Proximate, Elemental Composition and Antimicrobial Properties of Banana Peel Powder

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Abstract
The proximate, elemental composition and antimicrobial properties of banana peels was investigated using A.O.A.C standard methods. The antimicrobial activity effect of aqueous extract of fresh and dry banana peel against bacteria including (staphylococcus aureus, pseudomonas aeruginosa, and Escherichia coli) was carried out by the well-agar diffusion method. The water extract of dry banana peel showed various inhibitory effects against staphylococcus aureus with a zone diameter of (8mm in 50ug/ml) and pseudomonas aeruginosa with a zone diameter of (10mm in 100ug/ml), with no effect against (Escherichia coli) which was soaked for 24 hours, and the aqueous banana peel extract shows no inhibitory concentration on the fresh banana peel. Aqueous extract of banana can be utilized in cosmetics formulations against both gram-positive and negative bacteria to replace the synthetic chemical formulations in the cosmetics industry.

Background of the Study

Banana (*Musa sapientum*) is the second most important fruit crop in Nigeria. Its year-round availability, affordability, varietal range, taste, nutritive and medicinal value make it the favourite fruit among all classes of people. Bananas are very important fruit crops in the tropical world. Banana constitutes a major staple food for millions of people and provides a valued source of income through local and international trade. Banana is a principal source of food, employment and income in its major production areas. (Gopu *et al*, 2021).

The names which it is called in different languages make it unique and outstanding, in Nigeria language where it is called (mboro) in Efik, (ogédé) in Yoruba, (unere)in Igbo, (Ayaba) in Hausa. Banana, tropical fruit belonging to Musaceae family, with the common name for herbaceous plant of the genus (*Musa Accuminata*) which is grown in many countries all over the world (Oladiji *et al.*, 2010). All parts of banana plant such as flower, pulp, stem, and leaves have an important application in industries most important the cosmetics industries. Banana is a good source of vitamin A and a fair source of Vitamin C and B2, and are rich source of minerals like magnesium, sodium, potassium and phosphorous and fair source of calcium and iron (Anarson *et al*, 2023) it comes in various sizes and colors when ripen which include yellow, red, and purple banana plants

are among the most important staple food crops in humid forest zone of West and Central Africa. (Mishra *et al* 2023).

Fig.1: Banana peels

Banana peel (FIG. 1) is a waste product of banana, and studies have shown that banana peel also have Bioactive compound such as flavonoids, tannins, phlobatannins, alkaloids, glycosides, and terpenoids are present in banana peel. This bioactive compound is reported to exert pharmacological effect, especially as an antioxidant, antidiabetic, anti-inflammatory, and antibiotics (zaini *et al* 2020). Banana peels are characterized as a good source of lignocellulosic compound as well as its carbohydrates, vitamins, and minerals. It is also use for biofuels, food processing, pharmaceutical, cosmetics, beverages, textiles, energy resources, paper, bio-absorbent pesticides, and agricultural sectors. (Khan *et al*., 2015; Munfarida *et al*., 2021; Bhavani *et al*, 2023).

Banana peels are used in traditional medicinal purposes to cure a variety of conditions including fever, burns, its regulate the digestive system easily both constipation and diarrhea, irritable bowel syndrome, intestinal sores, ulcerative colitis, nephritis, gout, coronary heart infections, high blood pressure, diabetes, aches and snake bite., this also works well as teeth whitening agent (Salman *et al*., 2022), banana peel is a good source of flavonoids which stimulates and repair damaged of hair structures they are used as shampoo to prevent hair loss, skin care products, acne reduction and other cosmetics applications (Broto *et al*., 2022) Banana peels can be used to make a variety of culinary and beverages items like tea brewed from banana peel can be used to make weight loss in food sector, ferulic acid that has been isolated from banana peel is typically utilized as a Flavoring and aroma- enhancing agent (Alzate Acevedo *et al*.,2021) it can also be utilized to make ice creams, cakes, cookies, bread and bio-vanillin goods (Hikal *et al*.., 2021).

The banana industry during production cycle its generates large volumes of solid waste-loss derived from maintenance and harvesting processes, highlighting the rachis, pseudo stems, leaves and banana peel, which can be used in different processes, such as packaging products and other applications (Sasha *et al* 2021).

