

Determination of Arsenic, Cadmium and Lead Elements in Chewing Sticks (Miswak) Using ICP-MS

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Abstract: *Salvadorapersica* (Miswak) is used in many parts of the world as a tool for the cleaning of teeth and general oral hygiene. This material is imported into the United Kingdom, from countries in Africa, Asia and the Middle East, and is sold in ethnic shops. They are popular amongst members of certain ethnic communities. Very little is known about the trace elements content of chewing sticks and their possible impact on human health. Therefore, in the current study, a survey of trace elements composition of chewing sticks, sold in ethnic shops (in Leicester, Birmingham, Luton, London) and some Libyan cities was carried out using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). We determined the content of arsenic (As), cadmium (Cd) and lead (Pb) in both the bark (which is often removed before chewing) and the flesh components of twigs from *Salvadorapersica*. After cleaning, the samples were dried and digested using a microwave digester and the content of heavy metals analysed by ICP-MS. Concentrations of As, Cd and Pb were 0.038, 0.15 and 2.18 (mg/kg, mean value) for the flesh and 0.11, 0.28 and 3.88 (mg/kg) for the bark, respectively. The content of As was found to be the lowest whereas the content Pb was highest for both the flesh and the bark components. Concentrations of these elements in the bark were significantly higher compared to the flesh. The precise reason for this is not clear although it could partly be due to air pollution or contact with soil. It is therefore recommended that users take extra care to fully remove the bark before using the chewing stick. Further studies are in progress to identify the role of environmental and processing conditions on the content of heavy metals in chewing sticks.

Keyword: *Miswak, Chewing sticks, Arsenic, Cadmium, Lead.*

I. Introduction

Arsenic, cadmium and lead are non-essential elements and they are harmful for human beings [1]. These elements are considered to be some of the most toxic elements in the world; they can interrupt the functioning of major human organs such as kidney and lungs. Also it has been reported that there is a correlation between Pb exposure and neurotoxicity [2]. These elements can increase the generation of reactive oxygen species (ROS), which may have harmful effects at the cellular and organ level [1]. Human exposure to these elements via different routes such as water and foods can lead to diverse disease processes. However, intake of these elements from non-food sources such as chewing stick (*Salvadorapersica*) are often overlooked although they may be a contributory factor in the development of disease and this requires further investigation.

Miswak (Arak, *Salvadorapersica*) is one type of chewing sticks. It is a well know small upright evergreen tree or shrub in the Middle East, Africa and the Indian subcontinent [3] the plant has a high tolerance for salinity and can live in arid land, surviving on little moisture in soil. The tree is considered as slow growing tree. It has a crooked trunk which grows more than one foot in diameter reaching maximum height of three meters. The bark is scabrous and cracked, whitish with pendulous extremities.

The root bark of the tree is light brown and the inner surfaces are white, odour is like cress and the taste is warm and pungent. The leaves are small, oval, thick and succulent with a strong cress or mustard. The fresh leaves are eaten as salad and are used in traditional medicine for cough, asthma, scurvy, rheumatism, piles and other diseases. The flowers are small and fragrant and are used as a stimulant and mildly purgative [4,5]. Pencilsized stick of various plants of 10-25 cm long with diameter 1- 2 cm is prepared from the root, stem, twigs or bark [6,7].

Miswak is preferred over others and used popularly due to its flavour, texture and effectiveness in cleaning. It can be easily crushed between the teeth; it appears to have phloem in its stem and roots, which makes the stick spongy. Its sticks consist of fine fibres, which when frayed, become brush-like (see figure 1).



Figure 1: Chewing stick "Miswak" as ready to use.

Miswak as a plant contains these toxic elements which may come for different sources including soil, water, air and others. Also contamination of plant can be assessed by measure toxic elements in the plant to give a good view as a biomonitors of these elements. Many studies have measured trace elements in biomonitors such as lichens [8,9], mosses and tree barks [10-13]. These biomonitors are useful tools and they can illustrate distributions on geographic maps [14,15] and also their progress over time. In the present study, concentrations of As, Cd and Pb in different types of chewing sticks were determined, which are commonly used for teeth cleaning amongst a number of the UK population and it is on sale in ethnic shops in the UK cities and also in some Libyan shops.

