The World Health Organization (WHO) recognizes heavy metals as a risk factor people are exposed to mainly through food and other commercial products. Some of these elements are necessary for humans in minute amounts [Co, Cu, Cr, Ni] while others are carcinogenic or toxic affecting Central Nervous System (CNS) [Hg, Pb, As], kidneys and liver [Hg, Pb, Cd, Cu] and skin, bones or teeth [Ni, Cd, Cu, Cr] (Duffus,2002).The Agency for Toxic Substances and Disease Registry (ATSDR) had released a list called "Top 20 Hazardous Substances". ARSENIC, LEAD, MERCURY and CADMIUM ranked 1st, 2nd, 3rd and 4th respectively in that list.

Infants are the population group most vulnerable to the toxic effects of heavy metals due to higher absorption of metals by the gastrointestinal tract, faster metabolic processes, an incompletely developed detoxification system, and higher food consumption in relation to body weight (Mania*et al.*, 2015). The mechanism of toxicity for heavy metals can be explained by their ability to interact with nuclear proteins and DNA, causing oxidative deterioration of biological macromolecules (Khalid*et al.*, 2016).

Talcum powder is a cosmetic product made from finely ground talc, an extremely soft mineral. As a powder, it helps to absorb moisture and cut down on friction, making it useful for keeping skin dry and helps in preventing rashes. The clay minerals composition is of hydrated magnesium silicate with chemical formula $Mg3Si4O10(OH)_2$. Baby powder is an astringent powder for preventing diaper rash, as a spray and for other cosmetic uses.

Contamination of talcum powders with heavy metals occurs during production, as a result of inadequate purification of natural raw materials used as ingredients.

The current study aims to test the presence of heavy metals in baby talcum powder which will be measured in parts per million (ppm) using Atomic Absorption Spectrophotometer (AAS) and the values so obtained will be compared with standard set values by FDA and also aims to spread awareness on the issue and advocate Good Manufacturing Practices(GMP).

Materials and Methods :

Sample collection and preservation : Three different samples of commonly used baby talcum powders in India, namely, Johnson's, Patanjali and Himalaya were collected. The samples were checked for expiry dates.

Weighing and sample pre-treatment (Acid digestion or Hot-Plate digestion): The finely grinded baby powders were weighed 1 gram using a weighing balance and the contents were transferred to separate beakers for all 3 samples. Each 1g of sample was digested with approximately 5ml of conc. HNO_3 (nitric acid) and 5ml conc. HCl (hydrochloric acid).These were covered with watch glass and kept on the hot plate set at 60^{o}C for 2 hours.

Filtering of the samples: The above digested samples were filtered into the volumetric flask using filter paper and funnel. After filtering; the volumetric flasks were marked with distilled water and kept aside.

Preparation of standard solutions of Lead, Cadmium and Mercury: Standard solution of lead, cadmium and mercury for Atomic Absorption Spectrophotometry (AAS) were prepared from commercially available readymade standards by taking proper concentrations and diluting the volume with distilled water.10 µl, 20µl, 30µl and 40µl concentrations were taken with the help of micropipette from the readymade standard solutions for 0.2, 0.4, 0.6 and 0.8 ppm standard solutions respectively in 100 ml volumetric flasks separately for all three metals, namely, lead, cadmium and mercury.

Calibration of AAS: In each case of the selected heavy metals, four different concentrations were prepared (0.2, 0.4, 0.6, 0.8 ppm) to calibrate the AAS. The resultant calibration curve of well-prepared standard concentration

gives a linear curve of absorbance against µg/litre for Hg and ng/litre for Pb and Cd for all metal solutions.

Atomic Absorption Spectrophotometry (AAS) for lead (Pb) and cadmium (Cd) analysis: AAS is a quantitative method of metal analysis. This measures the concentration of element by passing light of specific wavelength emitted by radiation source of a particular element through its atoms present in the sample. Samples are introduced into the atomizer as an aerosol by the nebulizer. This technique offers fast analysis of 10-15 seconds per sample with very good precision (repeatability). The data and absorption curve were recorded for lead and cadmium using this technique.

Cold Vapour Atomic Absorption Spectrometry (CVAAS) for Mercury (Hg) analysis: CVAAS is a flameless AAS procedure for mercury detection based on absorption of radiation at 253.7nm by Hg vapor. The mercury was first reduced to elemental state by a strong reducing agent such as sodium borohydride or stannous chloride. The mercury vapor passes to the absorption cell positioned in the light path of the spectrometer by argon carrier gas. This analytical method is characterized by low detection limits, fast measurement (30-50 seconds per sample) and minimum interferences. However, analytical procedures are tedious and require high consumption.

Results and Discussion :

The current study has covered concerns relating to toxicity of heavy metals such as lead(Pb), cadmium (Cd) and metallic mercury (Hg) in three commonly used brands of baby care talcum powders in India namely; Johnson's, Patanjali and Himalaya. The samples were amorphous and all of them were whitish in appearance. Some scientists' have correlated the long-term talcum powder use to mesothelioma (a rare condition and deadly form of cancer which attacks the lining of chest wall, lungs and other organs).

