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Extraction and Physicochemical Characterization of Oil from Unripe Plantain (*Musa Paradisiaca*) Peels

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Abstract

Extraction and physicochemical analysis of oil from unripe plantain (*Musa paradisiaca*) peels was carried out using cold extraction method. The peels were washed with distilled water, sun dried for 3 hours and oven dried for 6 hours at 85oC. It was then ground thoroughly. 700g of the sample was weighed and 1.20 liter of n-hexane was added for 72 hours. It was placed in a water bath for the evaporation of the solvent. The physicochemical properties determined were Saponification Value (SV), Iodine Value (IV), Free Fatty Acid Value (FFA), Peroxide Value (PV), Acid Value (AV) the mean results obtained SV 335.18mg/KOH/g, IV 7.16gI2/100g, FFA 338.76mg/KOH/g, AV 696.35mg/KOH/g and PV 328.46meq/kg. In comparing these physicochemical properties with the standard given by WHO/FAO, it was observed that IV and PV were below the range, SV, AV and FFA was above the range. Hence, the oil obtained from unripe plantain (musa paradisiaca) peels is not fit for human consumption because AV, SV and FFA are higher than the standard given by WHO/FAO rather it can be used for making of soap and shampoos, PV showed the stability of the oil and IV indicates it's nondrying quality which will not be suitable for ink and paint making due to its low iodine content.

Keywords: Physicochemical analysis; Extraction; Musa paradisiaca; Waste.

1. Introduction

Waste is referred to as trash, garbage, refuse of any material, eliminated or regarded as no longer useful after the completion of a process [1]. Waste can either be in a liquid or solid form and can be hazardous and recyclable as well. There are different sources of waste; it could be from households, schools, offices, medical, agriculture, market, industries or automobiles and others [2]. Increase in population, demand for food and other necessary things for living has increase the amount of waste generated [3]. In Nigeria, it is common to see waste dumps everywhere without giving attention to it. This result to public health challenges because vectors like flies and rodent are in abundance to spread diseases such as diarrhea, typhoid, dysentery etc. Waste management is a major problem in Nigeria, despite the policies and agencies created by the government, wastes are left unattended to [4]. In the Niger Delta region of Nigeria most especially Bayelsa state, plantain farming is a common practice, which give rise to high consumption of plantain in Bayelsa state. After consuming or eating the plantain the peel is littered in the environment mostly in market places (Kpansia market, Opolo market) and this causes nuisance to the environment. Rather than see plantain peels as waste, it is necessary to see it as a raw material that needs to be utilized. In Nigeria and other parts of other the world, plantain (*Musa paradisiaca*) serves as a major staple food and is particularly desired for the variabilities [5]. In Bayelsa state, plantain is consumed as staple food. The method of eating or cooking includes boiling, frying, roasting known as boli, plantain chips etc. The peels are known to constitute waste in the society thereby adding to the problem of environmental pollution. Plantain is employed in the folklore management of diseases such as ulcer wound healing and many others due to its anti-ulcerogenic, anti-microbial, anti-urolithiasis activities, analgesic properties [6]. Peels are the major by-products obtained during the processing of various fruits and these were shown to be a very good source of polyphenols, carotenoids, dietary fibers, and other bioactive compounds which possess various beneficial effects on human health [7]. Due to the high rate of consumption of plantain, there is an increase in the amount of peels generated, hence, a raw material for other sectors of the economy. Extracting oil from the peels of plantain will also reduce the waste. Essential oil is a concentrated hydrophobic (water hating) liquid. Essential oil is also known as volatile oils, ethereal oils, they are oil extracted from plant. Essential oils are generated or extracted by distillation, solvent extraction etc. It is used for aroma therapy a form of alternative medicine like massage [8]. It can also be used for making perfumes, cosmetics, soaps, treatment of cancer and others. Improper use of essential oils may cause allergic reactions and skin irritation. There are different forms of essential oils such as Lavender, tea tree oil, and eucalyptus and others [9].

Aliyu, *et al.* [10], carried out oil extraction and physicochemical analysis on ground kernel seed of Indigenous Jatropha, Circas and Castor. The result obtained showed that the oil has a saponification value of 123.3± 3.428, mgkoH/g, Iodine value of 76.93 ±0.397 I2/100g and acid value of 2.39 ±0.065mgKOH/g were obtained.