Thus, contributing to the implementation of a circular economy problem banana peels due to its bioactive chemical components it can be used to eliminate the risk of synthetic chemical in cosmetics formulations which can be a good source of antioxidant and antibacterial to fight cancerous cells on the skin and help reduce the risk of UV damage and prevent the damages of cell inflammations. Banana peel after been discarded they create a tremendous amount of by product causing disposal problems and environmental pollution causing greenhouse effects to the society. The banana peels, full of lignocellulosic material, can be converted into many useful products such as flour, personal-care - product, paper, etc. this research seeks to investigate the property of banana peels for useful application in cosmetics formulations.

MATERIALS AND METHOD

Sample collection and preparation

Banana peels was collected after the matured fruit of the plant that was harvested from a local farm land in Ekpo Abasi, Calabar South Area of Cross River State, Nigeria. And it was taken to university of cross river state for further preparation and analysis it was then was and cut into smaller pieces and then place under the sun for 4-5 days to get dried and then grounded into porous form, while the fresh banana peel was grounded by an electric grinder.

Proximate analysis

Proximate analysis was done using the method described by AOAC (2002) parameters investigated include: moisture content, ash content, protein content, crude fiber, crude lipid and carbohydrate.

Determination of Elemental composition

Elemental composition of banana peel was determined by using Atomic absorbing spectrophotometer and flame photometer

Potassium

Potassium was determined by using flame photometer (AOAC 1990) 10g of each sample was weighed and subjected to dry aching in a well cleaned silica crucible at 550•c in a muffle finance for 5hours then the sample was dissolved in 5ml HNO_3 then heated until colourless solution was obtained then the solution was transferred into 100ml volumetric flask by filtration through a filter paper.

Calcium

The calcium content was determined based on the method of Perkin Elmer Corporation, USA (1994). 10g of each sample was treated with 10ml of concentrated HNO_3 and 4 ml of 70 % $HClO_4$. The resulting solution was evaporated to a smaller volume (7 ml) by careful heating and transferred to 50 ml volumetric flask. One milliliter (1 ml) of $SrCl_2.6H_2O$ was added and made up to volume with distilled water. The solution was sprayed into atomic absorption spectrophotometer (Perkin Elmer, model 5100 PCAAS, USA) at 422.7nm to determine the concentration of calcium. The calcium standards used were 0ppm, 5ppm, 10ppm, 20ppm and 30ppm.

Zinc

Zinc was determined after digestion of sample 10g by Atomic Absorption Spectrophotometer (AAS) at 213.8 nm using air-acetylene as a source of flame for atomization (AOAC, 1990). Zinc level was then estimated from standard calibration curve (0.5 - 3.0 µg Zn/ml) prepared from ZnO.

Iron

The iron content was determined based on the method described by Perkin Elmer Corporation, USA (1994). Ten milliliters (10 ml) of concentrated HNO3 was added to 10g of the sample and left overnight. The sample was carefully heated until the production of red nitrogen dioxide fumes ceased. The sample was cooled and 4 ml of70 % $HClO_4$ was added and evaporated to a smaller volume (7 ml) by careful heating. The resulting solution was quantitatively transferred into 50 ml volumetric flask and diluted to the mark with distilled water. The solution was sprayed into an atomic absorption spectrophotometer (Perkin Elmer, model 5100 PCAAS, USA) at 248.3nm to determine the concentration of iron. The iron standards used were 0ppm, 1ppm, 2ppm, 3ppm and 4ppm.

Manganese

Manganese was analyzed with the aid of Atomic Absorption spectrophotometer (AAS) (Buck scientific instrumentals model 200A/ 2010) Dry and grind the sample into a fine powder. Ash the powder in a furnace at 500°C for 2 hours. Dissolve the ash in HCl and dilute with 50 ml of distilled water in a beaker, thereafter 4ml of mineral acid containing the mixture of HCl and HNO_3 was in the ratio of 1:1 was added to the solution and stirred thoroughly and then heated in a fume cupboard for 15 min cooled, filtered and then analyzed. the manganese content was calculated in mg/10g.