The obtained concentration, mean values of lead, cadmium and mercury are given in table (Table 1, 2 and 3). All the three samples showed a very high amount of lead, highest in Himalaya (0.430) followed by Patanjali (0.316) and Johnson's (0.240).**The safe limit of lead is 20ppm by FDA.** Cadmium was present in lower amounts than lead, its concentration being highest in Patanjali (0.027ppm) followed by Himalaya (0.022ppm) and least in Johnson's (0.015). **The safe limit of cadmium is in the range of 0.9-3 ppm according to FDA.** Mercury was present in least amounts of all the three heavy metals. Mercury concentration was maximum in Himalaya (0.025ppm) followed by Patanjali (0.013 ppm) and least in Johnson baby powder (0.005ppm). **The safe limit of mercury according to FDA is 0.5 ppm.**

Table 1. Lead concentrations (in ng/l) in the samples

Sample Label	Concentration (ng/l)	% Relative Standard Deviation	Mean Absorbance
JH	0.240	HIGH	0.0025
HIM	0.430	HIGH	0.0045
PAT	0.316	5.02	0.0033

Table 2. Cadmium concentrations (in ng/l) in the samples

Sample Label	Concentration (ng/l)	% Relative Standard Deviation	Mean Absorbance
JH	0.015	3.98	0.0031
HIM	0.022	10.89	0.0044
PAT	0.027	HIGH	0.0054

Table 3. Mercury concentrations (in µg/l) in the samples

Sample Label	Concentration (ng/l)	% Relative Standard Deviation	Mean Absorbance
JH	0.005	0.451	0.1925
HIM	0.025	0.982	0.0033
PAT	0.013	0.552	0.0341

Where,

ng/l = nanogram per litre

µg/l = microgram per litre

JH = JHONS

HIM =HIMALAYA

PAT= PATANJALI

In our findings, the concentration of lead, cadmium and mercury in all three brands were lower than the maximum safe limit mentioned above.

Lead poisoning is considered as a health hazard since decades. Kids are at a risk due to pica (cravings to eat things like dirt) and inhalation or aspiration. Lead is not an essential element and has no known biological value (Chauhan*et.al.*, 2010). Our findings convey that this amount of lead may be harmful for babies eventually and can even be detrimental if aspired as reported in a case study (Pairaudeau*et.al.*, 1991).It is one of the most toxic exposures to human body (Rehman *et.al.*, 2013).In the present investigation, levels of lead are high in baby powders and these high levels of exposure to these toxic metals on a daily basis in babies may cause serious health effects. Accidental aspiration may worsen the situation. Long use can be detrimental and may cause respiratory disorders.

Accumulation of cadmium in body of children can start at a young age; talcum powders being one of the major sources. Inhalation may cause lung cancer in adulthood (Schoeters *et.al.,* 2006). Cadmium exposure is linked to learning disabilities (Chauhan *et. al.*, 2010). High and prolonged exposure in any form may lead to neurological problems and trigger mental retardation and decreased IQ. It is especially toxic to kidney due to accumulation. (Rehman *et.al.*, 2013).High levels of cadmium in baby powder are dangerous for children and its everyday use may be extremely harmful.

In the present study it was found that Patanjali baby powder contains maximum amount of cadmium whereas it claims to be the purest form of herbal products while the results suggest that it may be full of chemicals.

Mercury is a highly toxic element with no known safe levels of exposure. Ideally, mercury should be present in human body as it has no physiological benefit. It is a serious health hazard for children and is a global pollutant (Bose-O'Reilly *et.al.*, 2010). Children are less exposed to mercury but some cosmetic formulations (baby powders) use mercury compounds that can be potentially dangerous (Davidson *et.al.*, 2004).Mercury in our findings appear to be least in talcum powders tested but the possible health effects of even trace amounts of mercury may prove this small amount to be most toxic amongst the three heavy metals considered.

The continued use of these products containing heavy metals may cause gradual release of metals into body and show harmful effects hence extensive use should be avoided. The research dealt with limited population in terms of number of powder samples; hence generalization cannot be done from this study. However, it can be used as a reference or foundation for future in depth studies. This research serves as an eye opener to consumer, manufacturers and health care professionals due to toxicity concerns of these metals. Formation of proper laws and regulations with strict control is highly recommended.

Conclusion:

In the present study we determined the concentration of lead, cadmium and mercury in baby talcum powders of three different commonly used commercial brands and established whether the concentrations of these heavy metals were within standards set by FDA. Based on the results we concluded that lead is one of the most prominent toxic heavy metals in terms of concentration, however, mercury and cadmium levels were also considerable but all the three

heavy metals were within permissible limits. The present study focused only on determining toxic metal presence and measuring its concentration in parts per million (ppm). Lead was present in maximum concentration amongst all the three metals tested and its maximum concentration in is HIMALAYA BABY POWDER (0.430 ppm). Mercury was least in concentration among the three metals and its concentration was least in Johnson's baby powder. The heavy metals were found in the range of 0.005 – 0.430 ppm which is within permissible limits of all three heavy metals as set by FDA (20 ppm for Pb, 0.9-3 ppm for Cd and 0.5 ppm for Hg). The heavy metals tested in the present investigation have no biological value till date. Prolonged exposure to any of the three powders may be detrimental to child health in the long run. Heavy metals are harmful and can cause various cardiovascular diseases, talcosis (pulmonary disease), talcosilicosis, talcoasbestosis (occupational lung disease) etc. Aspiration and pica are major causes of heavy metal ingestion. This research serves as an eye opener to consumer, manufacturers and health care professionals due to toxicity concerns of these metals. Formation of proper laws and regulations with strict control is highly recommended.

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