Estimation the Presence of Heavy Metals and Trace Elements in Indian Herbal Cosmetics by Atomic Absorption Spectrophotometer

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Abstract

Heavy metals are identically Pb, Cd and micronutrients elements like Ca, Mg, Al, Cu and Zn were quantitatively estimated using Flame Atomic Absorption Spectrometry (FAAS). Similarly, heavy metals such as As and Hg were quantitatively estimated by Hydride Generation Technique i.e. Cold Vapor Atomic Absorption Spectrometry method expending nitrogen as carrier gas in 30 herbal cosmetic preparations available in Indian markets. The results designate that among the toxic heavy metals. In the present study, Arsenic was found significantly well below the permissible limit, but Cd was found above the permissible limit in all the samples. Trace elements like Ca and Mg were found in higher amount than compare to Al, Cu, and Zn. Presence of trace elements can corroborate to be beneficial but existence of toxic heavy metals in such amounts certainly has adverse effects on the consumer health who always take the herbal products in an impression of being safe because of the natural origin. In conclusion, execution of strict and isolated regulatory guidelines and promotion of Good Analytical Practice (GAP), Good Manufacturing Practices (GMP) and Good Agricultural and Control Practices (GACP) is suggested for herbal cosmetics by WHO and other regulatory agencies. This study presents the status of heavy metals and trace elements in marketed herbal cosmetic formulations and provides a simple and convenient AAS method which can effectively be adopted at Industrial level for the quality control and standardization of herbal cosmetic preparations and other related products.

Keywords: Herbal cosmetics, WHO, GMP, AAS, Trace elements, Heavy Metals.

Introduction

Herbal medicines have been recognised and have been used from years throughout the world by physicians and patients due to their potential therapeutical effect and their fewer side effects.1-2 These preparations are the most treasured products consist of natural components which are used for personal use, called as head to heal. Herbal cosmetics are the valuable products contain the high rich of active constituents of plants active ingredients which enrich the skin with trace (nutrient) elements and other useful minerals, prevent from infection and hence responsible for their cosmetic effects. Even though the herbal preparations are safe, but some of herbal preparations cause serious poisoning and toxic effect due to the preparation containing dangerous toxic drugs or heavy metals. World Health Organization (WHO) and other health organizations currently encourage, recommended and promote traditional herbal preparation in National Health Programs because such drugs are easily available at low cost and are comparatively safe.

According to the WHO, heavy metals concentration of herbal preparation must be controlled. In this case Health Canada...
has taken the initiative and implemented a few measures to control heavy metal concentrations and acceptable determined limits i.e. Lead 10 ppm, Arsenic 3 ppm, Mercury 3 ppm, Cadmium 3 ppm, Antimony 5 ppm. In the present study, 9 elements, As, Hg, Cd, Pb, Cu, Al, Zn, Ca and Mg were estimated quantitatively in 30 herbal cosmetic samples. The details are given in Table-1.

Table No. 01: Herbal Cosmetic Product formulation(s) and detail(s):

