DETERMINATION OF HEAVY METALS IN EDIBLE PALM OIL ADULTRATED WITH PLANT DYE

ABSTRACT

Edible palm oil has been the parity of the human diet from generation to generation and has contributed both to nutrition and health. The present work was undertaken to investigate the possibility of adulterating palm oil with natural potash (lake salt) and red dye from the leaf sheath of sorghum bicolour. Concentrations of potash and red dye ranging from 0.01-0.1% and 0.1-1.0% respectively were prepared in water; and then added to fresh palm oil at oil/adulterant ratios ranging from 10:1-10:10, to obtain adulterated palm oil with known concentrations and adulterant ratios. Adulterated samples were examined visually for appearance, and evaluated for quality indices and sensory attributes. The use of potash changed the characteristic orange red color of palm oil to yellowish red even at levels below 0.01%; and also resulted in product with increased consistency. The results of heavy metals showed that Zn 8.06±0.06, Cd 1.01±0.05, N 1.00±0.00, C 125.91±0.09, Pb 9.30±0.07 Cobalt, Lead zinc were above the detectable limit of the WHO standard while Cd and Ni were within the permissibility limit. The results obtained from this study indicate that the palm oil may cause a public health risk if proper monitoring is not maintained by regulatory agencies. Thus, there is a need for improved screening of our local processed palm oil from the time of production to the time of consumption.

Keyword: Heavy metals, oil palm, Plant dye

1.1 INTRODUCTION

The oil palm is a monocotyledon, which grows from the center. It produces one leaf at a time, emerging from the apex, with the leaflets folded against each other. It then spreads it leaflets as photosynthetic ability of the individual leaf develops. A palm can live up to sixty-five years and reach a height of 20 meters (Akinoso et al., 2018). The palm was able to flourish in a non-optimal area because of the succession regime to which oil palm has adapted. The palm is an early succession plant, which grows in climates which are suitable for high tropical forest. Therefore, oil palms are only able to establish in the forest climate either on river banks or where an opening is created to allow sufficient sunlight (Jacobs, 2017).

The oil Palm (*Elaeisguinensis*) is West Africa’s most important oil producing plant. The fruit produces two distinct types of oil: orange-red crude palm oilwhich is extracted from the mesocarp and brownish yellow crude palm kernel oil extracted from the seeds (kernel). The former consists of mainly palmitic and oleic acids and the latter of mainly lauric acid. Both oils are important in the world trade. Crude palm oilis the richest natural source of carotenoids and tocotrienols. The carotenoids (500–700 ppm) are responsible for the characteristic deep orange-red color while its semi-solid consistency at tropical room temperature is mainly due to the presence of triacylglycerols of palmitic and oleic acids (Henderson, 2015).

Palm oil, the second most consumed lauric acid group oil is derived from the dried kernels of the oil palm, *Elaeis Guinensis*. Palm oil comprises less than 5 percent of the total natural fats and oils, but they are important feed stocks of the oleo chemical industry. Nuts and seed oils are receiving growing interest due to their high concentration of bioactive lipid components which have shown various health benefits. Palm oilis an edible plant oil derived from the kernel of the oil palm *Elaeisguinensis*. Palm mesocarp oil is 41% saturated and semisolid at room temperature and contain several saturated and unsaturated fats in the forms of glyceryllaurate (0.1% saturated), myristate (1%saturated), palmitate (44% saturated), stearate (5% saturated), oleate (39% monounsaturated) and linoleate (10% polysaturated) (Cook et al., 2017).

Heavy metals are naturally-occurring elements that have high atomic numbers and densities higher than the density of water by at least five times. Most heavy metals occur in the Earth's crust. Heavy metals cannot be easily degraded. The occurrence of heavy metals in food often results from environmental and industrial contamination (Gutteridge and Thornton, 2015). Esterhuyse et al. (2018) linked heavy metal contamination in food to environmental pollution. Others routes through which humans are exposed to heavy metals include contaminated air, water, and soil (Matthaus et al., 2017). It could also be from the raw materials used for the processing of the specific food products and water.

The toxicological effects of heavy metals on human health and nutrition have been increasingly studied in recent years. Some elements such as Cu, Zn, and Fe can act as nutrients and are important for health, while others such as Ni, Pb, Cd, As and Hg may be harmful for humans if excessive amounts are consumed (Fukuwatari and Shibata, 2018). Heavy metals are considered as serious inorganic pollutants because of their toxic effects to life (Giovannucci et al., 2018). The heavy metals enter the human body through inhalation and ingestion. The intake via ingestion depends upon food habits. It is well established that Pb and Cd are toxic and children are more sensitive to these metals than adults. The metals namely Cu and Zn are essential micronutrients and have a variety of biochemical function in all living organisms. While Cu and Zn are essential, they can be toxic when taken in excess; both toxicity and necessity vary from element to element (Gutieerres et al., 2019).

