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EFFECTS OF VOLATILE COMPONENTS FROM BANANA (*Musa Species*) ON POLYETHYLENE TEREPHTHALATE PACKAGED WATER

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Abstract: Effect of volatile components from banana (*Musa species*) on polyethylene terephthalate (PET) packaged water was studied using Gas chromatography (GC 7890) and mass spectrometer comprising automated liquid sampler and gas chromatograph interfaced to a mass spectrophotometer (MS) for analysis. Twelve components were quantified. Among them are Dibutyl phthalate (1.55%), Methylenebis (2, 4, 6-triisopropylphenylphosphine) (0.0886%), Diisooctyl phthalate (0.301%), Bis (2-ethylhexylester) (0.0586%), and Triethylcitrate (0.121%). The results showed that component of the PET was degraded by the volatiles from the banana leading to contamination of the water.

1. INTRODUCTION

Several submission of water is a crucial aspect in human sustenance, honestly as drinking water or as an ingredient of food. Water is necessary for survival but is said to be a chief cause of disease and nursling death in many underdeveloped countries, as well as in developed countries (Ford, 1999). Three most basic essentials of life are air, water, and food, in that order. A person can go without food for roughly a month, drink for about a week, and air for less than five minutes (Sooryamoorthy and Antony, 2003). Among the eight necessities of basic health care defined by the International Conference on Primary Health Care was the availability of clean drinking water. During colonial era in Nigeria, the government provided free water to the general public. Nigeria, on the other hand, has transitioned. Water is subjected to rates and levies in municipalities (Sangodoyin, 1990). Within the confines of a sufficient government water supply, private sector engagement has emerged, and packaged drinking water, sometimes known as "clean water," is a typical occurrence in the country. Drinkable water is commercially packaged in 50–60 mL plastic sacks that are easy to open and referred to as "sachets of clean water." packaged water is inexpensive and handy. It is becoming widespread. As a result, its manufacture has been abused, resulting in a position where purified water is anything nonetheless pure.

The resin used to produce disposable soda and water bottles is polyethylene terephthalate (PET). Polyethylene terephthalate is a polycarbonate-like compound. It's made up of long chains of an aromatic ester polymerized. Ethylene glycol and terephthalic acid are the ingredients used to make the PET backbone. Heat, oxidation, light, ionic radiation, hydrolysis, and mechanical shear can all breakdown non-biodegradable polymers, as can pollutants like carbon(II)oxide, sulphur(IV)oxide, nitrogen(IV)oxide, and ozone (Ravve, 2000), The polymer becomes brittle fragments, and releases breakdown products as a result.

Bananas are a tropical fruit grown in over 122 countries worldwide. The starch in bananas is transformed into reducing sugars during ripening, and sucrose levels rise as the fruit ripens (Lii et al.).

In most nations, the sale and consumption of packaged water is precipitously increasing (Gardner, 2004). The perception that good-quality natural spring water and potable drinking water offer a salubrious, reviving, and tasting alternative to high-calorie soft drinks; and convenience, which has made the products valuable to any lifestyle when required and have contributed to increased demand for the drinking water (Gardner, 2004). In recent years, only a few studies (Olayemi, 1999; Gyang et al., 2004) have been undertaken in Nigeria on the excellence of packaged water. They were solely concerned with the final product, ignoring the procedures that determine the final fate of the packaged water, as well as the people in whose hands lie the will and power to effect the desired change. Water, according to Traven (2000), is a transparent, colorless, and odourless liquid that can exist in three states: liquid, solid, and vapour. Water is an essential requirement for life, because it provides food for humans, animals, bacteria, and plants. According to Biswas (2005), water has been regarded as a vital factor for human existence and growth. More than two millennia ago, the Greek philosopher Thales of Miletus declared "the finest of all thing is water," and human life continues to rely on water. Water obtainability is an urgent problem in many developing countries, according to Okonkwo et al. (2008), and cause substantial distress to families and communities that rely on non-public water sources. They think that this critical water demand is linked to a rise in human population, which puts strain on the supply of clean drinking water, particularly in developing nations. Tortora and his associates (2002), said water-borne illnesses is the world's most severe public health problems. Sachet-packed drinking water was launched as a less priced alternative to bottled water, according to Ogundipe (2008). It's also a step above from the hand-filled, hand-tied polythene bags that used to be offered as drinking water to consumers. He went on to say that the easy availability of bottled drinking water has occasioned a vast blooming water business in Nigeria, with Nigerians using hundreds of millions of litres of water each year. According to Jayanty et al. (2002), said that bananas contain over 250 volatile components, the banana fruity top notes are obtained from volatile esters. (Wendakoon *et al*, 2006). The main volatile compounds identified in "Cavendish" bananas, according to Boudhrioua et al. (2003), were (E)-2-hexenal and acetoin, (E)-2-hexenal and hexanal in "Plantain," and 2,3-butanediol and two diastereomericsolerols in "Frayssinette." 3-methyl butanol, 3-methyl butanoic acid, and solerol were the most prevalent aglycones (two diastereomers). This component, which is seldom found in fruits, was discovered in conjugated volatile compounds of fruits for the first time. The presence of these two diastereomers in "Frayssinette" extracts seems to be cha) and acetovanillone racteristic of this banana type. According to Mattheis et al. (2005), reducing O_2 and increasing CO_2 can increase the shelf life of a lot of fresh fruits. Fresh foods exposed to O_2 levels below their tolerance limit, on the other hand, may encourage anaerobic respiration and lead to the production of off-flavors. According to Ortiz et al. (2009), keeping fruit in a controlled atmosphere (CA) inhibits many fruits' ability to generate ethylene and changes the production of aroma volatiles. At both test dates, freshly picked fruit generated much more esters than air-stored fruit, although branched butyl