| SL No | Composition of Formulations | Uses of the formulation | Sample code |
|-------|-----------------------------|-------------------------|-------------|
| 1     | Prunus aemumic, Glycyrrhiza glabra, Avena sativa. | Remove dark spots and blemishes. | 1.0 |
| 2     | Aloe barbadensis. | Useful in skin darkness and dryness. | 2.0 |
| 3     | Ocimum sanctum | Antiseptic, Antifungal, Cleansing pores. | 3.0 |
| 4     | Carica papaya | Heals damages skin, Control oil of skin. | 4.0 |
| 5     | Flagarriavesca | Remove skin dead cells and impurities. | 5.0 |
| 6     | Rosa, Trigonellafoenum graecum, Santalum album | Improve the complexion, Skin pore cleansing and revitalizing. | 6.0 |
| 7     | Citrus sinensis | Astringent, Moisturizer, Scars, Acne, Smoothness. | 7.0 |
| 8     | Rosa, Santalum album | Anti-aging, Tone up the skin, Tighten the pores. | 8.0 |
| 9     | Citrullus lanatus | Moisturizer, Refresher, Skin toner and tighter. | 9.0 |
| 10    | Solanum xantiocarpum | Antiaging, Skin cleansing. | 10.0 |
| 11    | Citrus limon | Skin nourishment, Cleansing and moisturizing. | 11.0 |
| 12    | Citrus sinensis, Carica papaya, Malus domestica, Prunus serotina, Fragaria vesca, Citrus limon, Punica granatum, Prunus persica. | Pimplces, Antiaging, Skin cleansing, Softening. | 12.0 |
| 13    | Citrus limon, Crocus stivus, Curcuma longa, Santalum album. | Depigmentation, Skin cleaning and fairness. | 13.0 |
| 14    | Azadiractaindica | Antiaging, Skin softening. | 14.0 |
| 15    | Rosa, Prunus amygdalus, Crocus stivus, Citrus limon, Curcuma longa, Santalum album. | Fairness, Softness | 15.0 |
| 16    | Embeliaires, Rubi cordifolia, sidecordifolia, Acacia catechu, Valerianajatamansi, Swarna gairik, Acorus calamus, Psoraleacorylifolia, Aloe barbadensis, Curcuma longa, Azadiractaindica, Santalum album. | Acne, Pimple and blemishes. | 16.0 |
| 17    | Elettiericardamum, Valerianajatamansi, Glycyrrhiza glabra, Vettiveriianzaniodes, Moringaoleifera, Cyperusscariosus, samudraphen, Pavoniaodora, Cinnamonumglanzescens, Curcuma longa, Azadiractaindica, Santalum album. | Skin fairness and glowness. | 17.0 |
| 18    | Symplocosracemosa, Punica granatum, Mangifera indica, Azadiractaindica. | Fairness | 18.0 |
| 19    | Curcuma longa, Santalum album. | Antifungal, Antiseptic. | 19.0 |
| 20    | Aloe barbadensis | Anti-aging, dehydration of skin. | 20.0 |
| 21    | Citrus limon, Triticum stivum, Glycyrrhiza glabra, Calendula officinalis, Aloe barbadensis, Curcuma longa, Azadiractaindica, Santalum album. | Detoxifying and nourishment of skin. Protect from sunlight. | 21.0 |
| 22    | Azadiractaindica, Curcuma longa, Santalum album | Antifungal, Antiseptic. | 22.0 |
| 23    | Rubiaceordifolia, sidecordifolia, Swarna gairik, Acorus calamus, Psoralea cordifolia, Aloe barbadensis, Curcuma longa, Azadiractaindica, Santalum album, Rosa | | 23.0 |
| 24    | Ocimum sanctum, Honey (saccharine liquid) | Antiseptic, Antifungal | 24.0 |
| 25    | Rosa, Prunus amygdalus, Crocus stivus, Citrus limon, Curcuma longa, Santalum album, Crocus stivus | | 25.0 |
| 26    | Rosa, Santalum album, Fragaria vesca, Carica papaya | Fairness, Softness | 26.0 |
| 27    | Citrullus lanatus, Citrus limon | Antiseptic | 27.0 |
| 28    | Elettiericardamum, Valerianajatamansi, Valerianawallichii, Vettiveriianzaniodes, Glycyrrhiza glabra, Moringaoleifera, Cyperusscariosus, samudraphen, Brassica compestris, Saussurealappa | Skin fairness and glowness | 28.0 |
| 29    | Santalum album, Azadiractaindica | Antiseptic, Antifungal | 29.0 |
| 30    | Symplocosracemosa, Punica granatum, Mangifera indica, Azadiractaindica, Curcuma longa, Santalum album. | Fairness | 30.0 |

**MATERIAL AND METHOD**

**Instrument**- Atomic absorption spectroscopy (EC Electronics Corporation of India Limited AAS Element AS AAS-4141) equipped with a deuterium lamp for background correction was used for determination of trace elements and heavy metals.

**Sample**- 30 samples of marketed herbal preparations were collected. The brand names were given the codes serially. The details are given in Table-1.
Reagents and Chemicals

Nitric acid (SDFCL, Mumbai), Hydrochloric acid (SDFCL, Mumbai), Sulphuric acid (SDFCL, Mumbai), Hydrogen peroxide (Merck Millipore), Sodium borohydride (Sigma-Aldrich), Stannous chloride (Sigma-Aldrich). Water used in all experiments was ultrapure water from Milli-Q-water purification system. The standard solutions were prepared in five different concentrations to obtained calibration curve by diluting stock solutions of 1000 ppm of each element. Sample was removed from the hot plate if effervescence becomes excessively vigorous. Further 30% hydrogen peroxide was added in 1 ml increments, followed by gentle heating until the effervescence was subsides. 5 ml of concentrated hydrochloric acid and 10 ml of deionized water was added and the sample was heated for another 15 min without boiling. The sample was cooled and filtered through a Whatman No. 42 filter paper and diluted to 50 ml with deionized water.