There is a wide spread speculation in Nigeria that crude palm oilis being adulterated. The adulteration is believed to be practiced by producers in order to increase the quantity of PALM OIL, for the sole purpose of profit maximization. Unfortunately, the adulteration practice is normally done without considering its possible effect on the quality of palm oil and the health of consumers. The adulterants reportedly used include carrot, papaya, natural potash and red dye; with potash and red dye being the preferred and most widely used adulterants due to their abundance and low cost (Hodge, 2015). Natural potash, also called lake salt and locally known as "kanwa" is a mineral consisting of chlorides, sulphates and carbonates of Na, Ca, and K, as well as some micronutrients (Holick et al., 2021). Kanwa is also a food condiment used locally as tenderizer for tough cuts of meat; as thickener for increasing the viscosity of soup; and as emulsifying agent between oil and water. Red dye on the other hand is the aqueous extract (evaporated to dryness) of the leaf sheath of *sorghum bicolor* (Kanfman and Wiesman, 2017). The plant is known as "Karan dafi" in Northern Nigeria whereit thrives, and the dye extracted is commonly used in coloring leather red, coloring of clothes, calabashes and as a body pigment.

One major problem associated with the use of adulterants is that these compounds have not undergone stringent studies and the level of threat they may pose to human health when consumed, not well established. For crude palm oil, adulteration could lead to loss of quality and nutritive properties, loss of organoleptic attributes and overall degradation of the oil (Maqbool and Stallings, 2018). The aim of this work was to investigate the possibility of adulterating palm oil with potash and red dye from leaf sheath of *sorghum bicolor*. Effort was also made to develop a simple, rapid and effective test for identifying adulterated crude palm oil.

1.2 Statement of the problem

The quality of any oil is indicated by some physico-chemical properties. The specific value of some of these properties provides an indication of both the nutritive and physical quality of the oil. Recently; palm oilhas become the second most consumed oil all over the world as a result of its being rich in natural antioxidants, vitamins and exhibiting high oxidative stability with attendant long shelf life. One major problem associated with the use of adulterants is that these compounds have not undergone stringent studies and the level of threat they may pose to human health when consumed, not well established. For crude palm oil, adulteration could lead to loss of quality and nutritive properties, loss of organoleptic attributes and overall degradation of the oil. No literature was found on adulteration of palm oil with non-oil product such as potash and red dye of natural origin. The objective of this work was to investigate the possibility of adulterating palm oil with potash and red dye from leaf sheath of *sorghum bicolor*.

Consumers trust that the oil they buy are safe and their quality is guaranteed. They also expect to be provided with information that can help them to make informed decisions about the purchase of products and that the information on product labels is not false or misleading. The analysis of heavy metals that include lead, nickel, manganese, zinc, cadmium and chromium is therefore justified to provide precautionary use of the drinks, as well as provide a basis to sensitize government authorities.

1.3 The objectives of the study will entail

1. To determine the physicochemical parameters in palm oiladulterated with red dye from the leaf sheath of sorghum bicolour

2. To determine the heavy metal composition of physicochemical parameters in palm oiladulterated with red dye from the leaf sheath of sorghum bicolour

1.4 Scope of Study

To achieve the specific aim of this work, the scope is to investigatedsome selected heavy metals and physicochemical parameters in palm oiladulterated with red dye from the leaf sheath of sorghum bicolour.

1.5. SIGNIFICANCE OF STUDY

Many of the red oil in Nigerian markets are deemed to contain metal level of NAFDAC/ WHO standard. This present study will be highly significant as it will confirm if the level of heavy metal in this oil actually falls within the specified standard.

Consumers of oil will benefit from the study as they can be aware of the level of heavy metal contains in the oil and also the need to avoid the drinks should the result show high level content.

- This research will enlighten consumers on the physico chemical content of palm oils in our market and this will help them make decision on which brand to buy.

MATERIALS AND METHODS

2.1 Materials

Oven, weighing balance, heating mantle, volumetric flask, conical flask, spatula, watch glass, AAS.

2.2 Sample collection

To assure the absence of adulterant of any type, the crude palm oil used in this study was processed in the Lab from freshly harvested ripe palm fruits purchased from Eke Awka. The fruits were supplied by a local palm oil processor, while the potash and red dye used as adulterants were purchased from a local grocery store.

2.3 Sample preparation

Palm oil was extracted in the Lab using traditional technique (Matthaus, 2017): Fresh palm fruits were parboiled in a cooking pot (to prevent enzymatic spoilage and to soften fruits mesocarp for easy pounding) and then pounded using wooden pestle and mortar until pulp and nuts were obtained. The nuts (palm kernels) were removed and the pulp manually squeezed to obtain a red viscous fluid (oil, fiber, water, impurities), which was heated for traces of water to evaporate, and finally sieved using metal basket to obtain a clear red palm oil.

