

## Quantification of Lawsone and Adulterants in Commercial Henna Products

**Authors :** Ruchi B. Semwal, Deepak K. Semwal, Thobile A. N. Nkosi, Alvaro M. Viljoen

**Abstract :** The use of *Lawsonia inermis* L. (Lythraeae), commonly known as henna, has many medicinal benefits and is used as a remedy for the treatment of diarrhoea, cancer, inflammation, headache, jaundice and skin diseases in folk medicine. Although widely used for hair dyeing and temporary tattooing, henna body art has popularized over the last 15 years and changed from being a traditional bridal and festival adornment to an exotic fashion accessory. The naphthoquinone, lawsone, is one of the main constituents of the plant and responsible for its dyeing property. Henna leaves typically contain 1.8-1.9% lawsone, which is used as a marker compound for the quality control of henna products. Adulteration of henna with various toxic chemicals such as p-phenylenediamine, p-methylaminophenol, p-aminobenzene and p-toluenodiamine to produce a variety of colours, is very common and has resulted in serious health problems, including allergic reactions. This study aims to assess the quality of henna products collected from different parts of the world by determining the lawsone content, as well as the concentrations of any adulterants present. Ultra high performance liquid chromatography-mass spectrometry (UPLC-MS) was used to determine the lawsone concentrations in 172 henna products. Separation of the chemical constituents was achieved on an Acquity UPLC BEH C18 column using gradient elution (0.1% formic acid and acetonitrile). The results from UPLC-MS revealed that of 172 henna products, 11 contained 1.0-1.8% lawsone, 110 contained 0.1-0.9% lawsone, whereas 51 samples did not contain detectable levels of lawsone. High performance thin layer chromatography was investigated as a cheaper, more rapid technique for the quality control of henna in relation to the lawsone content. The samples were applied using an automatic TLC Sampler 4 (CAMAG) to pre-coated silica plates, which were subsequently developed with acetic acid, acetone and toluene (0.5: 1.0: 8.5 v/v). A Reprostar 3 digital system allowed the images to be captured. The results obtained corresponded to those from UPLC-MS analysis. Vibrational spectroscopy analysis (MIR or NIR) of the powdered henna, followed by chemometric modelling of the data, indicates that this technique shows promise as an alternative quality control method. Principal component analysis (PCA) was used to investigate the data by observing clustering and identifying outliers. Partial least squares (PLS) multivariate calibration models were constructed for the quantification of lawsone. In conclusion, only a few of the samples analysed contain lawsone in high concentrations, indicating that they are of poor quality. Currently, the presence of adulterants that may have been added to enhance the dyeing properties of the products, is being investigated.

**Keywords :** *Lawsonia inermis*, paraphenylenediamine, temporary tattooing, lawsone

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