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PHYSICO-CHEMICAL ANALYSIS OF COMMERCIAL SACHET WATER IN AGUATA LOCAL GOVERNMENT AREA OF ANAMBRA STATE

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ABSTRACT

The physicochemical analysis of four samples of commercial sachet water bought from Ekwulobia in Aguata L.G.A of Anambra State was carried out using an Atomic Absorption Spectrophotometer (AAS). The four samples were emptied into four different volumetric flasks filtered with filter paper and digested with Nitric Acid. The concentrations of heavy metals in the samples were determined. The AAS analysis revealed the presence of Iron (0.073-0.115mg/l), Nickel (0.0000-0.0111mg/l), Cadmium (0.05-0.127 mg/l), Magnesium (1.351-7.024mg/l), and Chromium (0.00-17.60mg/l) at varying concentration of the four different samples. The concentration of Chromium (17.60mg/l) was the highest, while that of Nickel was the lowest. The physico-chemical parameters determined include; colour, odour, taste, temperature, hardness, pH and conductivity. These parameters were compared with the acceptable standards of the World Health Organization (WHO) and the Standard Organization of Nigeria (SON). The colour, odour and taste properties correspond with WHO and SON standards, but hardness, pH, and conductivity varied. The hardness and pH were low, while conductivity was high, compared with WHO and SON standards. It is recommended that quality assurance tests should be carried out from time to time on water samples to ascertain standard quality.

Keywords: Heavy Metals, Parameters, Quality Assurance, Sachet water, Standard quality.

INTRODUCTION

Water is one of the most abundantly available liquids in nature. Water is an essential natural resource that affects social, economic, and ecological sustainability aspects of life (Daum, 2014). Water quality is as important as quantity in determining domestic water sustainability (Amadi *et al.*, 2012). Raw water contains different levels of impurity depending on its source. Water

may get contaminated with sewage or industrial waste. Inadequate sanitation or hygiene may affect the desired quality of water. Water may also be contaminated by heavy metals arising from mining and industrial activities. Common heavy metals encountered include Chromium, Cobalt, Nickel, Copper, Zinc, Arsenic, Selenium, Silver, Cadmium, Antimony, Mercury, Thallium, and Lead (Frankland, 2008). A high percentage of Nigerians consume commercial sachet water directly. It is assumed that all sachet water from various companies had been certified safe by standard quality organizations such as the National Food and Drug Administration Council (NAFDAC), Standard Organization of Nigeria (SON), and Nigerian Standard for Drinking Water Quality (NSDWQ) (Thomson, 2001). Implementing the World Health Organization (WHO) guidelines for drinking water varies among countries (Ndububa, 2020). This is for guidance rather than mandatory standards; WHO recognizes the need to consider local, national, environmental, social, and economic conditions.

The prevailing health issues common in some localities led to the need to analyze the heavy metal content and the physicochemical characteristics of sachet water consumed in Aguata Local Government Area of Anambra State. Diseases relating to contaminated drinking water constitute a significant burden on human health. Interventions to improve the quality of drinking water provide significant health benefits. Associated health issues arising from heavy metals include vomiting, nausea, diarrhea, gastrointestinal hemorrhage, anemia, lung cancer, pneumonitis, etc. (Aldernosoc, 2004). Heavy metals enter plants, animals, and humans through inhalation, diet, and human handling (Petterson, 2002). Heavy metals can bind to vital cellular components, structural proteins, enzymes, and nucleic acids, interfering with their functionality (Aldernosoc, 2004). Long-term exposure to heavy metals can have carcinogenic, central, and peripheral effects on the nervous and circulatory systems.

In humans, heavy metal poisoning is generally treated by the administration of a chelating agent such as calcium disodium ethylenediaminetetraacetate ($CaNa_2EDTA$) that converts heavy metals to chemically inert forms that can be excreted without further interaction with the body. Chelates have no side effects and can remove beneficial metals from the body. Vitamins

and Minerals supplements are sometimes co-administered for this reason—Chelation therapy (American Cancer Society, 2008; National Capital Poison Centre, 2010).

Some elements regarded as heavy metals are essential in trace quantities for human health. These elements include Vanadium, Manganese, Iron, Cobalt, Copper, Zinc, Selenium, and Strontium.