2.4 Sample adulteration

Aqueous potash and dye solutions ranging from 0.01-0.1% and 0.1-1.0% respectively were prepared by dissolving 1g of potash or red dye in 100ml distilled water, and then diluting with distilled water to obtain the required concentrations. Exactly 10g of the freshly processed palm oilwas weighed into 145 transparent plastic vials of 25ml each and warmed in a water bath set at 45^{o}C to decrease oil’s viscosity. Then to 50 of the vials, potash solutions were added while to the remaining 95, dye solutions were added; following the ratios shown in Table 1. (Adulterant concentration of 0.10% and a corresponding Oil/adulterant ratio of 10:1 for instance, indicate that 1ml of 0.1% adulterant solution was added to 10g of fresh red palm oil). The samples were agitated, capped and then stored on the shelves of the laboratory under diffused light and inspected visually (for color and appearance) every 24 hours for 30 days. Fresh red palm oilwith no added adulterant served as the control. During the entire storage period, samples whose appearance differed slightly or completely from that of the control were eliminated from the study, retaining only samples whose color and consistency were comparable to those of the control.

Maintenance of Sample: Samples were maintained at ambient temperature in sterile containers and were quickly transported in sterile canisters to the laboratory for analysis.

Moisture content determination

Moats and Rimu (2017) method was used. 5ml of the sample were weighed into clean, dried and pre weighed crucibles. The crucibles and their contents were dried in the moisture extraction oven at 105^0C for 1 hours. The samples were then removed from the oven, cooled and reweighed. The samples were again put back into the oven and dried until a constant weight was obtained. This analysis was carried out in triplicate and the average value was recorded as moisture content.

% Moisture content =

Initial weight of sample– weight of oven dried sample X 100

Initial weight of sample

3.5 Determination of specific gravity (AOAC, 2005)

Procedure

Weigh empty SG bottle and note the weight.

Fill the bottle with distilled water.

Weigh again and note the weight of the bottle and water.

Fill the bottle with the oil.

Weigh again and note the weight.

CALCULATION

$$SG = \frac{\text{weight of the oil (g)}}{\text{Weight of distilled water}}$$

pH

About 2g of the oil sample was weigh into a clean dry 25ml beaker

13ml of hot distilled water was added to the sample in the beaker and stirred slowly.

It was then cooled in a cold-water to 25^{o}C.

The PH electrode was standardized with buffer solution and the electrode immersed into the sample and the PH value was read and recorded.

2.6 Melting point determination(JIS K 007- 1992)

Each oil in a capillary tube was allowed to freeze in a freezer for 1 h and heated slowing in a water bath. The temperature at which the oil began to slip in the capillary tube was recorded as the slip point or melting .

3.7 Determination of iodine value **(Merke et al., 2019)**

Twenty five (25) milliliters of iodine monochloride was added to 1ml of the oil, stoppered and left to stand in the dark alongside a blank without the oil sample and 10 mL of chloroform added instead; for 1 h. The flask was rinsed with 50 mL of distilled water and 10 ml of 10% KI solution was added. The liberated Iodine was immediately titrated with 0.1 M Na2S2O3 until the iodine solution was brownish yellow then 1 mL of starch solution indicator was added. The titration was continued until the developed blue colour disappeared. The volume of the Na2S2O3 was used to calculate the iodine value.

Iodine value = (Blank- Titre value) * molarities of Na2S2O3 *12.69

Weight of sample gm

3.8 Determination of saponification value (JIS K 007- 1992)

Two (2) grams of the oil was refluxed with 25 mL of alcoholic potassium hydroxide solution (0.5 M) for 1 h with frequent shaking. The excess alkali was titrated with 0.5 M hydrochloric acid and 1 mL of phenolphthalein indicator. A Blank titration was carried out alongside and the Saponification value calculated thus:

Saponification value = (Blank-Titre value)*28.05

Weight of oil (g)

3.9Determination of free fatty acid of the oil (Onyegbado et al., 2022)

1 g of the essential oil was poured in a beaker and warmed; 25 ml of methanol was added to the sample and stirred thoroughly followed by 2 drops of phenolphthalein indicator and a drop of 0.14 N NaOHsolution. The mixture was titrated against NaOH solution until a light pink colour which persisted for about 1 minute was observed. The end-point was recorded and used to calculate the free fatty acid from Equation below

*FFA =(titer value x N x*28.2)

Weight of oil

Where FFA denotes the free fatty acid and N is the normality of the base.