II. Materials And Methods

2.1. Sample Collection And Sample Preparation

Miswak samples (10 types), originating mainly from Africa, Asia and the Middle East countries. These types were including Neem (*Azadirachta indica*), Zaitoon (*Olea europaea*), kikar (*Acacia arabica*), Khiran (*Capparis aphylla*), lime tree (*Citrus aurantifolia*) and Chaw stick (*Gouania lupuloides*). These samples were purchased from ethnic shops (in Leicester, Birmingham, Luton, and London) in the UK and some from Libyan cities (Tripoli and Sabha city) was carried during 2009 and 2010. These types of Miswak are more used amongst Muslim communities in the UK and Libyan population in Libya.

Samples were divided to two groups, the sticks of first group were peeled and separated to flesh and bark without washing, however, the second group were soaked in tap water overnight, then peeled and separated to flesh and bark. All different samples were dried and ground by using coffee grinder, and then were kept at 4°C for the digestion.

For sample digestion, a dry ground weight (0.3 - 0.5 g) of sample was mixed with 4 ml of 70% nitric acid (HNO_3) (Romil-UpA, Ultra Purity acid) and 2 ml of hydrogen peroxide (H_2O_2) and then digested for 40 minutes using a microwave digestion unit at a maximum temperature of 170°C (CEM, Microwave digestion MAR Xpress, USA). The digested solution was evaporated to dryness and then diluted to 25 ml in volumetric flasks with ultra-pure water (Romil-UpS, Ultra Purity water) for analysis.

2.2. Element Measurement

Total concentrations of As, Cd and Pb in the digested samples were determined by inductively coupled plasma mass spectrometry (ICP-MS) (A Thermo-Fisher Scientific X-SeriesII) at Nottingham University. Details of ICP-MS conditions used are similar to those previously reported Al-Rmalli et al., (2011) [16].

III. Results

3.1. Quality Control And Standard Reference Material

As, Cd and Pb concentrations obtained by ICP-MS technique were evaluated by the use of certified reference materials and were found to be in good agreement with the certified values of the reference material. The analytical procedure and the reliability of the digestion process of chewing sticks were validated by analysis of NIST standard reference material (tomato leaves NIST 1573a SRM, USA). Average recoveries of As and Cd from the reference material were 92, 89% of the certified values (certified values of As and Cd are 0.112 ± 0.004 and 1.52 ± 0.04 mg/kg), respectively. However, for Pb a certified reference material (Seaweed CRM 9, NIES, Japan) was used, and the recovery was 93% of the certified values (certified value of Pb is 1.35 ± 0.05 mg/kg).

3.2. Concentrations of As, Cd and Pb in Miswak

Various types (10 types) of miswak were collected in this study, and 63 samples of these types were analysed. As, Cd and Pb concentrations in these samples were determined for both miswak sticks without wash and overnight soaking in water (Table 1). Samples were divided to two groups, flesh and bark of miswak. From Table 1 mean (SD) of As, Cd and Pb were 0.042 (0.03), 0.164 (0.10), 2.078 (1.49) mg/kg for flesh and 0.128 (0.13), 0.283 (0.18), 4.344 (1.91) mg/kg for bark, respectively.

Table 1: Distractive Statistics Including Mean, Standard Division And Percentiles Of Non-Essential Elements (mg/kg) In Chewing Stick (All Samples, N = 63).

	Mean ± SD	10 th	25 th	50 th	75 th	90 th
Miswak Flesh						
As	0.042 ± 0.03	0.013	0.020	0.027	0.063	0.114
Cd	0.164 ± 0.10	0.043	0.074	0.179	0.254	0.336
Pb	2.078 ± 1.49	0.429	0.595	1.983	2.81	3.668
Miswak bark						
As	0.128 ± 0.13	0.031	0.044	0.081	0.194	0.256
Cd	0.283 ± 0.18	0.061	0.114	0.297	0.400	0.588
Pb	4.344 ± 1.91	0.495	0.974	1.913	7.709	15.776

Results showed that bark contains higher toxic elements than flesh. Bark may be exposed to contamination more than flesh from different sources, whereas, elements in flesh mainly depend on uptaking of plant from soil. Median (50th percentile) were lower than mean values for As concentrations for both flesh and bark, median of As were 0.027 and 0.081 mg/kg for flesh and bark, respectively. Also table-1 represents data of percentiles which illustrate the data distribution and outlet values.