Sample preparation:

10 mL of nitric acid was added to 2 g of accurately weighed dried sample in a 100 mL beaker and was heated on a hot plate at 95°C for 15 min to digest by wet digestion method. The digest sample was cooled and added 5 mL of concentrated nitric acid and heated for another 30 min at 95°C. The heating steps were repeated until reduced to 5 mL. The sample was again cooled and added 2 mL of deionized water and 3 mL of 30% hydrogen peroxide. Close the beaker and sample was heated gently to start the peroxide reaction.

Sample analysis:

Prepared samples were analyzed for Cd, Pb, Cu, Al, Zn, Ca and Mg by using flame atomic absorption spectrophotometer and for As, Hg by using hydride generation technique. Hg was analyzed by cold vapor atomic absorption spectrometry. The 1000 ppm standard solutions of elements were diluted in 5 different concentrations to obtain calibration curve. All the measurements were run in triplicate for the samples and standard solutions for to obtain the robust value. The instrumental conditions during the analysis of trace and heavy metals are listed in table-2.

Table No. 02: Instrumental condition for Analysis:

| Element Names | Current (mA) | Slit width (nm) | λmax (nm) | Flame Colour | Flame type | AAS Performance |
|---------------|-------------|----------------|-----------|--------------|------------|----------------|
| Ca            | 3.5         | 0.5            | 422.5     | Orange       | Air/Acetylene | Flame         |
| Mg            | 3.5         | 0.5            | 285.0     | Orange       | Air/Acetylene | Flame         |
| Cu            | 5.0         | 0.5            | 325.0     | Blue         | Air/Acetylene | Flame         |
| Zn            | 5.0         | 1.0            | 214.0     | Blue         | Air/Acetylene | Flame         |
| Al            | 10.0        | 0.5            | 310.0     | Red          | Air/Acetylene/Di-Nitrogen Monoxide | Flame         |
| Cd            | 3.5         | 0.5            | 229.0     | Blue         | Air/Acetylene | Flame         |
| Pb            | 10.0        | 1.0            | 217.2     | Blue         | Air/Acetylene | Flame         |
| As            | EDL         | 1.0            | 193.9     | Blue         | Air/Acetylene | Hydride generation |
| Hg            | EDL         | 5.0            | 253.8     | -            | -          | Cold vapour    |

Recovery studies:

The accuracy of the method was performed as per ICH guideline by standard addition method at 3 different levels to demonstrate the validity of our method. A known amount of standard solutions containing As, Hg, Cd, Pb, Cu, Al, Zn, Ca and Mg were prepared and spiked with digested samples, after dilution of sample to 50 ml.

RESULTS AND DISCUSSION

The contents of trace elements are described in table-3 in the screened preparations as a mean of triplicate determination. The calcium concentrations varied from 153 to 16600 ppm, 8 samples having contents between 2520 and 5991 ppm. Sample 3 had the lowest calcium concentration and sample 16 had the highest. Calcium was also found below detectable limit in total seven samples. The copper concentrations varied from 2.7 to 50.1 ppm, most samples having contents between 9.2 and 23.1 ppm. Sample 20 had the lowest copper concentration and Sample 4 had the highest. The concentrations of copper were comparable in sample 6 and 7 with a range of 21.4-21.5, in 8 and 9 with a range of 20.2-21.2. The magnesium concentrations varied from 110 to 10.599 ppm, 12 samples having contents between 4601 and 8370 ppm while three samples, 19, 20, and 21 had the equal magnesium concentration 110 ppm. Sample 9 had the highest magnesium concentration. The zinc concentrations varied from 4.9 to 57.23 ppm, most samples having contents between 30.2 and 57.23 ppm. Sample 20 had the lowest zinc concentration and sample 12 had the highest. The concentrations of zinc were comparable in sample 8 and 10 with a range of 51.50 and 51.01 the same being true for sample code 18 and 11 at 47 and 47.05. The aluminum concentrations level ranged from 3891 and 5525 ppm, most samples having contents between 3891 and 5525 ppm. Sample 1 had the lowest aluminum concentration and sample 4 had the highest.
Among the heavy metals, data presented in Table 4 reveals that the mercury concentrations varied from 0.042 to 2.181 ppm, most samples having contents between 0.042 and 0.310 ppm. Sample 5 had the lowest mercury concentration and sample 18 had the highest. But mercury was found below detectable limit in eight samples. The concentrations of mercury varied from 0.042 to 0.310 ppm, most samples having contents between 0.042 and 0.310 ppm. Sample 21 had the lowest cadmium concentration and sample 24 had the highest. According to the WHO, the permissible limit for cadmium is 0.3 ppm in herbal preparations and unfortunately, all the herbal cosmetic products were found to contain cadmium concentration higher than the permissible limit. The lead concentrations level ranged from 1.468 to 33.1 ppm. Sample 4 had the lowest lead concentration and sample 21 had the highest. But lead was found below detectable limit in four samples. According to the WHO, the permissible limit for lead is 10 ppm. Six samples were contained Pb content above the permissible limit. The results of recovery study were within the acceptable range verifying the validity of proposed method for analysis (Table-5) and revealed that any small change in the drug concentration in the solution could be accurately determined by the proposed method.

