DETERMINATION OF HEAVY METALS IN BLACK TATTOO INK SOLD WITHIN ZARIA, NIGERIA

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Abstract: The aim of this study is to determine the concentration of cadmium, lead, nickel, mercury and zinc in three different imported black tattoo ink sold in Zaria, Nigeria. Three commonly different brands of black tattoo ink coded BTN1, BTN2 and BTN3 being sold in Zaria town were randomly purchased. Each brand of the tattoo ink was mixed, sample taken and digested using a mixture of concentrated acids ($HNO_3/HClO_4/H_2SO_4/H_2O_2$ ratio 3:2:1:1).The concentrations of the metals were determined using Atomic Absorption Spectrometry (AAS).One-Way Analysis of variance (ANOVA) was done at 95% confidence limit on the data obtained.The results of the analysis indicated that the concentrations of Cd, Pb, Ni, Hg and Zn were found to be in the range of 2.357 – 2.554 mg/Kg, 3.640 – 6.514 mg/Kg, 1.859 – 2.837 mg/Kg, 0.499 – 0.638 mg/ kg, and 36.272 – 47.008 mg/Kg, respectively. These values (except that of Zn) were higher than the given EPA's Guidelines in 2012. The one-way ANOVA showed that there was no significant difference (P > 05) between the metal levels in the different brands of black ink. This result reveals that the type of pigment used in tattoo inks contributes to its heavy metal content.The use of tattoo inks could result in an increase in the heavy metal level in human body which could lead to health problems.

Keywords: Carcinogen, heavy metals, potential health risk, tattoo ink

Introduction

The word tattoo comes from the Tahitian "tatu" which means "to mark something."Atattoo substance is defined as any substance or preparation intended tobe injected into the human skin with a view exclusively or mainly to impart a skin marking ordesign. It is arguably claimed that tattooing has existed since 12,000 years BC.In recorded history, the earliest tattoos can be found in Egypt during the time of the construction of the great pyramids (it undoubtedly started much earlier). When the Egyptians expanded their empire, the art of tattooing spread as well.The Ainu people of western Asia used tattooing to show social status. Girls coming of age were marked to announce their place in society, as were the married women.Tattooing practice is adopted worldwide and represents an important socio-culturalphenomenon, but, the injection into the skin of colouring agents such as metals might pose arisk of allergies and other skin inflammations as well as systemic diseases (Forte *et al*., 2009).

Today, tattooing is making a strong comeback. It is more popular and accepted than it has ever been. All classes of people seek the best tattoo artists.Tattoo suppliers rarely advertised their products. One had to learn through the scuttlebutt where to go and who to see for quality tattoos.Tattoo ink is composed up of pigment carrier molecules, pigment like organic pigment, vegetables pigment and some plastic-based pigments are suspended in carrier solutions. The different pigments in tattoo ink make the entire different colour. The pupose of the carrier molecules is to keep the mixture evenly mixed and to make it easier to apply.It is the general experience that black ink is more lasting in a tattoo than othercolours (Bäumler, 2013).

The main chemical compounds and component of tattoo ink are, iron (iii)oxide (Fe_3O_4), iron (ii) oxide (FeO), carbon and logwood.One or more pigments are mixed in ink but all of them have carriers. The carriers are mixture of different things, usually liquid like ethanol and the purified water.Tattoo inks contain toxic substances which include phthalate, metals and other carcinogenic hydrocarbons. Black tattoo inks are often made from soot-containing products of combustion called polycyclic aromatic hydrocarbons (PAHs). Among the PAHs in the inks is benzo(a)pyrene, a compound identified in an Environmental Protection Agency toxicity report as "among the most potent and well-documented skin carcinogens" (Taylor*et al*., 2003).Many tattoo inks contain heavy metals that have been linked to a large number of health problems, including cancer and neurodegenerative diseases. Among the most concerning metals found in tattoos are mercury, lead, antimony, beryllium, cadmium and arsenic (Ministry of Health, 2013).

Acute heavy metal intoxications may damage central nervous function, the cardiovascular and gastrointestinal (GI) systems, lungs, kidneys, liver, endocrine glands, and bones (Lenntech, 2013; Annan, 2013). Chronic heavy metal exposure has been implicated in several degenerative diseases of these same systems and may increase the risk of some cancers (Basketter, 2003; Wu, 2011). Man-madechemicals and products of heavy metals are taken up into the body via inhalation, ingestion and skin absorption. Heavy metals on exposure may not necessarily produce a state of toxicity in the body as they accumulate in the tissues over time until they reach toxic concentration (ERMA, 2011). Tattoo ink is placed via needles into the dermis layer of the skin, where it remains permanently (although some colors will fade over time). Some people have reported sensitivity springing up even years after they first got their tattoo; also it can cause tattoos to burn or sting as the heavy metals in the ink are affected by the test's magnetism.