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Arun, *et al.* [11], studied how plantain peels could serve as a potential source of antioxidant dietary fibre for developing cookies. The following reagents were used to extract and analyzed the anti-oxidant activity of plantain peels such as hexane, ethyl acetate and methano. The analysis indicates that peels are rich in total dietary fiber (64.33g/100g), vitamins (33.12mg/100g) and minerals (35.61mg/100g). Randa, *et al.* [12], studied antimicrobial activity of essential oil extracted from Artemisia Annua (sweet wormwood). Artemisia Annua essential oil was extracted using hydro - distillation from the plant on microorganisms and the antimicrobial effect of the essential oil was compared with some commonly used synthetic antimicrobials. Artemisia Annua essential oil could serve as antibiotics. Ibrahim and Yusuf [13], carried out extraction of oil from orange seeds (citrus sinesis) belongs to the family of (Rutacceae), using soxhlet method. The oil gotten was compared with other vegetable oils such as groundnut oil, soya beans. From the result obtained the saponification value was 190.32mgKOH/g, Peroxide value of 5.8meq/kg and iodine value of 54.19g/100g. Extraction with supercritical fluids (SC-CO_2) has been used in different food and agricultural applications. Tiger nut oil is similar to Olive oil, nut oil has unique gold yellow color and also have neutral taste. Mehmet and Jean [14], investigated the potential uses of oil extracted from carrot seed using soxhlet method. The oil had mineral contents: Phosphorpus (75.40 ± 19.28), Calcium (164.11 ± 31.02), potassium (180.55 ± 37.36), sodium (24.35 ± 4.39), Magnesium (15.48 ± 1.61) and Aluminum (23.31 ±2.17), Carrot seed is one of the most commonly used vegetables for human nutrition.

2. Materials and Methodology

2.1. Materials

2.1.1. Sample Collection and Preparation

Un-ripe Plantain peels were collected from waste collecting points and from the market, they were washed with distilled water and sun dried for 3 hours after which they were oven dried for 6 hours at 85^0C. 1.400kg of oven dried plantain peel samples were weighed using an electronic weighing balance and the extraction was done using the cold extraction method.

2.1.2. Reagents

Potassium hydroxide (KOH), Phenolphthalein, Hydrochloric acid (HCl), Ethanol (CH_3CH_2OH), Sodium hydroxide (NaOH), Iodinemonochloride (ICl), Potassium iodide (KI), Sodium thiosulphate ($Na_2S_2O_3$), Ethanoic acid (CH_3COOH), n-hexane, Wijis reagent.

2.1.3. Plant Used

Unripe plantain peels were obtained from the market in Amassoma, Wilberforce Island, Bayelsa State.

2.2. Method

2.2.1. Determination of Saponification Value

About 1.0 g of the sample (un-ripe plantain peels) was weighed into a 250mL conical flask; 25 mL of alcoholic potassium hydroxide solution was added into the flask and was kept on the water bath to boil gently but steadily for 40 minutes and was brought to cool. After the flask has cooled, it was titrated with excess potassium hydroxide with 0.5N hydrochloric acid, using about 1.0mL phenolphthalein indicator. A blank was also carried out but without the sample.

Calculation: Saponification Value = 56.1 (B-S) N/W

Where, B = Volume in mL of standard hydrochloric acid required for the blank.

S = Volume in mL of standard hydrochloric acid required for the sample

N = Normality of the standard hydrochloric acid

W = Weight in gm of the oil/fat taken for the test.

2.2.2. Determination of Acid Value

1g of sample (unripe plantain peels) was weighed into a 250mL conical flask and 50mL of ethyl alcohol and 1mL of phenolphthalein indicator solution. The mixture was boiled for about five minutes and titrated hot against standard sodium hydroxide solution (shaking vigorously during the titration). The weight of the oil taken for the estimation and the strength of the alkali used for titration shall be such that the volume of alkali required for the titration does not exceed 10mL.

Calculation: Acid value = 56.1V N/W

Where, V = Volume in mL sodium hydroxide used

N = Normality of Sodium hydroxide solution

W = Weight in gram of the sample

2.2.3. Deterination of Free Fatty Acid Value

The acidity is frequently expressed as free fatty acid for which calculation is given as;

Free fatty acids as oleic acid = 28.2 Volume of base *N per cent by weight W

2.2.4. Determination of Iodine Value

1.0g of the oil was weighed into a 250mL conical flask, to which 25 mL of carbon tetrachloride was also added. It was mixed well. 25 mL of Wij's reagent was added using a pipette and was swirled for proper mixing and kept in

the flasks (in dark) for four hours. a blank determination was also carried out simultaneously. After standing, 15 mL of potassium iodide solution was added, followed by10mL of recently boiled and cooled water, it was titrated to liberate iodine with standardized sodium thiosulphate solution, using starch as indicator at the end until the blue colour formed disappears after thorough shaking. A blank was also determined in the same manner as test sample but without oil.

Calculation: Iodine value = 12.69 (B – S) N/ W

Where, B = volume in mL of standard sodium thiosulphate solution required for the blank. S = volume in mL of standard sodium thiosulphate solution required for the sample.

N = normality of the standard sodium thiosulphate solution.

W = weight in g of the sample.