3.3. Soaking Effect In Concentrations Of As, Cd And Pb In Miswak.

Concentrations of As, Cd and Pb for both flesh and bark were determined, the chewing sticks samples were collected from shops (without washing), however, some of them were soaked overnight in water and then analysed. Generally, sticks which were soaked overnight in water contain lower toxic elements than sticks without washing (Figures 2, 3, 4).

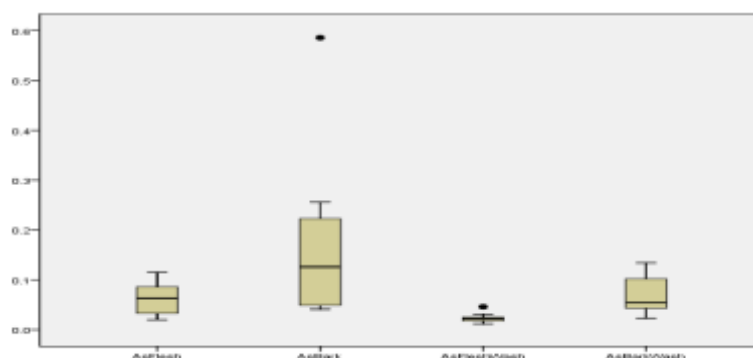


Figure 2: Comparison of As concentrations (mg/kg) in flesh and bark of chewing stick before and after overnight soaked in water.

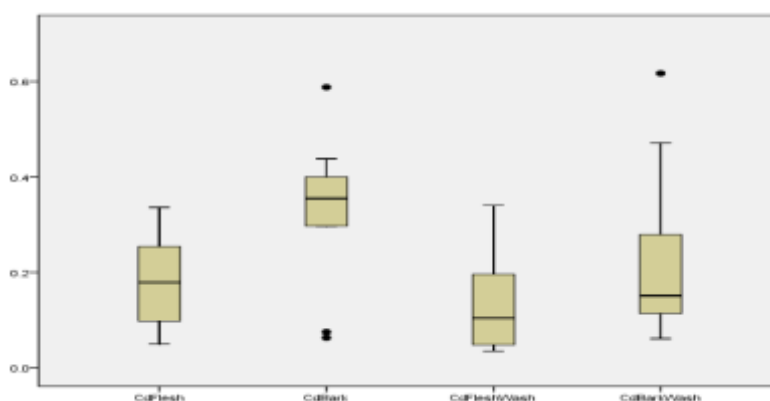


Figure 3: Comparison of Cd concentrations (mg/kg) in flesh and bark of chewing stick before and after overnight soaked in water.

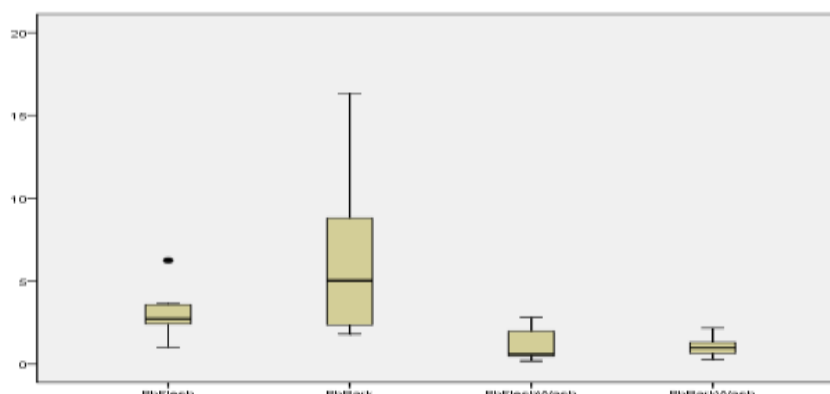


Figure 4: Comparison of Pb concentrations (mg/kg) in flesh and bark of chewing stick before and after overnight soaked in water.