3.10 Determination of acid value of the oil

To determine the acid value of the extracted oil, 2g of the oil sample was weighed into a conical flask containing 50 ml of isopropyl alcohol. 3 drops of phenolphthalein indicator were added to the mixture. The resulting mixture was titrated against 0.1 M NaOH [19], and Equation was applied to calculate the acid value of the oil.

Acid value = (5.61 x titer value)

Weightof sample

Peroxide value determination (Eddy et al., 2011)

One (1) gram of the oil sample was allowed to boiled with 1 g potassium iodide and 20 mL of solvent mixture (Glacial acetic acid and chloroform [2:1] v/v) for 30 s and then vigorously for another 30 s. This was poured into 20 mL of 5% potassium iodide and the boiling tube washed twice with 25 mL of distilled water. This was titrated with 0.002 M of the $Na2S2O3$ using starch indicator, a blank was similarly titrated. Calculation

Peroxide value = 1000(V2-V1)T

M

Where M = mass of oil taken (1 g); V2 = volume of 0.1 N Na2S2O3; V1 = volume of 0.1 N Na2S2O3 used I blank and T = normality of Na2s2O3 (0.1 N)

3.11 HEAVY METAL ANALYSIS

Preparation of sample

The sample was homogenize and dried in the oven at 105^0C to dryness.10g of sample was accurately measured in 250ml conical flask and 12ml of conc. HNO_3 in a fume hood was added and covered with a watch glass. Samples will be heated in a heating mantle close to dryness and cooled.10ml each of conc. HNO_3 and $HCLO_4$ will be further added. Samples will be evaporated gently on a heating mantle until dense white fumes of $HCLO_4$ appeared. The Sample was cooled and diluted to 50ml with distilled water and boiled to expel any chlorine or oxide of nitrogen. The Sample was cooled, filtered and transferred into 50ml volumetric flask and made up to mark with distilled water.

Preparation of standard solutions

Standard solutions of Lead, Cadmium, Copper, and Nickel will be prepared from 1000 ppm Standard Stock Solution of GFS Fishers' AAS Reference Standard. These stock solutions will be serially diluted to give concentrations of 0.5, 1.5, and 2 ppm for lead while 0.5, 1, 1.5, and 2 ppm for cadmium, and 0.5, 1, 1.5,2 for copper, and 0.5, 1, 1.5,2 nickel standards.

Digestion of samples

All the sample will be digested using the same method. 5gm of each sample was carefully pipette into digestion test tube and 10 ml of digested acid (3:1 HCl:HNO_3) Was added to each sample. This was placed on the hot plate as 30 min. On completion of digestion, the digested samples will be allowed to cool to room temperature and made up to 50 ml with distilled water, then the samples will be filtered(use wit man filter paper No.41) and of each samples will be transferred into volumetric flask for analysis by flame atomic absorption spectroscopy(FAAS).

3. RESULT

The result for the physical and chemical properties of the unadulterated and adulterated palm oil used in the study are presented in table 1 and 2.

Table 1: Physical properties ofunadulterated and adulterated palm oil used in the study

SAMPLE	MOISTURE	pH	DENSITY	MELTING POINT
CONTROL	**0.50**	**6.89**	**0.91**	**32**
DYE ADULTRATED 1	**0.20**	**7.25**	**0.92**	**34.2**
DYE ADULTRATED 2	**0.20**	**7.13**	**0.91**	**34.2**
COLOUR ADULTRATED 1	**0.20**	**7.47**	**0.9**	**34**
COLOUR ADULTRATED 2	**0.20**	**7.43**	**0.91**	**35**
PLANT ADULTRATED 1	**1.2**	**7.38**	**0.91**	**30**
PLANT ADULTRATED 2	**1.2**	**7.63**	**0.91**	**34**