The aim of this study is to determine the concentrations of Cd, Pb, Ni, Hg and Zn in three different imported brands of black tattoo inks (BTN1, BTN2 and BTN3) sold in Zaria, Nigeria.

Materials and Methods

Sample collection, preparation and analysis

All glassware and plastic containers used were washed with liquid soap, rinsed with water,soaked in 10% volume/volume nitric acid for 24 h, cleaned thoroughly with distilled water and driedin such a manner to ensure that any contaminationdoes not occur.

A total of 36 (12 each) of three different imported black tattoo ink (BTN1, BTN2 and BTN3) were collected from different outlets in Samaru- Zaria, Nigeria in their original package. Collected samples were labelled andtaken to the laboratory. Each brand of tattoo ink were homogenized in acid washed mortar and pestle, two (2) gram of each sample was weighed and digested using HNO_3(65% Merck), concentrated $HClO_4$ and H_2SO_4(98%) and H_2O_2 (30%) (3:2:1:1) (Masa *et al*.,

2013). Thesolution was filtered through a Whatman 41 filter paper to remove the insoluble particles and brought to a final volume of 50ml with de-ionized water. The concentration of cadmium, lead, mercury, nickel and zinc were determined using Atomic Absorption Spectrophotometer Model AA090M046. The analysis was done in triplicate and subjected to one-way ANOVA using SPSS v20software.

Results and Discussion

The mean concentration (mg/Kg) of the metals analysed in the three different imported black tattoo inks are presented in Figs. 1 – 5. The mean concentration (mg/Kg) of cadmium in the different black ink (Figure 1) was found to be in the order: BTN1 (2.554 mg/Kg) >BTN2 (2.456 mg/Kg) >BTN3 (2.357). The cadmium level in the three different brands of imported black ink were found to be higher than the maximum concentrationof 0.2 mg/Kg for cadmium given in the EPA's Guidelines for Tattoo and Permanent Make-up Substances (EPA, 2012).Cadmium is a heavy metal that poses severe risks to human health, including kidney, bone and pulmonary damage, and skin irritation (Eghbali *et al*., 2014).Cadmium compounds are harmful by inhalation, in contact with skin and if swallowed. Cadmium chloride and cadmium sulphate may cause heritable genetic damage, impair fertility and may cause harm to theunborn child. Thecriticaleffects of cadmium in relation to tattooing areconsidered to be the effects on bones and kidneys (Eva *et al*., 2012; EFSA, 2011; FAO/WHO, 2010).

The mean concentration (mg/Kg) of lead in the different black ink (Fig. 2) was found to be in the order: BTN1 (6.514 mg/Kg) > BTN3 (5.556 mg/Kg) > BTN2 (3.640 mg/Kg). TheEPA's Guidelines for Tattoo and Permanent Make-up Substances(EPA, 2012) gives a maximum of 2 mg/Kg for lead. Lead interfereswith a variety of body processes and is toxic tomany of the body's organs and tissues, includingthe heart, bones, intestines, and kidneys, nervousand reproductive systems. In severe cases, leadpoisoning symptoms can include seizures, comaand death. Other symptoms commonly associatedwith lead exposure include abdominal pain,confusion, headache, anemia and irritability. Thecritical effect of lead in relation to tattooing isconsidered to be the effects on the developing nervous system in children aswell as the unborn child (IARC, 2006;EFSA, 2010).