In the present study, herbal cosmetic products were found to contain variable amounts of trace (nutrient) elements. The variation in concentration of these elements may be mainly due to compositional differences of products and environmental condition where constituent plant is grown, use of fertilizer, pesticides. But generally, it is concluded that the studied products are rich source of essential elements Mg, Ca, Zn, Cu, and Al and hence might play an important role in the maintenance of the skin nutritional requirements.

### Table No. 03: Metal content in herbal preparations:

| Sample ID | Ca (Mean ± SD) | Cu (Mean ±SD) | Mg (Mean ± SD) | Zn (Mean ± SD) | Al (Mean ± SD) |
|-----------|----------------|---------------|----------------|----------------|----------------|
| 1.0       | 2520±51.38     | 9.2±0.4       | 2899±495       | 52.0±30.30     | 130±4.94       |
| 2.0       | 5991±263.32    | 10.6±0.4      | 5118±877       | 51.97±30.8     | 4913±38.83     |
| 3.0       | 153±11.50      | 10.0±1.0      | 6285±51       | 50.12±0.40     | 5123±38.30     |
| 4.0       | BDL            | 50.1±0.6      | 7381±69       | 52.10±3.7      | 5525±28.62     |
| 5.0       | 790±223.00     | 49.0±0.1      | 6700±91.2     | 50.00±0.22     | 5159±35.70     |
| 6.0       | BDL            | 21.4±0.22     | 4601±31.56    | 34.52±7.23     | 3891±80.46     |
| 7.0       | 190±112.52     | 21.5±0.8      | 5155±160.91  | 40.01±0.25     | 4492±37.89     |
| 8.0       | 3177±310.22    | 20.2±0.56     | 4910±93.96   | 51.50±3.01     | 4501±90.00     |
| 9.0       | 3696±310.35    | 21.2±4.22     | 10599±8000   | 53.22±0.34     | 5002±1108.14   |
| 10.0      | BDL            | 23.2±0.7      | 8212±473.01  | 51.01±0.61     | 4289±37.84     |
| 11.0      | BDL            | 20.5±0.5      | 8370±311.25  | 47.05±0.43     | 4845±78.11     |
| 12.0      | 3722±200.11    | 23.1±0.9      | 7959±200.23  | 57.23±0.60     | 543±67.11      |
| 13.0      | 4352±190.11    | 20.12±0.45    | 5498±7100.3  | 50.89±0.21     | 4780±83.00     |
| 14.0      | 1506±2114.22   | 23.01±0.6     | 8300±75.0    | 50.69±0.43     | 575±15.86      |
| 15.0      | 1226±453.08    | 22.9±0.29     | 480±35.36    | 19.02±0.63     | 311±30.22      |
| 16.0      | 16600±452.4    | 21.22±0.7     | 2103±54.31   | 20.29±0.55     | 1131±79.06     |
| 17.0      | 4200±305.23    | 20.1±0.67     | 1372±15.96   | 30.2±0.36      | 808±92.45      |
| 18.0      | 4302±270.11    | 17.1±0.5      | 3510±114.33  | 47.0±0.15      | 3792±96.11     |
| 19.0      | BDL            | 15.1±2.41     | 110±0.63     | 6.77±0.12      | 324±72.96      |
| 20.0      | BDL            | 2.7±0.69      | 110±0.56     | 4.9±0.22       | 277±53.29      |
| 21.0      | BDL            | 4.5±0.2       | 114±0.32     | 6.9±0.53       | 229±55.20.05   |
| 22.0      | 190±114.02     | 210±0.65      | 5150±159.23  | 39.01±0.50     | 4452±51.39     |
| 23.0      | 1501±116.02    | 23.0±0.5      | 8300±80.2    | 50.2±0.03      | 580±1±0.02     |
| 24.0      | 2599±51.55     | 9.0±0.5       | 2970±92.5    | 51.66±0.55     | 125±6.82      |
| 25.0      | 791±321.11     | 47.69±0.7     | 6977±703.56  | 51.26±0.22     | 5196±38.03     |
| 26.0      | 16600±666.1    | 21.0±0.6     | 2088±570.2   | 20.91±0.34     | 1100±89.20     |
| 27.0      | 4220±310.11    | 19.9±0.5      | 1300±12.65   | 32.0±0.12      | 810±63±91.37   |
| 28.0      | 3210±330.22    | 22.0±0.5      | 4930±98.2    | 52.46±4.53     | 4522±90.22     |
| 29.0      | 151.00±113.0   | 10.10±0.96    | 6280±22.2    | 48.88±0.42     | 5231±49.02     |
| 30.0      | 2623±51.11     | 9.6±0.2       | 2967±87.23   | 50.27±0.20     | 125±6.11      |
Toxic heavy metals Pb, Cd, As and Hg were detected in all the investigated cosmetic products. The cosmetic products related regulations do not decide maximum permissible limit values for heavy metals content in cosmetic products except of 1 ppm for Hg (ACSB 2007). However, Cd is prohibited in any amount in cosmetics (Council Directive 76/768/EEC of 27 July 1976). The presence of heavy metals in cosmetics can cause serious problems to consumer as they can cause premature aging of the skin, skin allergies, and skin cancer. Further, toxic metals have a role to set up conditions that lead to inflammation in arteries and tissues, results in osteoporosis13. Thus, there is an urgent need for constant quality assessment of cosmetic products in the market in order to ensure the safety of consumers. To achieve this, regulatory bodies and the government sector should implement the stringent policies to regulate and monitor the standards of herbal products manufactured, advertised, sold, and used. At the same time, scientific community should develop simple and convenient analytical methods.

