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EXTRACTION AND QUALITY EVALUATION OF RAFFIA PALM (*Raffia hookeri*) AND OFO (*Detarium microcarpum*) GUMS

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ABSTRACT
Extraction, purification and quality evaluation of raffia palm (Raffia hookeri) and ofo (Detarium microcarpum) gum extracts were carried out. Gum was extracted from both raffia palm exudate and ofo seed. The gums were respectively purified and analysed for functional properties, antinutrients and mineral contents of the gum samples. The mineral analysis of the gums revealed that magnesium contents of ofo and raffia gums were 7.94mg/100g and 9.37mg/100g respectively. Calcium contents were 16.03mg/100g and 101.40mg/100g for ofo and raffia respectively and they were significantly ($p<0.05$) different from each other. Iron content was 2.09mg/100g and 4.66mg/100g for ofo and raffia respectively. Potassium contents were 8.05mg/100g (ofo) and 5.06mg/100g (raffia) while sodium contents were 3.26mg/100g and 3.72mg/100g each for raffia and ofo gum. No significant ($p>0.05$) difference was observed between the bulk density for raffia (0.86g/ml) and ofo (0.84g/ml). Water absorption capacity of ofo gum was 65.23 water/100g while that of raffia gum was 68.64 water/100g. The oxalate contents were 2.11mg/100g and 2.6mg/100g for raffia and ofo gums respectively. Phytate concentration was 2.75 and 3.26% each for raffia and ofo and there was significant ($p<0.05$) difference between the samples. Saponin level was 1.44 and 1.84% for raffia and ofo respectively while alkaloid content was 0.93% and 1.05% each for raffia and ofo gum. Significant ($p<0.05$) difference was observed between the gums in terms of the antinutrients. The percentage gum yield from raffia exudates was 50% while that of ofo seed was 79%. The results proved that both ofo gum and raffia gum could be incorporated in food formulation if incorporated.

Keywords: Extraction, raffia gum, ofo gum, minerals, antinutrients.

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INTRODUCTION
Food gums are carbohydrates of relatively high molecular weight (usually polysaccharides) with one or two exceptions. They are long chains (sometimes branched but usually linear) of sugars with "substituents" protruding from the main chains (Kurt *et al*., 2016). A chain can contain from several hundred to several thousands of sugar units (Flitch and Ulign, 2003). Gums are often referred to as hydrocolloids because of their size and affinity for water. When added to water, they form stable aqueous colloidal dispersions or sols. The molecules are highly branched as a result, most gums are able to form gels (Onwuka, 2014).

Raffia palm (*Raphia hookeri*) is a medium sized tree. It has a large reddish bulbous trunk and larger feather palm leaves. It can be easily located all around the rainforest. In Nigeria, it is normally found where there are streams and rivers, although it can be found

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around houses. Raffia palm, is an economically useful plant in Africa; the leaves are used for shelter, and the stem produces palm sap (palm wine), which is drank as cultural beverage. The fermented sap could be distilled into alcohol or local gin or ogogoro in Nigeria (Wallis, 2015).

The *Deterium microcarpum* (ofo) is a locally common plant that belongs to the family Fabaceae (legume family). The seeds are toasted, broken and dehulled before use, and mostly serve as soup thickener in Nigeria. The *Deterium microcarpum* (ofo) fruit is edible and rich in vitamin C. The leaves are also used for cooking (Ebi and Afreroho, 2011).

Raffia palm exudate is the waste product of palm wine tapping operation and has never been used in food applications at both domestic and industrial scales. Its nutrient, antinutrient and functional properties are not yet widely found in literature. The material is exuded in large quantity but merely allowed to decay at the base of the parent tree (raffia palm) where it constitutes environmental nuisance by creating odour and attracting many flies (or saprophytes). On the other hand, ofo seeds are mainly used domestically as thickening agents in traditional soups preparation. Ofo seed gum is yet to be introduced in the market and therefore not well known to consumers and food manufacturers. Profound effort has not been made in using them as thickening or stabilizing agent both in peasant or commercial manufacture of food products. Thus the potentials of raffia palm exudate and ofo seed gums are yet to be widely investigated. This limits their economic significance. Therefore the main objective of this study is to extract, purify and evaluate the quality of gum respectively from raffia palm exudate and ofo seeds thereby create variety in food gums available for incorporation in food production.

MATERIALS AND METHODS

The raffia palm (*Raffia hookeri*) exudates used for this study was collected from a raffia palm tree in Orodo, Mbaitoli L.G.A in Imo State while the ofo seeds (*Detarium microcarpum*) were purchased from Eke-ukwu Market, Owerri, Imo State, Nigeria. The blender (Binaton-model BLK-450 MK2, China) was gotten from Imo State University, Owerri.