Lead

Lead was determined after 10g of ash of banana peel sample was subjected to wet oxidation using. Perchloric and nitric acid in accordance with the method of osborn and voogt (1978). Atomic Absorption spectrophotometer (Analyst 200, Perkin Elmer waltham, MA USA) was used to analyze the concentration of lead According to the method of bambard (1985).

Antimicrobial activity testing assay

The Antimicrobial activity of banana peels extract was determined by employing the method of aqueous extract which was prepared by suspending 10g of Each samples into 100ml of distilled water for 24 hours then filter with filter paper. 100ug/ml, 50ug/ml, 25ug/ml, 12.5 ug/ml, 6.25ug/ml, 3.125ug/ml of the sample was measured into a test tube using a syringe and labeled properly. pathogens such as Staphylococcus aureus, Pseudomonas Aeruginosa and Escherichia coli (E. Coli) was obtained from the department of microbiology (UNICROSS) Calabar, which measure growth inhibition. The muller hinton media was prepared in distilled water sterilization which was carried out in an autoclave at 121•c for 15min and the media was cooled at room temperature and the media was cut into well 5mm diameter by cork borer and 0.1m of the aqueous extract were injected into sterilized disc and where then set for incubation.

Statistical analysis

This analysis was done in duplicate all data converted were subjected to statistical package for social science versions 21.0 and express the mean - standard error of mean (sem). Statistical significance of the results between group was determined using one way analysis of variance (ANOVA) was used to assess the significance differences. The criterion for statistical significance was set at $P<0.05$ all data were presented as mean standard deviations (SD).

RESULTS AND DISCUSSION

The proximate composition of the fresh and dry banana peels was presented in table: 1 viewed that fresh peels contain high percentage of moisture having a higher percentage (79.00 ± 0.16) while dry banana peel has the moisture composition of (13.70 ± 0.08) the comparatively high moisture of fresh banana peel could be as a result of it freshness and seasonal availability of banana fruit.

Table 1: Proximate Composition analysis of fresh and dry banana peels

Proximate parameters (%)	Concentrations	
	Fresh banana peels	Dry banana peels
Moisture	79.00 ± 0.16	13.70 ± 0.08
Ash	4.50 ± 0.00	2.50 ± 0.01
Crude fibre	6.00 ±.023	46.50 ± 0.02
Crude lipid	6.60 ±0.02	46.40 ± 0.08
Crude protein	0.15 ± 0.03	0.33 ± 0.01
Carbohydrate	3.75 ± 0.12	13.57 ± 0.07

The ash content in banana was recorded (4.50 ± 0.00) percentage in fresh banana peel and (2.50 ± 0.00) percentage of dry banana peel was recorded and that could suggest that banana peel was a good source of mineral Organic matter.

The crude fibre was recorded high in the dry banana peel (46.50 ± 0.08) and low in fresh banana peel (6.00 ± 0.02) which indicate a very good source of fibre. Crude lipid was recorded high in the dry banana peel (23.40 ± 0.04) and in the fresh banana peel it was low (6.60 ± 0.02) which is more reliable source of lipid.

The crude protein the highest was observed in the dry banana peel (0.33 ± 0.01) and observed low in the fresh banana peel (0.15 ± 0.03) respectively. Carbohydrate content is lesser in the fresh (3.75 ± 0.12) while (13.57 ± 0.07) in the dry banana peel respectively.

The moisture content in both the fresh and dry banana peel was recorded high due to it seasonal availability and freshness of the banana peel which indicate it effectiveness by exploring the potential benefit of banana peels. Ash content is a residue left after burning the banana peel which can be use as skin exfoliant, promote and maintain PH balance, and promote cell renewal. The crude protein and crude fibre can be used in various products which improve skin firmness and elasticity. Carbohydrate in banana peel provides certain benefits in cosmetics including probiotics properties, antioxidants activity, and skin hydration.