compounds (2-methyl butyl butanoate) exhibited a significant decrease after 6 weeks of storage (Harb et al., 2008). Similar to CA, packaging and eatable coatings can generate a modified atmosphere (MA) with lower O_2 and greater CO_2 levels. The usage of edible coatings affects the quantity of volatile flavor chemicals in citrus, apple, and mango fruits (Cohen et al., 1990). Anaerobic respiration and the formation of ethanol and acetaldehyde, as well as trapped volatiles like ethanol and acetaldehyde, were most likely induced by the coating barrier (Baldwin et al., 1999). Mango "carnauba" showed effectiveness in slowing ripening, keeping fruit firmness, and boosting fruit quality attributes such as fatty acid levels and volatile scent when the impacts of numerous eatable coatings on mango fruit were studied. Dabrowska *et al* (2003), looked at the impact of carbon dioxide levels in bottled water. The greater amounts of acetaldehyde in bottled water were not related to CO_2, according to various research. Diffusion was supposed to be aided by the pressure created by the gas on the PET wall. Low pH had no influence on migration in another experiment using PET fragments in contact with de-ionized water at pH 4.5 and 6.5. Orodu et al. (2017) investigated volatile components from crushed garlic (Allium sativum) into water packed in polyethylene terephthalate. The findings revealed the presence of 53 distinct components/contaminants and other water-soluble volatile chemicals. Orodu (2021) states that he put sachet water in the fridge that containing scent leaf and discovered that the water tasted like scent leaf. When the water was tested, a total of 24 contaminants were detected.

2. MATERIALS AND METHODS

2.1 Materials: Banana fruits**,** Syringe (10 mL**),** Petri dish**,** Desiccator**,** Glass vials**,** Sachet and bottled water (PET)**,** Knife

2.2 Methods

The banana fruits were cut and placed in a petri dish in a desiccator with sachet water and bottled water at a storage temperature of 30^{o}C. For four days, the set-up was remained in place. The water from the sachet was removed, washed with distilled water, and collected with a 10 mL syringe into water vials from the sachet for analysis. First, the suspicious components were extracted from the aqueous phase into the organic phase using dichloromethane before being sent for GC-MS analysis.

2.3 Gas Chromatography-Mass Spectrometry

GC-MS analysis was performed using an Agilent GC-7890 (Agilent) with an automated liquid sampler and a gas chromatograph interfaced to a mass spectrophotometer (GC-MS). The injector temperature was set at 550^{o}C and the carrier gas was helium. The oven temperature was scheduled to rise from 100^{0}C to 375^{0}C at 20^{0}C/min after being kept at 100^{0}C for 5 minutes. The component's name, molecular weight, and structure were determined. GC/MS is an instrumental analytical technique that uses a gas chromatograph and a mass spectrometer. The GC is used to break down complex chemical combinations into their component constituents in general. Once the molecules have been separated, a mass spectrometer can identify and quantify them. The sample is prepared by extracting the analytes of interest into a liquid solvent phase prior to analysis. After concentrating the extract to 1 mL, it was examined as follows: A microliter of liquid organic material was introduced into the GC, where an inert carrier gas swept it onto a separation column (helium). The analytes in the mixture were carried through the column by the carrier gas, where they were separated by their interactions with the coating (stationary phase) on the column's interior wall and the carrier gas. Each analyte interacted with the stationary phase at different rates.

3. RESULTS AND DISSCUSSION

The analysis of water sample for volatile components gave a result that showed the presence of 12 components which were identified and quantified.

Table 1: showing the components present in the sachet water.