2.2.5. Determination of Peroxide Value

5g of the sample was weighed into a 250mL conical flask. 30mL of acetic acid-chloroform solvent mixture was added and swirled to dissolve. 0.5mL saturated potassium iodide solution was added with a pipette. It was Left to stand for 1min in the dark with occasional shaking, then 30 mL of water was also added and Slowly titrated to liberate iodine with 0.1 N sodium thiosulphate solution, with vigorous shaking until yellow colour is almost gone and about 0.5 mL starch solution was added as indicator and was further titrated with vigorous shaking to release all I_2 from $CHCl_3$ layer until blue colour disappeared. If less than 0.5 mL of 0.1 N $Na_2S_2O_3$ is used repeat using 0.01 N $Na_2S_2O_3$. Conduct blank determination (must be less than 0.1 ml 0.1 N $Na_2S_2O_3$). Calculation:

Peroxide value = Titre X N X 100/W

Where, Titre = mL of Sodium Thiosulphate used (blank corrected)

N = Normality of sodium thiosulphate solution

3. Results and Discussion

3.1. Results

Table-1. Showing the physicochemical parameters of un-ripe plantain peel oil

Parameters	AV (mg/KOH/g)	FFA (mg/KOH/g)	IV (gI_2/100g)	SV (mg/KOH/g)	PV (meq/kg)
1st	667.59	341.22	7.61	339.42	327
2nd	655.44	351.80	6.89	328.44	324.21
3rd	766.03	323.25	6.98	337.67	334.16
Mean value	696.35	338.76	7.16	335.18	328.46
STD. DV	60.65	14.43	0.40	5.90	5.13
WHO/FAO	4.00	5.782-7.28	80-106	181.4-260	10.0

3.2. Discussion

The physico-chemical parameters of the un-ripe plantain peels were analyzed in triplicates and the mean and standard deviation was recorded in table 1 above. The following results were obtained for the physicochemical parameters of un-ripe plantain peel oil and are presented as mean± standard deviation; acid value 696.35±60.65mgKOH/g, Free fatty acid 338.76± 14.43mgKOH/g, Iodine value 7.16± 0.39gI_2/100g, Saponification value 335.18 ±5.89mgKOH/g and Peroxide value 328.46 ± 5.13meq/kg.

3.3. Acid Value

The acid value (mg/KOH/g) of unripe plantain peels oil was determined in triplicates had a mean value of 696.35 mg/KOH/g, which was higher than the standard value 4.00mg/KOH/g recommended by FAO/WHO for edible oil. Acid value is an important value in determining physicochemical parameters of oil because it indicates the edibility of oil. The acid value of melon seed was observed to be 2.80±0.82mg/KOH/g [15]. In their study of extraction and characterization of oil from melon and coconut seeds. The value obtained was 696.35mg/KOH/g was higher than the FAO/WHO which implies that the oil may not be suitable for cooking but useful for making of paints, shampoos and liquid soaps.

3.4. Saponification Value

Saponification value (mg/KOH/g) of unripe plantain peels oil was determined in triplicates had a mean value of 335.2mg/KOH/g was obtained. Saponification value determines the contents of fatty acids in oil, the value was higher than the FAO/WHO standard value of 181.4- 260mg/KOH/g, Akinyede, *et al.* [16], obtained a saponification value of 196 and 212mg/KOH/g Dioclea reflexa and Monodora myritica seeds in their study of physicochemical composition and oil characterization from Dioclea reflexa and Monodor amyritica, the oil obtained from unripe Plantain peels can be used in soap makings. The saponification value was higher than the FAO/WHO standard.

3.5. Peroxide Value

Peroxide value (meq/kg) of unripe plantain peels oil was determined in triplicates had a mean value of 5.15 meq/kg. The result obtained was below the FAO/WHO standard of 10 meq/kg. Popoola and Yangomodu [17], obtained a peroxide value of 2.5 meq/kg for cassava seed oil which was lower than the result obtained in this study.

Peroxide value measures the degree of lipid oxidation in fats and oils. The lower peroxide value of unripe plantain peels oil indicates that the oil will not easily go rancid which is related to its stability.

3.6. Iodine Value

The iodine value ($gI_2/100g$) determined in triplicates had a mean value of $7.159gI_2/100g$. The value was lower than the FAO/WHO standard of 80- $106gI_2/100g$, Iodine value of oil measures the unsaturated acid present and also indicates its nondrying quality. Therefore, the test measures the amount of iodine consumed by the acid. The greater the iodine value, the greater the unsaturation and greater the liquidity. Hence lower iodine value may not be suitable for ink and paint production but are useful for soap making. Aremu, *et al.* [18], obtained iodine value of 2.65-$153.00gI_2/100g$. In their study of the physicochemical and characterization of the

Oil extracted from some Nigerian plant foods.

3.7. Free Fatty Acid

The free fatty acid determines the range to which fatty acid can hydrolyzed. The formation of free fatty acid usually contains rancidity. The determination of free fatty acid in oil usually indicates the condition and edibility of the oil. The free fatty acid value obtained (338.8mg/KOH/g) was higher than the recommended value by FAO/WHO with a mean value of 5.782-7.28mg/KOH/g

4. Conclusion and Recommendation

4.1. Conclusion

The physico-chemical parameters of un-ripe plantain peel oil were determined and also compared with other oils extracted from plants and WHO/FAO standards for edible oils. The oil extracted from the unripe plantain peels showed that the oil is not edible but is useful in the industry, such as soap, shampoo, and paint making.

4.2. Recommendation

It should be known from the study that most fruit, seed, tuber parts etc. considered to be waste could be raw material for an industry. Hence, it is recommended that no part of any plant should be thrown away as a waste but that the government should build industries that will utilize plant waste to produce quality products in Nigeria.

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