Concentrations(mean (mg/kg) \pm SD) of As for non-washing sticks were (0.062 \pm 0.04) and (0.175 \pm 0.17) for flesh and bark, respectively, however, for overnight soaked sticks were (0.023 \pm 0.01) and (0.069 \pm 0.04)for flesh and bark, respectively. Concentrations of Cd for non-washing sticks were (0.186 \pm 0.10) and (0.320 \pm 0.17) for flesh and bark, respectively, however, for overnight soaked sticks were (0.137 \pm 0.11) and (0.234 \pm 0.19) for flesh and bark, respectively. Concentrations of Pb for non-washing sticks were (3.00 \pm 1.49) and (7.19 \pm 5.58) for flesh and bark, respectively, however, for overnight soaked sticks were (1.18 \pm 0.92) and (1.06 \pm 0.58) for flesh and bark, respectively.

IV. Discussion

Chewing sticks have been used for centuries as a tooth cleaning device. One of the most commonly type used is known as the miswak. Miswak is an oral hygiene aid and in widespread use even beyond the Arab world. The World Health Organization has recommended and encouraged the use of these sticks as a tool for oral hygiene in areas where their use is customary[17].

Miswak has been extensively studied in terms of pharmacological activity of its major components, and the results indicate potent antimicrobial, anticonvulsant, analgesic, ace-inhibiting, antimycotic, hypolipidemic, antiplasmodial, antibacterial, antiulcer, topical medicament, locomotor activities. However, no study has been done for determined toxic elements in chewing sticks in the UK. Very little information is available in the literature about the toxic element contents of chewing sticks.

In this paper, ten types of chewing sticks were analysed, and As, Cd and Pb elements in these samples were determined by using ICP-MS technique. The important findings in the current study were that chewing stick bark contains higher levels of toxic elements than flesh. Soaking of chewing stick overnight in water can reduce (2 -3 times) the toxic concentrations in both flesh and bark.

Tree bark can be biomarkers of traffic emissions for trace elements and other pollutants. It is reported that tree bark from the industrial zone and traffic environments have similar enrichments in trace elements. Arsenic concentration is dependent upon the soil's levels of arsenic contamination, and thus varies from approximately 0.01 to approximately 1.5 mg/kg (dry weight basis) in the case of those plants living in uncontaminated soils [18]. Results were obtained from the current study shown that As concentrations of chewing sticks within the range of uncontaminated area (see Fig. 2).

Gueguen et al. (2012) [13] has reported that concentrations of As and Cd in tree bark ranged 0.1-2.0 and 0.05-3.2 mg/kg, respectively for unpolluted areas. Whereas, Pb concentration was upto 125 mg/kg for rural areas, however, it was 657 mg/kg for industrial and traffic areas. Environments suffering from metallurgical emissions show high enrichments in Cd, Pb and other trace elements. It has been published that Cd concentrations are much higher in the industrial zone than close to traffic or in other urban or rural environments. Comparing to our results of As, Cd and Pb in both flesh and bark of chewing sticks, our results shown similar or lower concentrations for elements to that tree grown in uncontaminated soils, this lead to say chewing sticks that measured in the present study were collected from uncontaminated areas. Furthermore, chewing stick bark contained higher toxic elements than flesh one (wood part).

V. Conclusion

Miswak is one of the most commonly type of chewing sticks used around the world. It has been extensively studied in terms of pharmacological activity of its major components; the use of these sticks can be a good tool for oral hygiene. However, no study has been done for determined non-essential elements in Miswak. In the current study, As, Cd and Pb elements in the ten types of chewing sticks were determined by

using ICP-MS technique. Results obtained show that chewing stick bark contains higher levels of toxic elements than flesh. This could partly be due to air pollution or contact with soil. Soaking of chewing stick overnight in water can reduce (2 -3 times) the non-essential concentrations in both flesh and bark. It is therefore recommended that users take extra care to fully remove the bark before using the chewing stick and soak it overnight in water before using it.

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