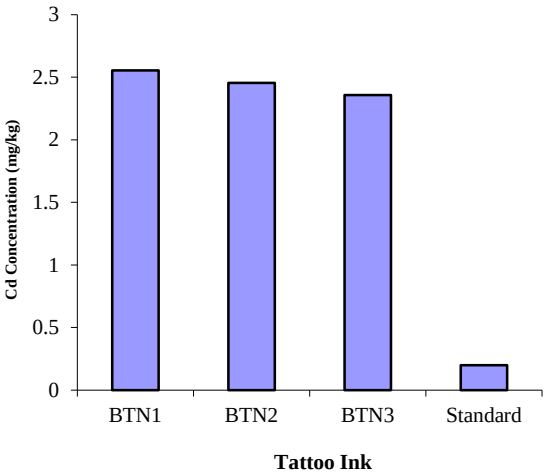

Fig. 1: The mean concentration (mg/Kg) of cadmium in three different black tattoo ink

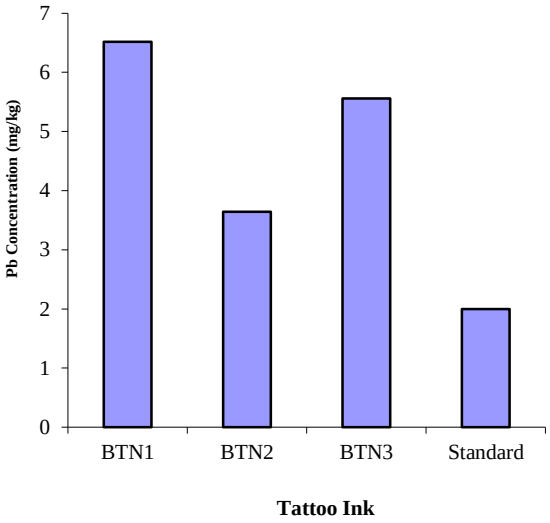

Fig 2: The mean concentration (mg/Kg) of lead in three different blacks tattoo ink

The nickel levels in the three different brand of black tattoo ink (Fig. 3) were in the trend: BTN1 (2.837 mg/Kg) > BTN2 (2.103 mg/Kg) > BTN3 (1.859 mg/Kg). The maximum concentration for nickel as given by the EPA's Guidelines for Tattoo and Permanent Make-up Substances(EPA, 2012) is 0.2 mg/Kg. With regard to the carcinogenic effect, nickel andnickel compounds are classified as carcinogenic in the respiratory tract after inhalation and skin contact, and may cause harm to the unborn child. The critical effect of nickel in relation to tattooing isconsidered to be sensitization. Nickel sulphate, nickel chloride and nickel nitrate are classified as skin irritantsand thus, it cannot be excluded that skin irritation might be a critical effect inrelation to tattooing as well (IARC, 2010; Eva *et al*., 2012).Mercury was detected in the black tattoo ink (Fig. 4) and the concentration was in the following order: BTN2 (0.638 mg/Kg) > BTN1 (0.611 mg/Kg) > BTN3 (0.499 mg/Kg). These concentrations were higher than the maximum EPA's Guidelines for Tattoo and Permanent Make-up Substances(EPA, 2012) 0.2 mg/Kg for mercury.Exposureto mercury and other heavy metals is a risk involved with getting a tattoo.Mercury is a neurotoxin, meaning it has detrimental effects on the nervous system. It can damage the brain and lead to physical and emotional disorders (Taylor *et al.*, 2003).Inksused for permanent tattoos contain mercury, different heavy metals like cadmium or iron oxide. These metals, which give the tattoo its "permanence" in skin, have been known to cause allergic reactions, eczema and scarring (MacIntosh, 2007).

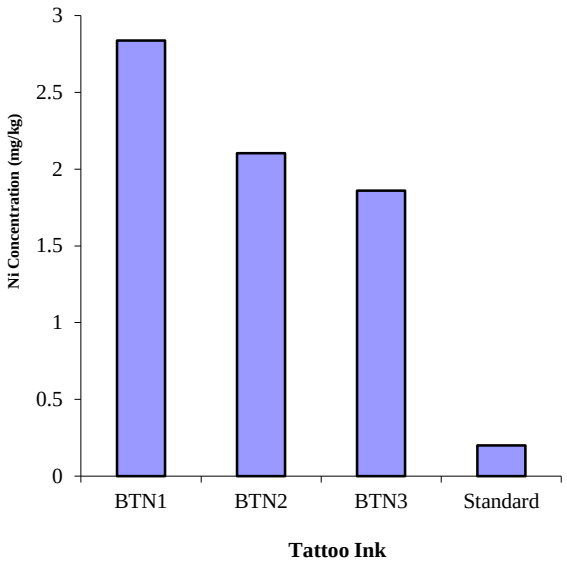

Fig. 3: The mean concentration (mg/Kg) of nickel in three different Black Tattoo Ink