The most widely techniques to analyze trace and heavy metals are atomic absorption spectrometry (AAS), inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled plasma atomic emission spectrometry (ICP-AES), and X-ray fluorescence spectroscopy (XFS) 14. However, the instrumental methods of ICP-MS, ICP-AES, and XFS are usually more costly, and their use is not as straightforward and convenient as AAS. In this study, a

| Sample ID | As (Mean ± SD) | Hg (Mean ± SD) | Cd (Mean ± SD) | Pb (Mean ± SD) |
|-----------|----------------|----------------|----------------|---------------|
| 1.0       | 0.68±0.022     | BDL            | 0.71±0.009     | 8.44±0.041    |
| 2.0       | 1.36±0.021     | BDL            | 0.78±0.200     | 6.74±0.200    |
| 3.0       | 1.46±0.024     | 0.11±0.002     | 1.23±0.112     | 12.8±0.562    |
| 4.0       | 2.14±0.034     | 0.16±0.002     | 0.78±0.272     | 1.46±0.849    |
| 5.0       | 1.84±0.029     | 0.04±0.003     | 0.89±0.249     | 7.40±1.981    |
| 6.0       | 1.64±0.027     | BDL            | 0.99±0.319     | 10.02±1.140   |
| 7.0       | 2.01±0.001     | BDL            | 0.78±0.110     | 6.74±0.560    |
| 8.0       | 2.62±0.020     | 0.31±0.010     | 0.82±0.101     | 11.3±0.190    |
| 9.0       | 2.92±0.050     | 1.09±0.030     | 0.85±0.130     | 8.40±1.303    |
| 10.0      | 3.07±0.190     | 0.06±0.011     | 0.79±0.230     | 6.43±1.966    |
| 11.0      | 2.63±0.041     | 0.07±0.011     | 0.72±0.170     | 9.34±3.400    |
| 12.0      | 3.21±0.041     | BDL            | 0.75±0.162     | 9.39±3.340    |
| 13.0      | 2.92±0.044     | BDL            | 1.25±0.552     | 12.02±3.991   |
| 14.0      | 1.55±0.041     | BDL            | 1.78±4.483     | 6.71±2.470    |
| 15.0      | 2.23±0.030     | BDL            | 1.09±0.250     | BDL           |
| 16.0      | 3.68±0.180     | 0.30±0.022     | 1.15±0.236     | BDL           |
| 17.0      | 2.92±0.051     | 0.15±0.030     | 0.69±0.114     | BDL           |
| 18.0      | 3.42±0.046     | 2.18±0.227     | 0.99±0.311     | BDL           |
| 19.0      | 1.87±0.020     | 0.27±0.010     | 0.62±0.057     | 16.63±3.992   |
| 20.0      | 1.42±0.044     | 0.08±0.015     | 0.62±0.002     | 20.58±3.750   |
| 21.0      | 1.56±0.039     | 0.07±0.011     | 0.62±0.001     | 33.10±1.977   |
| 22.0      | 2.01±0.003     | BDL            | 0.78±0.121     | 6.74±0.552    |
| 23.0      | 1.55±0.024     | BDL            | 1.78±0.522     | 6.75±0.567    |
| 24.0      | 0.68±0.033     | BDL            | 0.71±0.001     | 8.44±0.096    |
| 25.0      | 1.84±0.035     | 0.04±0.004     | 0.89±0.567     | 7.40±1.723    |
| 26.0      | 3.68±0.171     | 0.31±0.000     | 1.15±0.034     | BDL           |
| 27.0      | 2.92±0.020     | BDL            | 1.25±0.542     | 12.00±3.795   |
| 28.0      | 2.26±0.020     | 0.31±0.085     | 0.82±0.106     | 11.30±1.450   |
| 29.0      | 1.46±0.022     | 0.11±0.000     | 1.23±0.114     | 12.83±0.422   |
| 30.0      | 0.68±0.029     | BDL            | 0.71±0.000     | 8.43±0.059    |