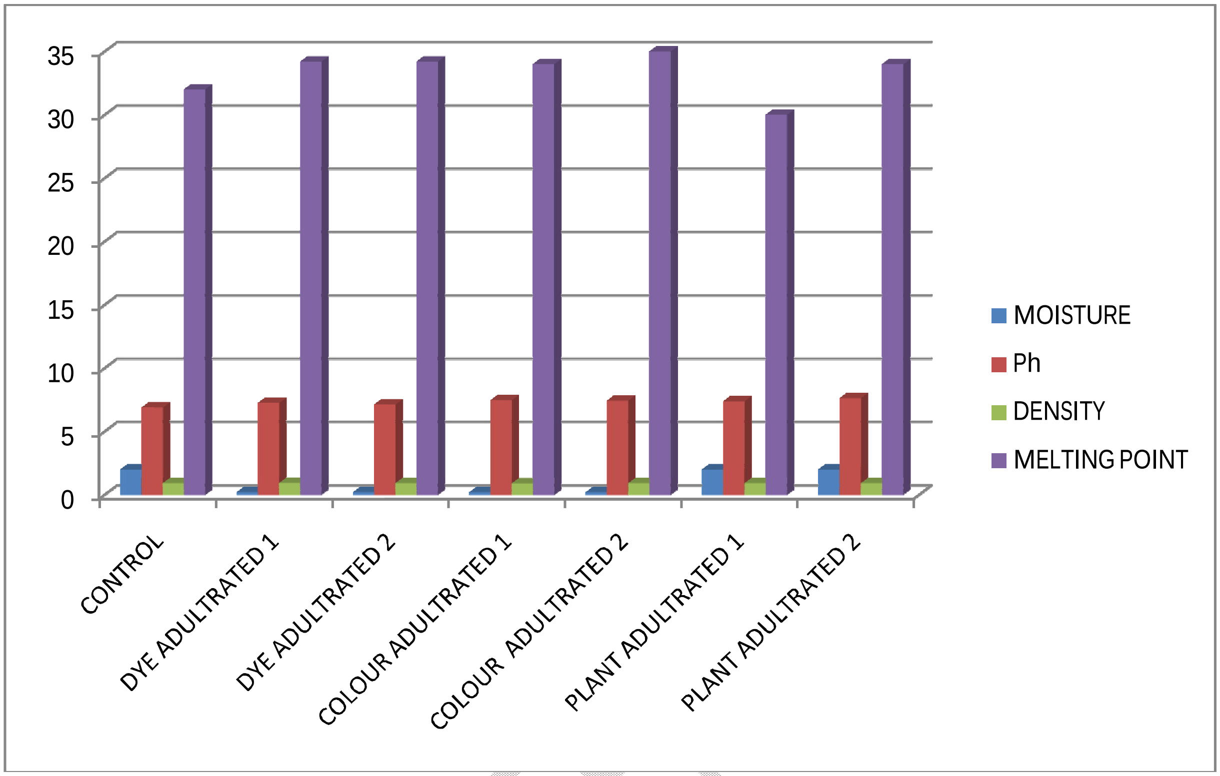

FIG. 1. PHYSICAL PROPERTIES OF PALM OIL

Table 2: Chemical Properties of unadulterated and adulterated palm oil used in the study

SAMPLE	FFA (%)	ACID VALUE (Mg)	IODINE VALUE(g)	PEROXIDE VALUE(Millieq/kg)	SAPONIFICATION VALUE (Mg/KOH)
CONTROL	**2.56**	**5.10**	**40.60**	**12.6**	**172.53**
DYE ADULTRATED 1	**1.96**	**3.90**	**125.63**	**1.6**	**221.63**
DYE ADULTRATED 2	**2.41**	**4.80**	**85.02**	**9.2**	**280.6**
COLOUR ADULTRATED 1	**3.61**	**7.20**	**120.55**	**11**	**277**
COLOUR ADULTRATED 2	**1.15**	**2.30**	**125.63**	**12.6**	**187.97**
PLANT ADULTRATED 1	**2.21**	**4.40**	**39.34**	**10.6**	**224.44**
PLANT ADULTRATED 2	1.46	**2.90**	**64.72**	**12.4**	**190.77**

