

QUALITY ASSESSMENT OF SOME SELECTED TOOTHPASTES USED IN NIGERIA

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ABSTRACT

Toothpaste is a gel that is used with toothbrush to clean the teeth. They are of different brands from different manufacturing companies hence, are made up of different compositions. In this research work, quality assessment of different toothpastes used in Nigeria were investigated. Five different brands of toothpaste were purchased in Edjeba market Warri Delta State, Nigeria and the physical parameters, and heavy metals were analysed in them. Physical parameters; the pH level of the toothpastes were determined using pH meter, the moisture and volatile contents were determined using a recommended method, the heavy metals (Cadmium (Cd), Copper (Cu), Zinc (Zn), Manganese (Mn) and Lead (Pb)) were determined using atomic absorption spectrometer (AAS). From the results obtained, the pH value of these toothpastes were within 6.59 to 7.03, all the toothpastes fell within the NAFDAC recommended pH range of 6.5 to 7.5. The moisture and volatile contents of the toothpastes were within the range of 3.1 to 7.4 which were within the range set by NAFDAC. The heavy metals; Cd, Cu, Zn, Mn and Pb were detected in all the toothpastes samples. The level of Cd ranged from 2.470 to 2.952, Cu level was between 0.096 to 5.165, the level of Zn ranged from 13.396 to 24.164, Mn concentration ranged from 1.700 to 3.402 and Pb level was between 4.917 to 6.113. The results of the concentration of heavy metals in the samples shows that some of the toothpastes contains heavy metal in an amount higher than the set standards and may pose health problems to the consumers. Hence, there is need to educate the users on the danger of swallowing toothpaste and how to properly use them especially for children and pregnant women to ensure safety.

KEYWORDS: Toothpaste, Heavy metals, Physical parameters, Consumers

INTRODUCTION

The teeth are an important part of the body that needs to be taken care of properly. Poor oral hygiene can cause oral diseases such as dental caries, odorous mouth, tooth decay and many more. The mouth (teeth, tongue) is the door through which we take in foods, liquid and solid substances into our body, for this its maintenance and hygiene is necessary for overall healthiness of the body systems. This has been an older practice, in the olden days,

they used toothpick to clean the teeth, but it didn't give or enhance total dental hygiene and this resulted in having cases like dental caries, gum diseases, mouth odor and coloured teeth. This has led to the introduction of aesthetic product such as toothpaste.

Toothpaste is a paste or gel in molten form that is used with a toothbrush to clean and maintain the healthiness of teeth. Toothpaste is used to promote oral hygiene: it is an abrasive that aids

in removing dental plaque and food from the teeth.[1]. Toothpaste helps to remove residue accumulated on the surface of the teeth, it helps to remove stain, dirt, from the teeth and to keep the teeth surroundings neat. It is personal hygiene product that is used every day by children and adult, men and women and across the nations. The benefit of toothpaste cannot be over emphasized. Toothpastes composition differs from brand to brand but a typical toothpaste brands used in Nigeria contain fluoride. Fluorine is one of the most efficient elements in preventing the formation of caries and strengthens the enamel. The toothpastes containing materials such as sodium lauryl sulphate, saccharin, titanium dioxide may pose health challenges to human and the environmental.[2].

Saccharin (1, 2-benzisothiazolin-3-one-1,1-dioxide)

Saccharin is one of a sweetener added to the toothpaste to give it a sweet taste. Saccharin is a non-nutritive or artificial sweetener. It's made in a laboratory by oxidizing the chemicals o-toluene sulfonamide or phthalic anhydride. It looks like white, crystalline powder. Saccharin is commonly used as a sugar substitute because it doesn't contain calories. Saccharin is one of the oldest artificial sweeteners on the market. In fact, it has been used for food and drinks sweeteners for over 100 years. Some say that replacing sugar with saccharin benefits weight loss, diabetes, and dental health.[3]. Health authorities agree that saccharin is safe for human consumption; these include the World Health Organization (WHO), the European

Food Safety Authority (EFSA), and the Food and Drug Administration (FDA).