Table 1: Some Detrimental Effects of Exposure to Heavy Metals

Element	Acute Exposure	Chronic Exposure	Main Article
Cadmium	Pneumonitis	Lung cancer	Cadmium poisoning
Mercury	Diarrhea Fever Vomiting	Nausea, tremor	Mercury poisoning
Lead	Nausea Vomiting	Anaemia	Lead poisoning
Chromium	Gastrointestinal hemorrhage	Pulmonary fibrosis	Chromium poisoning
Arsenic	Nausea Vomiting	Diabetes Hypo pigmentation Cancer	Arsenic poisoning

Physicochemical Characteristics of Water

The physicochemical characteristics of water include pH, Hardness, Electrical conductivity, odour, colour and taste.

pH: This is the measure of acidity/basicity of water. The pH of water ranges from 0-14. pH below 7 indicates acid and the presence of free hydrogen ions, while pH above 7 indicates basic and the presence of hydroxyl ions in the water.

Hardness of water: Hardness is formed when water percolates through deposits of Calcium and Magnesium containing minerals like limestone, chalk and Dolomite (Kingland, 2004). Drinking hard water is not harmful to one's health but can pose serious problems in the boilers.

Electrical Conductivity: This is the total amount of solids dissolved in water (TDS). The higher the temperature, the higher the electrical conductivity will be. (George, 2006). The electrical conductivity of water increases by 2-3% for an increase of 1° degree Celcius of water.

Good quality water should have necessary characteristics such as being odourless, colourless, and tasteless, as any deviation from these standards may pose health problems in humans.

MATERIALS AND METHODS

Four different sachets of water, representing the water sold in the Aguata Local Government area, were randomly selected and labeled as samples A, B, C, and D, respectively.

Analysis of Heavy Metals in Water

These water sachets were filtered with filter paper and digested with 0.1 HNO_3 into 25cm^3 volumetric flasks. They were heated in a water bath before being taken to the Atomic Absorption Spectrometer (AAS) Variant AA240. The analyzed elements include iron, nickel, cadmium, magnesium, and chromium. Their wavelengths were determined according to the method of APHA, 1998.

Laboratory Analysis of Sachet Water Samples

Physical properties

Temperature: The temperature of the water samples was measured using a mercury-in-glass centigrade thermometer. The thermometer was placed vertically, immersing the mercury bulb in the water. It was allowed to stand until the temperature reading was ready.

Colour: A standard and a water sample were placed in Nessler tubes at the 50ml mark, and the tubes were placed on a white surface. The colour of the sample matched the standard (WHO, 1983).

Odour: A wide-mouth glass-stopped bottle was used. It was rinsed internally and externally using 4M HCl until it was entirely odorless. It was finally rinsed with distilled water. The bottle was filled halfway with the sample as soon as it was collected. The stopper was inserted and shaken vigorously for 2-3 seconds. The stopper was removed, and the odour was quickly observed by putting the nostril close to the mouth of the bottle (Dietrich & Burlingame, 2003)

Taste: This was done by sipping the water and paying close attention to any noticeable flavours or unusual odour (Dietrich & Burlingame, 2003).

Chemical Properties

pH: The pH of the samples was determined directly from the microprocessor pH meter according to the manufacturer's direction (Webster, 2003)

Water Hardness: This was determined directly by titrating with a standard ethylene diaminetetraacetic acid (EDTA), a complexing agent. Since EDTA is insoluble in water, the disodium salt of EDTA was used for this experiment. (Sana &Reham,2018)

Electrical Conductivity: The electrical conductivity of water was measured using a Jenway Conductivity meter. The probe was dipped into the container of samples until a stable unit was obtained and recorded (Gapprov & Isakova, 2023).

RESULTS AND DISCUSSION

Results

	PARAMETER	**SAMPLE A**	**SAMPLE B**	**SAMPLE C**	**SAMPLE D**	**WHO Acceptable value**	**SON Acceptable Value**
1	Colour	Clean and clear	Clean and clear	Clean and clear	Clean and clear	Clean and clear	Clean and clear
2	Odour	ND	ND	ND	ND	Odourless	Odourless
3	Taste	ND	ND	ND	ND	Tasteless	Tasteless
4	Temperature (°C)	26.9	27.6	28.9	27.9	27.9-28.0	25-27
5	pH	4.2	4.8	5.4	5.9	6.5-8.5	6.0-8.5

6	Hardness(mg/l)	33.3	44.8	62.7	34.6	121-180	197-202
7	Conductivity (µs/cm)	460.7	461.3	443.1	444.6	5-50	61-68

The table below compares the Physicochemical Properties of the sampled sachet water with WHO/ SON acceptable values.