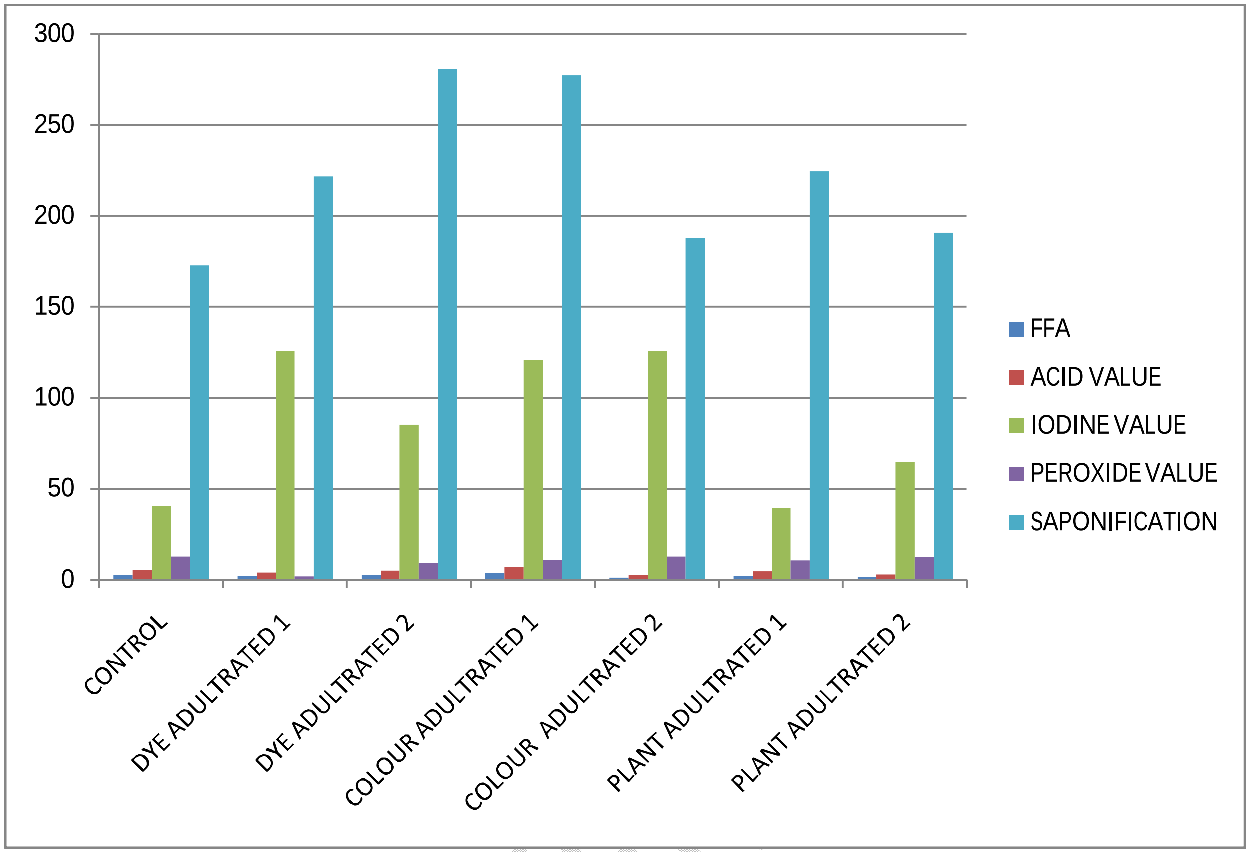

FIG. 2. CHEMICAL PROPERTIES OF PALM OIL

Heavy metal analysis

The result of the heavy metal analysis in the unadulterated and adulterated palm oil **used in the study are shown in table 3.**

Table 3: Heavy Metal Concentrations in unadulterated and adulterated palm oil used in the study

SAMPLE	**LEAD (Mg/100ml)**	**IRON (Mg/L)**	CHROMIUM (Mg/L)	**ZINC (Mg/L)**	**NICKEL (Mg/L)**	**COBALT (Mg/L)**	**COPPER (Mg/L)**	**CADNIUM (Mg/L)**	**MANGANESSE (Mg/L**
CONTROL	**2.56**	**9.1**	**2.8**	**8.3**	**6.8**	**1.8**	**7**	**12.53**	**6.6**
DYE ADULTRATED 1	**1.96**	**3.9**	**5.63**	**16**	**16.4**	**5.63**	**11.6**	**68.3**	**10.7**
DYE ADULTRATED 2	**2.41**	**4.8**	**4.7**	**10.2**	**20.6**	**5.02**	**9.2**	**55.7**	**8.6**
COLOUR ADULTRATED	**3.61**	**22.6**	**6.8**	**11**	**27**	**10.55**	**1**	**61.1**	**7**

1									
COLOUR ADULTRATED 2	**1.15**	**23**	**4**	**12**	**18.97**	**15.63**	**2.6**	**44.5**	**7.97**
PLANT ADULTRATED 1	**1.46**	**29.06**	**3.7**	**11.2**	**14.44**	**6.7**	**12**	**13.8**	**4.44**
PLANT ADULTRATED 2	**2.21**	**18.4**	**3.34**	**10.6**	**18.3**	**9.1**	**10.6**	**14**	**8.83**
FAO/WHO permissible limits	1.46	**8**	**0.1**	**6**	**3**	**0.06**	**30**	**9**	**6.4**