Fluoride (NaF)

Fluoride is the most popular and effective active ingredient in toothpaste to prevent dental cavities. Fluoride is present in small amounts in plants, animals, and some natural water sources. The addition of fluoride in toothpaste has beneficial effects on the formation of dental enamel and bones.[4]. Sodium fluoride (NaF) is the most common source of fluoride, but stannous fluoride (SnF_2), and sodium monofluorophosphate ($\text{Na}_2\text{PO}_3\text{F}$) are also used.[5]. From the above study, fluoride in toothpaste heals and re-mineralizes microscopic cavities as they forms, it hardens the tooth surface, making it more resistant to acid attack of bacteria and slow down the action of the acid producing bacteria.[6]. According to the EPA adults in the United States consume an average 2.9 mg of fluoride daily from foods and beverages. Thus, even assuming twice daily ingestion of 1.21 mg of fluoride during tooth brushing, the daily exposure to fluoride is still within an acceptable limit.[7].

Sodium Lauryl Sulphate (SLS)

($\text{C}_{12}\text{H}_{25}\text{NaO}_4\text{S}$)

Sodium lauryl sulphate (SLS) is an anionic surfactant used in home products, cleaning and hygiene products, including toothpastes.[8]. SLS is a surfactant that helps the toothpaste to foam. It is one of the most common ingredients found in the toothpaste. It helps to remove food debris and particles, and also allows your toothpaste to create the foam that forms as you brush, according to Chemical Safety Facts.

That foaming action aids in "the solubility of plaque and accretions during brushing," says the American Dental Association [9] and Colgate Global Scientific Communications.[10]. Many types of toothpaste contain sodium lauryl sulphate (SLS) or related surfactants (detergents). SLS is found in many other personal care products as well, such as shampoo, and is mainly a foaming agent, which enables uniform distribution of toothpaste, improving its cleansing power.[11].

Titanium Dioxide (TiO₂)

Titanium dioxide usually exists in a white powder form and is often used in food, or other products such as toothpaste, mouthwash, and cosmetics. The purpose of this compound is to brighten the color of the product in order to make it look whiter, or more opaque. In many cases, Titanium dioxide was used as a food additive, to make food look more visually appealing. Titanium dioxide is a common product used in many branded toothpastes, easily available in stores today, it is used in oral care products to whiten the teeth because of its opaque and whitening pigment.[12].

Heavy Metals

Heavy metals are referred to as those metals which possess a specific density of more than 5g/cm³ and adversely affect the environment and living organisms. They are naturally occurring elements with atomic number greater than 20. They have important biochemical and physiological functions in living organisms in trace amounts. Copper and zinc are very useful in the body whereas some metal (mercury, lead) can be poisonous. Copper is used alongside

with iron to form red blood cells. It helps to maintain healthy bones, nerves, and immune function. Copper nutritional deficiencies are associated with high cholesterol and high blood pressure. Zinc aids the immune system, metabolism function, wound healing, and DNA synthesis. Zinc nutritional deficiencies are associated with lethargy, poor wound healing, and immune problems. Metals are found naturally in the earth's crust and their compositions vary among different localities, resulting in spatial variations of surrounding concentrations.[13].

MATERIALS AND METHODS

Samples and Sample Preparation

Five different toothpaste brands were randomly purchased in different stores at Edjeba market, Warri, Delta State, Nigeria. The selected toothpastes were coded as M, N, O, P, and Q for some reasons.

pH Level Determination Procedures

- i. For each of the toothpastes sample, 2g was dispensed into 50mL Beaker
- ii. To the sample, 2mL of distilled water was added to it with manually stirring to form an aqueous solution. The pH of the toothpaste in the aqueous solution was taken within 5 minutes

Moisture and Volatile contents determination Procedures

- i. For each of the toothpaste sample, 5g was taken in pedri dish and was dried with oven at 105^oC and was kept to cool.