Table 2: Physicochemical Properties of sampled sachet water compared with WHO (2011) and SON (2007) acceptable standard

ND: Not Detected

From Table 2 above, It was observed that colour, odour, taste and temperature (26.9-28.9°C), agreed with WHO and SON acceptable standards. Water hardness (33.3-62.7 mg/l) was observed to be below WHO (121-180mg/l) and SON (197-202mg/l) acceptable standard. Electrical conductivity of the sampled sachet water (443.1-496.3µs/cm) was far above the WHO (5-50µs/cm) and SON (61-82µs/cm) are acceptable standards. The pH (4.2-5.9) of the sampled sachet water was below the WHO (6.5-8.5) and SON (6.0-8.5) acceptable values. This value disagreement may have resulted from disinfectants and other chemicals added during the sachet water treatment.

Table 3: The level of heavy metals present in sachet water compared with SON and WHO standard

PARAMETER	**SAMPLE A**	**SAMPLE B**	**SAMPLE C**	**SAMPLE D**	**WHO Acceptable value**	**SON Acceptable value**
Iron (mg/l)	0.150	0.730	0.091	0.820	0.100	0.500
Nickel (mg/l)	0.000	0.017	0.007	0.110	0.050	0.070
Cadmium (mg/l)	1.270	0.068	0.054	0.012	0.050	0.110

Magnesium (mg/l)	1.351	1.887	7.024	6.030	1.000	2.200
Chromium (mg/l)	12.100	17.600	0.000	15.400	5.000	6.500

From Table 3 above, it was observed that all the samples except sample C have higher values of Chromium than the WHO and SON acceptable values. Magnesium values were higher than the WHO standard in all the samples, whereas samples A and B were within the SON standard. Cadmium values were higher than WHO and SON standards in all samples except sample D. Nickel values were within the WHO and SON acceptable values. Iron values were all lower than the WHO and SON acceptable values except sample A, which was within the acceptable value.

DISCUSSION

Total hardness is mainly due to the presence of Calcium and Carbonates. The study's hardness values (33.3-62.7mg/l) were below the WHO and SON acceptable limits. This means that these sachet water bottles are soft water. They lack Calcium and Magnesium, which help build strong teeth and bones (Cervoni, 2024).

All the four water samples were weakly acidic with pH (4.2-5.9) in their order. Acidity in water has several drawbacks, as consumers may be exposed to heavy metals, irritation of the gut lining, tooth enamel erosion, and weakening of the bones (Fowler-Linder, 2021).

The Sampled sachet water all exhibited a high level of electrical conductivity. Water electrical conductivity and dissolved solids are closely related. The presence of dissolved solids in water influences its ability to conduct electricity. Therefore, water with high conductivity is water with a high content of ions such as metals, salts, calcium minerals, magnesium, sulphates, sodium, etc. This study presented electrical conductivity higher than the WHO and SON standards, although the Nigerian Standard for Drinking Water Quality (NSDWQ) (NIS, 2007) recommends conductivity of less than 1000μs/cm (Ndububa, 2020).

This study presented the concentration of Chromium in the samples as A (12.10mg/l),

B (17.60mg/l), C(0.00mg/l), and D(15.40mg/l). Sample B had the highest concentration, while sample C had no chromium concentration. Samples A, B, and D concentrations were above the acceptable limits of WHO and SON. The concentration of Magnesium in the sample was recorded as A (1.351mg/l), B (1.887mg/l), C (7.024mg/l) and D (6.030mg/l). Sample C had the highest concentration, while sample A had the lowest. Higher dosages of Chromium and Magnesium may cause health hazards such as chest pain, high blood pressure, pneumonitis, and lung cancer (Vermin & Agarwal, 2005).

The concentrations of iron, nickel, and Cadmium in the sampled sachet water agreed with the WHO and SON acceptable limits. The body requires both iron and Nickel in small quantities to satisfy its nutritional requirements. A high dose of Nickel may cause dermatitis (Genchi *et al.*, 2020), while a high dose of Cadmium over a long time will cause pneumonitis and lung cancer (Aldernosoc, 2004).

CONCLUSION AND RECOMMENDATIONS

The results show that Chromium and Magnesium were the highest heavy metals in the studied sachet water. Iron, Nickel, and Cadmium are within reasonable limits of WHO and SON acceptable standards. Also, in the physicochemical parameters, the samples were confirmed to be odourless, colourless, and tasteless, in agreement with the WHO and SON drinking water standards. The temperature fell within the acceptable standard.

Therefore, routine quality assurance checks should be conducted on sachet water samples to ensure that sachet water sold to Nigerians is safe for drinking. Water sustains life, and improving access to safe drinking water can bring tangible health benefits. Every effort should be made to achieve good drinking water quality.

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