Compounds	**RT(min)**	**Amount(%)**
Oxygen	4.1053	0.121
Triethyl citrate	13.1239	0.0777
1,2-benzenedicarboxylic Acid	14.4436	2.56
Dibutyl phthalate	15.1507	1.55
Hexanedioc acid Bis(2-ethylhexyl) ester	16.8264	0.0586
Methyl dehydroabietate	17.3823	0.0221
Diisooctyl phthalate	18.0008	0.301
Methylenebis(2,4,6-tri Isopropylphenylphosphine	21.2609	0.0886
Cis-6-octadecenioc acid	22.1274	0.0202
3-Ethyl-3-methylheptane	14.0222	0.00656
Hexasiloxane, tetradecamethyl	17.8998	0.007252
2-Fluoro-3-trifluoromethylbenzoic acid	20.6537	0.00779

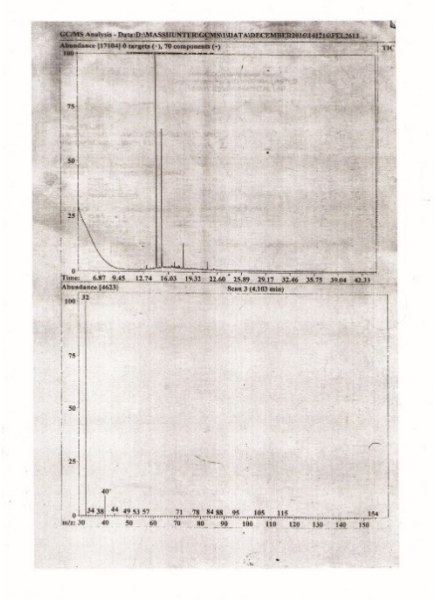

Figure 1. Chromatogram: for the experiment

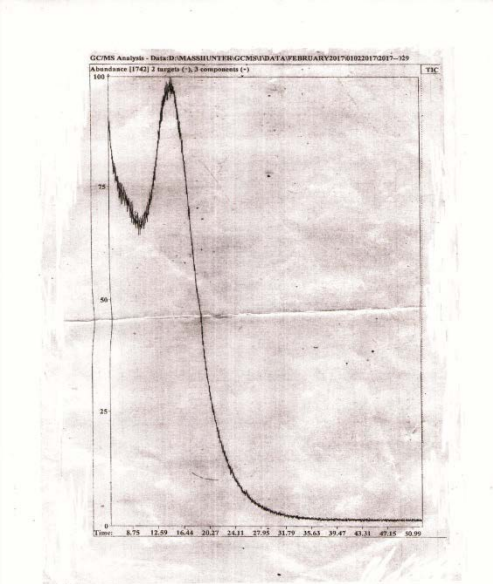

Figure 2. Chromatogram for control

Table 2: showing the compounds present in the control

Compounds	RT(min)	Amount (%)
Nitrogen	5.5277	0.0379
Nitrogen	5.5726	0.0750

4. DISCUSSION

Findings of experimental work are shown in Table 3.1, whereas the results of the control work are shown in Table 3.2. Four phthalates, one alcohol, one carboxylic acid, and one hydrocarbon were found in the sample. The presence of nitrogen, an important ingredient for dietary nutrition, was seen in control. The transdermal absorption of viprostol, a synthetic prostaglandin E2, via the skin of male hypertensive rats has been observed to be inhibited by triethyl citrate (Nicolauet al., 1989). Although no causative relationship has been shown, dibutyl phthalate (1,2-Benzenedicarboxylic acid) has been reported to induce unfavorable reproductive and developmental consequences in humans, comparable to those seen in rats. In humans, the implications of reproductive development comprise decreased anogenital distance in newborn boys, as well as shortened pregnancy, lower sex and thyroid hormones, and poorer sperm quality in adults. Contact with hexadecane may cause the skin to lose its natural fat, resulting in desiccation. If eaten and enters the airways, serious eye injury or irritation can be deadly. If breathed, inhalation can be dangerous (may cause respiratory tract irritation). On contact with haxanedioic acid, significant eye damage might occur. Terephthalic acid (Benzenedicarboxylic acid) can irritate the skin and eyes when it comes into contact with them. Coughing, wheezing, or shortness of breath can result from inhalation irritating the nose, throat, and lungs. It's carcinogenic, and long-term exposure can harm the kidneys. Diisooctyl phthalate has the same effect as terephthalic acid, however 2-decanol, like other higher molecular weight alcohols, may be toxic to humans.

5. CONCLUSION

This study found that keeping sachets and bottled water (PET) with things that are prone to emit volatile components affects the polyethylene terephthalate, allowing the component to leak into clean water, rendering it unsuitable for consumption.
The PET was disintegrated by volatile components from bananas (Musa species) put in same compartment, releasing phthalates, which are capable of causing cancer and have grave health consequences

6. RECOMMENDATION

Sachets and bottled water should not be stored in the refrigerator or laboratory with other things that are prone to release volatile components because PET can be damaged by the volatiles of substances stored with them, releasing dangerous chemicals into the water.

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