- ii. The weight of the toothpaste sample before and after drying were taken to measure the moisture and volatile contents. The contents was determined using the formula:

$$\frac{(W-W1) \times 100}{W}$$

Where;

W = weight in grams of the paste before drying

W1 = weight in grams of paste after drying

Heavy Metals Determination

A. Digestion preparation: 200mL of Sulphuric acid (H₂SO₄) was measured into 1000mL beaker, 200mL of Nitric acid (HNO₃) and 100mL of Perchloric acid (HClO₄) were added to the content in the beaker (2:2:1), the contents were stirred and allowed to cool for about 5 minutes.

B. Procedures

- i. The pastes (samples) were dried in the oven to remove moisture
- ii. 1g of the dried paste was accurately weighed into 250mL conical flask
- iii. 20mL of the mixture (HClO₄:HNO₃:H₂SO₄, 2:2:1) was measured into the flask

containing the sample in the fume hood. This was heated using the hot plate at 100⁰C for about 3hours to ensure complete digestion. To the sample 10cm³ of 4M HCl acid was added and heated for about 30minutes to almost dryness. The content was cooled and filtered. The filtrate was poured into a standard volumetric flask and made up to 100cm³ with deionized water. The digested samples were sent to analytical laboratory and the selected heavy metals concentration present in the toothpaste sample were determined using atomic absorption spectrometer (AAS).

RESULTS AND DISCUSSION

General Characteristics of the Samples

A total of five toothpastes samples consisting of three local and two foreign toothpastes.

The toothpastes were coded with letter M to Q. Sample P and Q are foreign while sample M, N, and O are local toothpastes.

Table 1: Physical Parameters of the Sample Toothpastes

Samples	pH values	Moisture and volatile contents (%)
M	6.64	3.4%
N	6.64	3.2%
O	6.87	4.2%
P	7.03	3.1%
Q	6.59	7.4%
SON	6.5–7.5	50%

The parameters analyzed were compared with the set standards from the regulatory body.

The physical parameters of the samples toothpastes.

The pH value results obtained from the toothpastes samples and the moisture and volatile contents as compared with Standard Organization of Nigeria (SON).

From the results obtained above, the pH of the toothpastes were found to be within 6.59 to 7.03. 80% of the toothpastes samples were acidic (a pH less than 7) and 10% of the samples were basic (pH greater than 7). Sample P had the highest pH value.

The moisture and volatile contents of the samples toothpastes were found to be 3.1 to 7.4.

Sample Q had the highest value while sample P had the smallest value.

The colour of the toothpastes samples were as follows: Sample 'M' is turquoise blue, sample 'N' is white in colour, 'O' is navy blue, sample 'P' is white, and sample 'Q' is black. However, colour has no significant effect on the paste. It is just for advertisement purposes.

Heavy Metals Analyzed In the Toothpastes

The heavy metals analyzed were cadmium (Cd), copper (Cu), Zinc (Zn), Manganese (Mn), and Lead (Pb). The selected metals were all found to be present in the sampled toothpastes. Atomic absorption spectrometer was used in the determination of the heavy metals.

Table 2: Concentration (mg/Kg) of heavy metals in sample

Parameters	Sample M (mg/Kg)	Sample N (mg/Kg)	Sample O (mg/Kg)	Sample P (mg/Kg)	Sample Q (mg/Kg)
Cd	2.470	2.952	2.727	2.791	2.663
Cu	0.866	1.123	5.165	0.096	0.802
Zn	24.164	14.912	14.552	14.013	12.396
Mn	2.278	2.438	2.117	3.402	1.700
Pb	5.642	6.113	5.715	5.582	4.917

The Concentration of Cadmium in the Sampled Toothpastes

The obtained results showed that the concentration of cadmium in the toothpastes

ranged from 2.470 to 2.952. Sample 'N' had the highest value and sample 'M' had the lowest value.

The concentration of copper (Cu) in the samples toothpastes.

From the results obtained, the level of copper in the samples were ranged 0.096 to 5.165. Sample 'O' had the highest value while sample 'P' had the lowest value.

The concentration of Zinc (Zn) in the toothpastes.

The results obtained showed that Zn concentration in the sampled toothpastes were ranged 12.396 to 24.164. Sample 'M' had the highest value while sample 'Q' had the lowest value.

The concentration of Manganese (Mn) in the samples.