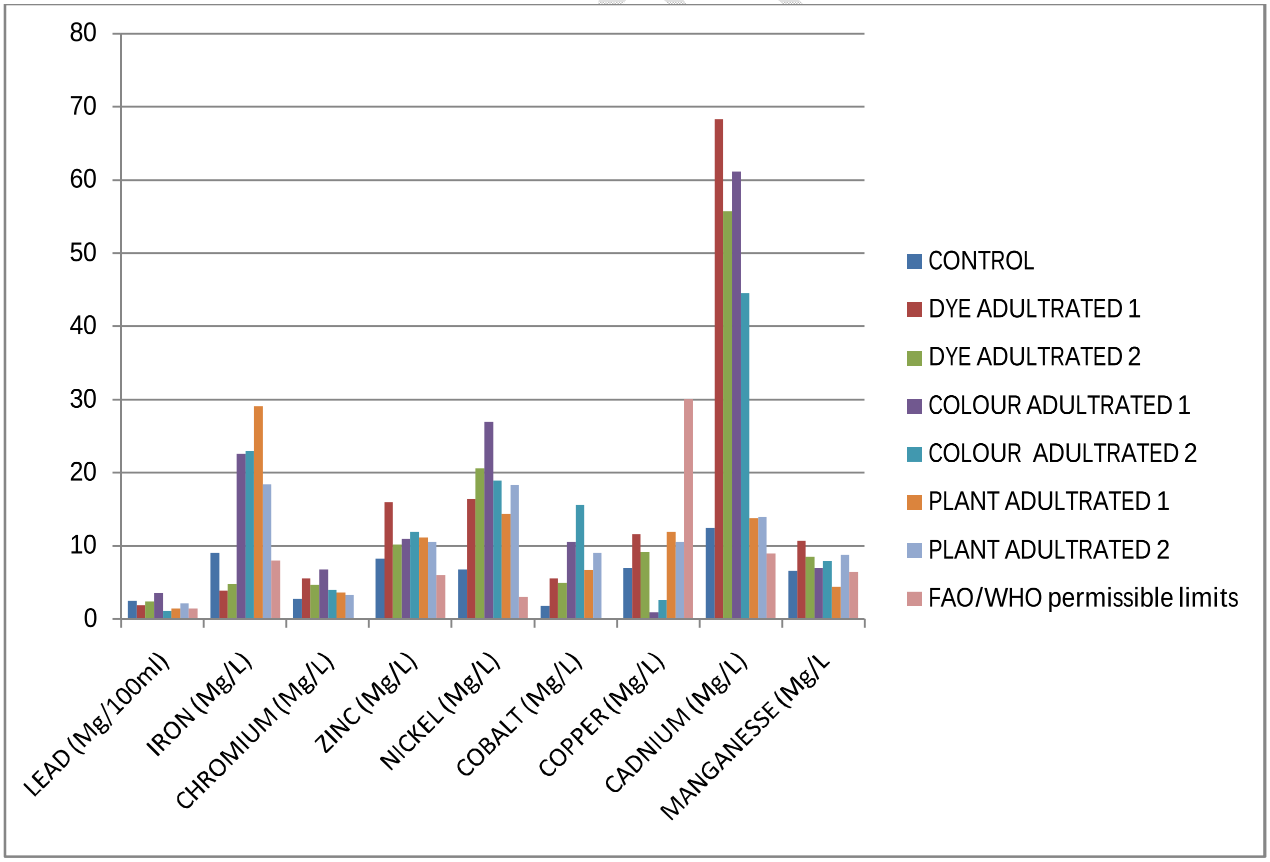

FIG.3. HEAVY METAL CONCENTRATIONS IN PALM OIL

4. DISCUSSION

Adulterated samples prepared using dye solutions of concentrations exceeding 1% showed bright redness which was by far brighter than the characteristic orange-red color of the control. Likewise dye concentrations lower than 0.1% had light-red color which was by far lighter than that of the control. Consequently, minimum and maximum concentrations of dye solutions were established as 0.10 and 1.0% respectively. The use of potash solutions at levels from 0.01% and above increased the volume of palm oil by up to two fold, but also changed the characteristic orange red color of palm oilto yellowish red and also resulted in a product with a more viscous consistency. On the other hand, the use of potash solutions below 0.01% resulted in two immiscible liquid phases. Consequently, potash was considered to be far from an ideal adulterant and eliminated from further study. Interest was therefore focused on red dye which appeared to be a representative adulterant for palm oil.

Table 1 shows some quality indices of the fresh palm oil alongside those of a representative adulterated sample. FFA which is one of the most important quality parameters in palm oilindustry as it indicates the level of deterioration of the oil, recorded values less than 3.5% which has been reported as the average acidity for commercial crude palm oil (Nwanyi et al., 2015). This indicates that the palm oil produced and used in the present study was obtained from freshly harvested ripe fruits with restricted activity of the endogenous lipase (triacylglycerol acylhydrolase) in oil palm fruits (Hartley and Wellnitz, 2018) and further suggests that adulteration with red dye reduced the value of FFA (due to dilution effect of the dye solution). Peroxide values followed similar trend. Oil color index was similar for both the adulterated and unadulterated samples, while the iodine values and fatty acid composition were within the reported ranges for palm oil (Rasol et al., 2018), for both the adulterated and unadulterated samples. The above findings suggest that measurement of common quality parameters of oil alone, may not be sufficient for identifying palm oil adulterated with red dye.

