

Our study has demonstrated that metal transfer from herb to final extract is both sample-dependent and solvent-dependent. More work is needed to establish typical metal transfer values for St John's wort using a large number of samples and additional solvent mixtures. The elucidation of metal form in St John's wort formulations (ie, before and after administration to patients) will be important for a better understanding of the roles of metals in medicinal products.

Pharmacists should continue to educate patients about self-medication and online purchases of non-registered products, particularly in the case of herbal medicines classified as food products, since these do not contain patient information leaflets.

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