Table No. 04: Metal content in herbal preparations:

| Metal | Base value (ppm) | Quantity added (ppm) | Quantity found (ppm) | Recovery % |
|-------|-----------------|----------------------|----------------------|------------|
| Al    | 125±7.9         | 10.0                 | 134.62               | 96.20      |
| Ca    | 364±16.34       | 8.0                  | 3655.22              | 98.62      |
| Cu    | 4.36±0.16       | 3.0                  | 7.35                 | 99.67      |
| Mg    | 110.36±0.33     | 1.0                  | 111.36               | 99.99      |
| Zn    | 17.26±0.5       | 2.0                  | 19.22                | 98.00      |
| As    | 2.94±0.041      | 0.3                  | 3.24                 | 98.00      |
| Hg    | 0.81±0.020      | 0.2                  | 1.03                 | 99.00      |
| Cd    | 0.67±0.44       | 1.0                  | 1.67                 | 99.60      |
| Pb    | 7.96±1.52       | 5.0                  | 12.96                | 99.98      |

Table No. 05: Recovery studies for trace elements and heavy metals:

| Metal | Base value (ppm) | Quantity added (ppm) | Quantity found (ppm) | Recovery % |
|-------|-----------------|----------------------|----------------------|------------|
| Al    | 125±7.9         | 10.0                 | 134.62               | 96.20      |
| Ca    | 364±16.34       | 8.0                  | 3655.22              | 98.62      |
| Cu    | 4.36±0.16       | 3.0                  | 7.35                 | 99.67      |
| Mg    | 110.36±0.33     | 1.0                  | 111.36               | 99.99      |
| Zn    | 17.26±0.5       | 2.0                  | 19.22                | 98.00      |
| As    | 2.94±0.041      | 0.3                  | 3.24                 | 98.00      |
| Hg    | 0.81±0.020      | 0.2                  | 1.03                 | 99.00      |
| Cd    | 0.67±0.44       | 1.0                  | 1.67                 | 99.60      |
| Pb    | 7.96±1.52       | 5.0                  | 12.96                | 99.98      |
simple, reliable, sensitive and convenient AAS method has been developed for quantitative estimation of trace metals and heavy metals which can conveniently be utilized for the quality control of herbal cosmetic preparations at industrial level.  

CONCLUSION

30 herbal cosmetic preparations sold in Indian market found to figure out some biologically important trace elements, which may be helpful to impart therapeutic efficiencies unfortunately, these products were also contained toxic heavy metal content above the permissible limits which may cause deleterious effects to the human health. In the present scenario, there is an urgent need to regulate them properly for the sustainable safety and efficacy.  

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