Heavy metals have been detected to be above the permissibility limit. Heavy metals can bioaccumulation in the biological system and proffer a potential health risk to consumers over a long period. The concentration of heavy metals ranges from different levels based on the location of the palm oil sample in this research work. Zinc is a necessary heavy metal that is needed by the body. Resnick et al., 2016 reported that 15-20 mg of zinc is needed per day. From the results of these studies zinc concentration was significantly higher but within the standard limit. Zinc remains the most important nutrient for human health and is essential for the functioning of most metallo enzymes. An oral dose of zinc can cause symptoms including vascular shock, vomiting, dyspeptic nausea, diarrhea, tachycardia, pancreatic, and damage of hepatic parenchyma Reeves *et al.,* (2019). A high level of zinc could cause absorption via interaction with some metallothione in at the brush border of the intestinal lumen Wallis et al. (2018). Cadmium is another toxic heavy metal detected in this study from our results cadmium shows a significant increase across the selected markets compared with the control market, though within the reference range on the palm oil investigated. Cadmium exposure and its absorption in the lungs have been found to be between 10-50% while the absorption in the gastrointestinal tract is less. WHO 2004 reported that average intake or daily intake varies from about 10-40 ug in non-polluted areas and could affect the renal tubular damage in humans especially with a long daily intake of about 140-260 ug of cadmium. In addition, the concentration at which cadmium becomes toxic depends on the health and status of the person.

Often at time cadmium could be nontoxic at a lower concentration in immune-compromised individuals than healthy individuals.

Cadmium exposure from environmental contamination and other sources may develop at a much lower level. Results have shown that both humans and animals studies indicate that skeletal damage may be an effect of cadmium exposure from our ready-to-eat food WHO (2004). A practical example is through our food sources like the seed, root of plants, fruits, and even the leaves that we consumed on daily basis. Nickel is discharged into the environment annually from the combustion of fossil fuel. From our results on the present studies, nickel was significantly higher in one of the selected markets compared with the control. This implies that nickel was within the permissible limit; hence research has shown that the daily intake of Nickel in the human diet is about 165 mg (Zakaria et al., 2018). Repletion of nickel in plants suggests that nickel is a vital trace element in animals though its functional efficacy has not been indicated. Nickel is regarded as necessary because of its deficiency in animal spices, nickel shortage can be revealed formally in the liver but its effect includes abnormal cellular morphology, oxidative stress disruption in lipid level. Nickel could also cause a decrease in growth and hemoglobin condensation and devastated glucose metabolism ATSDR (2003). The concentration of cobalt in these studies was above the reference range. Cobalt is a component of cyanocobalim (Vit B12) and an essential element in the body. It is found in large concentration in the liver. Cobalt is involved in the synthesis of Vit B12 which is required for the production of red blood cells and the prevention of pernicious anemia in humans and animals. Cobalt was also found to be within the permissibility limit recommended by Zittermann and Koerfer, 2018. From other research work cited about 0.03 ug cobalt is present in micrograms in vitamin B12 and other organic compounds. It is also useful as a therapeutic agent for the treatment of anemia and cyanide poisoning. Increased levels of cobalt in food and water do not tend to accumulate within the human body. Cobalt is excreted out in urine, though another incidence reported on goiter was higher in some regions Wallis et al.(2018). Lead is the most ubiquitous toxic metal and can be detected partially in all components of the environment. Lead is a known neurotoxin that could bring about impairment in children and can also cause the mobilization from bones during pregnancy and lactation ATSDR (2004). Lead toxicity has long been associated with sterility and gemeto-toxic effect in both male and female animals. Some clinical studieshave shown that lead is capable of passing through the placenta to fetus to cause developmental abnormalities during birth. Studies have also shown that an increased level of lead could cause chromosomal defects in workers and suppress the immune system as observed in experimental animals Merke (2019). From this study, the concentration of lead was above the permissibility limit.

5.2 Conclusion

Results indicate that measurement of common quality parameters of fats and oils may not be helpful in identifying palm oil adulterated with red dye. Even in the absence of a control sample, the dispersion of red particles within the colorless oil or the substantial decrease in volume can be a strong indication of adulteration. Dye was also evaluated as potential adulterant. While this compound showed good oil/water binding power and increased the volume of palm oil by up to twofold, it also changed the characteristic orange red color of palm oil to yellowish red even at levels below 0.01%; and also resulted in product with increased consistency.

This research work shows a detectable amount of some selected heavy metals in unadulterated and adulterated palm oil. The results of the findings indicate that all the selected heavy metals were below the permissible limit Cobalt and lead were above permissibility limit. The high concentration of most of the selected parameters used on these studies may be due to some environmental factors, such as exposing the palm oil during processing, storage and packaging that could lead to the unsafe palm oil not suitable for consumption.

5.3 Recommendations

This work has developed a simple, rapid and effective test by means of which a consumer can easily detect the presence of dye in palm oil.

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