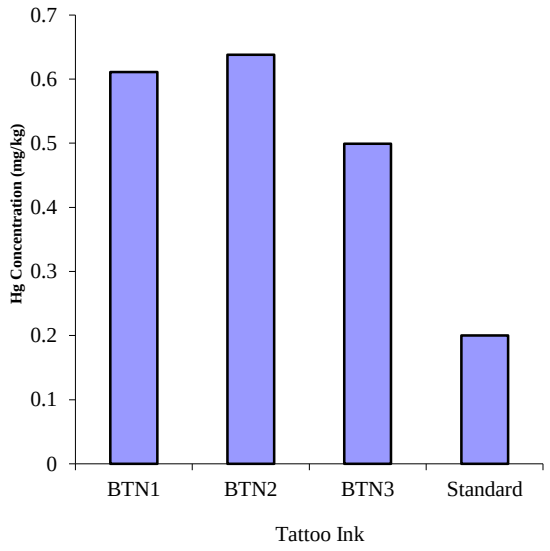

Fig. 4: The mean concentration (mg/Kg) of mercury in three different Black Tattoo Ink

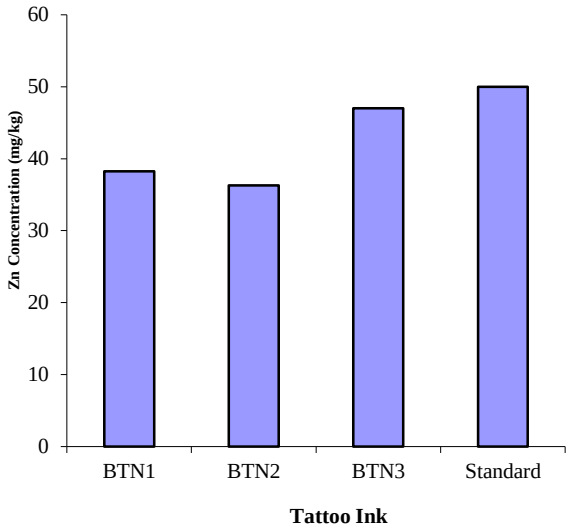

Fig. 5: The mean concentration (mg/Kg) of zinc in three different Black Tattoo Ink

The black tattooinks were found to contain zinc in the order: BTN3 (47.008 mg/Kg) >BTN1 (38.244 mg/Kg) > BTN2 (36.272 mg/Kg). Zinc levels in the three black tattoo ink were below the maximum EPA's Guidelines for Tattoo and Permanent Make-up Substances(EPA, 2012)of 50 mg/Kg (Fig. 5). Zinc is a necessary component of several enzyme systems, regulating various metabolic activities (Straif*et al.*,2009) and forms part of the dehydropeptides and glycoglycinedipeptidase enzymes functioning in protein metabolism.Relatively low concentration of the element in the body may leads to usually intestinal distress.It is unusual for people to experience zinc poisoning due to the ingestion of dietary zinc, as long as the dosage recommendation of physician are followed.Although zinc is an essential requirement for food health, excess zinc can be harmful.The free zinc ion is a powerful Lewis acid up to the end of being corrosive. Stomach acid contains hydrochloric acid, in which metallic zinc dissolves readily to give corrosive zinc chloride(Bocca, 2013).

Using one-way ANOVA, there was no significant difference($P > 0.05$) between the metal levels in the three different brands of the imported black tattoo ink. This implies that the type of pigment used in tattoo inks contributes to its heavy metal content.Beyond the long term risks of walking around with heavy metals injected into the body's largest organ (the skin), getting a tattoo in and of itself can be risky business. If the tattoo parlor's needles and equipment aren't properly sterilized in an autoclave between customers, one could be exposing self to hepatitis B or C, tuberculosis, mycobacterium, syphilis, malaria, HIV or even leprosy. Once the tattoo inks are dissolved, their components - including any dangerous ones such as those outlined above - are absorbed into the body and bloodstream. Many may never be fully eliminated from the body, and even those components which do get eliminated may cause damage before they are eliminated (Taylor *et al*., 2003; Engel, 2008).

Conclusion

The present study showed that metal composition of tattoo inks varies. The black tattoo ink of BTN1, BTN2 and BTN3 samples contain metals which are orders of magnitude greater than the Guidelines and may likely pose public health risk. Only zinc level was found to be compliant with the maximum permissible level specified in the Guidelines.Many people

may not be aware that tattoo inks may pose harm from the chemicals from which they are made.

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