Table 2: Elemental composition of 10g of fresh banana peels and dry banana peels

Element	Fresh banana peels (mg/g)	Dry banana peels (mg/g)
Potassium (k)	120	450
Calcium (Ca)	30	100
Zinc (Zn)	1	0.3
Iron (Fe)	0.2	2
Manganese (Mn)	0.1	1
Lead (Pb)	<0.1	<0.05

Table 3: Result of Inhibitory concentration of aqueous extract of banana peel using 100ml of water and 10g of the sample

Sample name	Organisms	100ug/ml	50ug/ml	25ug/ml	12.5ug/ml	6.25ug/ml	3.125ug/ml
Dry banana peels	*staphylococcus aureus*	-	8mm	-	-	-	-
	Pseudomonas aeruginosa	10mm	-	-	-	-	-

	Escherichia coli	-	-	-	-	-	-
Fresh banana peels	*Staphylococcus aureus*	-	-	-	-	-	-
	Pseudomonas aeruginosa	-	-	-	-	-	-
	Escherichia coli	-	-	-	-	-	-

The Elemental composition presented in Table 2 shows the presence of high potassium (K) in the fresh and dry banana peel the concentration (mg/10g) ranged from 120-150mg/10g in the fresh banana peel 400-500mg/10g in the dry banana peel the appreciative high potassium contents indicate it potential of regulating the body fluids and maintain normal blood pressure. Calcium composition range from 20-30 mg/10g in fresh banana peel while the dry banana peel with the highest concentration of 100-150mg/10g recorded. Zinc which ranged from 0.5-1 mg/10g in fresh banana peel and 0.2-0.3 mg/10g in dry banana peel. Iron 0.1-0.2 mg/10g in fresh banana peel and 1-2 mg/10g in dry banana peel. Manganese was recorded 0.05-0.1 mg/10g in fresh banana peel and 0.5-1 mg/10g in dry banana peel while lead was measured <0.1 mg/10g of fresh banana peel and < 0.05 for dry banana peel was recorded respectively. The Elemental composition of potassium which helps in neutralizing of free radicals, reducing oxidative stress and inflammation. Zinc help in acne treatment and prevent future breakout. Manganese help protect the skin from damage caused by UV light and pollution collagen production. Iron and calcium help the skin reduces wrinkles and firm skin. The presence of antimicrobial agent in banana peels therefore suggested that the peels possess variable medicinal potentials.

The Antimicrobial activity of the aqueous extract of banana peel where initially evaluated by well diffusion assay against different microbial isolates (*pseudomonas Aeruginosa*, *Escherichia coli*, and *staphylococcus aureus*) the result are present in Table: 3 which shows the aqueous extract of banana peels give a good inhibition effect against gram positive bacteria including *staphylococcus aureus* and *Pseudomonas aeruginosa* with inhibition zone of 8mm and 10mm respectively with no effect against *Escherichia coli (E. coli*) which shows no inhibitions to banana peel extract. These results reveal that the highest antimicrobial count was recorded in the (*p. aeruginosa*) in an aqueous extract with a zone diameter of 10mm this shows that staphylococcus aureus is resistance to the antimicrobial agent to inhibit the growth of pathogens present in aqueous banana peel extract, attributed to the fact that bacteria is inherently resistant to Antimicrobial agent due to the present of bioactive compounds. Aqueous banana peels extract used for various applications like skin, hair, acne, nutritional supplements, pharmaceutical uses. Aqueous extraction of banana peel exhibited a variable degree of antibacterial activity against gram positive and gram-negative bacterial isolation causing gingivitis including streptococcus species. Antimicrobial properties of fresh banana peel and dry banana peel found that it is effective against certain gram positive and gram-negative bacteria it can be of great significance in cosmetics formulations.

Conclusion

The current study suggested that the banana peel aqueous extract which proved to be potentially effective which can be used as natural remedies to cure skin infection like eczema, ringworm, scaling skin, blemishes etc., the banana peel which was found to have antimicrobial properties and this lead us to believed that the use of parts of plant in traditional herbs or medicine may be justified., many years back people has been eating Banana peels and discarding the peels away without having the knowledge that the peel can be used as healing agent which can be useful to the society for curing infection now that research has been carried out on banana peel the peel should not be discarded, rather it should kept as a raw material for the extraction of oil for the treatment of skin infection.Further studies are needed to determine the specific component responsible for the anti-microbial activity in banana peel which contains high antioxidant properties which make it more effective for the treatment of bacteria or fungi therefore instead of discarding the peels as is presently done, they can be processed into variable medicinal purposes and skin formulation.

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