From the obtained results, it showed that Mn concentration in the sampled toothpastes ranged from 1.700 to 3.402. Sample coded 'P' had the highest value while sample 'Q' had the lowest value.

The concentration of lead (Pb) in the toothpastes samples.

The results obtained showed that Pb amount in the sampled toothpastes ranged from 4.917 to 6.113. Sample 'N' had the highest value and sample 'Q' had the lowest value.

Table 3: COMPARISM OF THE HEAVY METALS EXPERIMENTAL RESULTS WITH SET STANDARDS.

Parameters (Mg/Kg)	Sample M	Sample N	Sample O	Sample P	Sample Q	Standards (WHO)	Standards (U.S NRC)
Cd	2.470	2.952	2.727	2.791	2.663	2	—
Cu	0.866	1.123	5.165	0.096	0.802	0.603	—
Zn	24.164	14.912	14.552	14.013	12.396	14 – 30	—
Mn	2.278	2.438	2.117	3.402	1.700	—	2 – 5
Pb	5.642	6.113	5.715	5.582	4.917	10.00	—

Discussion

In the present study, the sampled toothpastes were observed to have the pH ranged from 6.59 to 7.03 which were within the Standard Organization of Nigeria (SON) set standards of pH of 6.5 to 7.5

The moisture and volatile contents of the toothpastes were between 3.1 to 7.4 percent which were within the range specified by the Standard Organization of Nigeria (SON) 50%. The heavy metals found in the sampled toothpastes were present as contaminants or purposely added by the manufacturers to meet

a specific needs of the consumers. Sample 'Q' were formulated according to its features to remove hard plaque from the tooth, sample 'M' was also formulated for strong and protection from tooth holes. Other factors such as stain and odor remover (a solvent that removes a substance from surface), and so on were added to toothpastes to meet these needs. Now, the combination of these heavy chemicals in the present days toothpastes were for the purpose of meeting costumer's needs, but these heavy metals might be very harmful to the teeth and body systems with time. Toothpastes are personal care products that are used daily by man both young and old, therefore, can lead to a certain exposure to thousands of chemicals which may make their ways into our body by absorption or accidental swallowing and then remain there as toxins, many health problems men faces today have their roots from accumulated heavy metals in the body. The toxicity of these heavy metals causes various health issues such as high blood pressure, infertility, reduces brain development and Intelligent Quotient (IQ) in growing children, cancer, liver problems, headache and depression, DNA damage and reduces cell proliferation etc.

CONCLUSION

Toothpastes is a gel or paste in a molten form that is used together with toothbrush to clean the teeth and remove stain, plaque and odor from the mouth environment. Toothpaste is used daily by young and old across the world.

The current investigation has shown that toothpaste could also serve as a source by which humans or living organisms are exposed to heavy metals contaminations most especially when inhaled, ingested or absorbed into the body.

Cadmium (Cd), Copper (Cu), Zinc (Zn), Manganese (Mn) and Lead (Pb) were the selected heavy metals analyzed in the samples toothpastes. These selected heavy metals were found to be present in all the samples. Most of these heavy metals were found to be higher in the local toothpastes compared to the foreign toothpastes, some have amount of heavy metal above the set standards.

The results obtained from the samples were not uniform which indicates that the different manufacturers of these toothpastes do not use the same guidelines or specifications to produce their products.

RECOMMENDATIONS

From the experimental results, it was observed that some heavy metals were present in an amount higher than the set standards from regulatory bodies.

Research has shown that heavy metals are the major causes of varieties of health problems today in our society due to their toxicity. Trace amount of these metals are essential or needed to human body, but the excess of them or high concentration of these elements is very toxic to the body.

It is therefore, recommended that:

- i. The guidelines be made for the use of toothpaste, there is need to educate the

users on how to use the toothpaste safely.

- ii. The guidelines given by the regulatory bodies should be strictly followed by the toothpaste manufacturers and continuously monitored from time to time to ensure that toothpaste do not pose health challenges to the consumers.
- iii. Lastly, Parents should also guide and monitor their children when using toothpaste to avoid accidental swallow of the paste.

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