Extraction of raffia palm gum

The *Raphia hookeri* gum was extracted from the stem exudates of the mature plant, discarded by the wine tapper and purified using the method described by Olorunsola *et al.* (2014) with little modification. The exudate was obtained from the stem, and at apex of the tapped plants. The contaminating bark and other extraneous materials were removed from the exudates by hand. A 500g quantity of the exudates was added to 1 liter of distilled water. The mixture was homogenized using a laboratory blender (Binaton-model BLK-450 MK2, China) and left for 24 hours to ensure complete dissolution. The mucilage was screened through a muslin cloth to obtain particulate-free slurry.

Purification of raffia palm gum

Two litres (2L) of absolute ethanol was gradually added to the screened slurry. The precipitated gums were scooped out into a sieve and allowed to drain. The precipitates were defatted using 400ml diethyl- ether, air-dried for 3h, and dried. at 50 ^{O}C in a hot air oven (DHG-9053 Model, China). They were then pulverized using laboratory blender and screened through a 250µm sieve.

Production of *Detarium microcarpum* seed flour

The ofo (*Detarium microcarpum*) seeds were cleaned and sorted (to remove stones, dirts and unwholesome seeds). The seeds were

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toasted in a pre-heated frying pan on a stove for 20min, and allowed to cool to ambient temperature. After cooling, the seeds were cracked with a small hammer, de-coated and washed in distilled water. Then they were milled using attrition mill and dried at 50^0C for 4h in a moisture extraction oven (DHG-9053 Model, China). The milled sample was cooled, sieved through 250µm mesh-sized sieve and then packaged in air-tight container (high density polyethylene) and stored at ambient temperature.

De-fatting of ofo (*Detarium microcarpum*) seed flour

The flour (500g) was wrapped in a white cotton fabric and soaked in 500 mililiter (ml) of petroleum ether in an enclosed transparent glass jar and allowed to stand for a period of 72h. The wrapped flour was removed and rinsed in fresh petroleum ether and manually squeezed to express the entrapped solvent. The de-fatted flour was spread on a stainless tray for 4h to allow the trapped solvent to vapourize. The flour was sieved through a 500µm mesh, packaged in air-tight container and stored at ambient conditions for further processing.

Ofo (*Detarium microcarpum*) gum extraction

The method of Nwokocha and Williams (2009) was adopted for gum extraction from the de-fatted seed flour. Five grams (5g) of the flour sample was dispersed in 400 ml of distilled water and hydrated continuously by means of a magnetic stirrer (FBI 15001, Fischer Scientific, UK) for 6h. Four hundred mililitres (400ml) of Propane -2-ol was gradually (drop by drop) added to the hydrated flour solution. The precipitated gum that spools out of the solution was gently separated from the mother liquor with the use of perforated spoon. The clear liquor was decanted while the trapped solvent was removed by filtering under suction in a Buchner funnel. The precipitate was dried in a hot air oven (DHG-9053 Model, China) at 60^0C till a flaky-dried gum can be easily scrapped off the oven-tray. The resultant gum was cooled in desiccator to ambient temperature, pulverized using the dry material unit of an electric blender (Binatone, BLG-450 MK2 Model, China) and stored at ambient temperature in a sealed container.

Determination of percentage gum yield

The percentage gum yield from the raffia palm exudates and ofo seed were determined by weighing the exudates (weight 500g), and the ofo seed flour (35g) before extraction. The weight of the dried gum were also determined and recorded. The percentage gum yields for raffia palm exudates and ofo seed flour were calculated using the equation below:

$$\%\text{Yield} = \frac{\text{weight of gum}}{\text{weight of raw sample}} \times \frac{100}{1} \quad \ldots\ldots\ldots (1)$$

Physicochemical evaluation of the gum samples and statistical analysis

The mineral contents, anti-nutrient concentrations and some functional properties of the gum samples were evaluated following AOAC (2015). The standard deviations of the results were determined and the mean separation done using Tukey test.

RESULTS AND DISCUSSION

Percentage gum yield

The mean percentage gum yield from raffia exudates and defatted ofo flour was 50% and 79% respectively (Table 1). The result showed that the ofo seeds yielded more gum than the raffia palm exudates. Gum yield depends on the processing method applied. This is because processing has the tendency of withdrawing some constituents of the gum

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(Nnabuk *et al*., 2013). But it is worthy to state that the activity of a gum sample when applied in the intended food product is of greater interest than quantity.

Some mineral contents of ofo and raffia palm gum samples

The magnesium content of the ofo gum (7.94mg/100g) was significantly ($p<0.05$) lower than that of raffia gum sample (9.37mg/100g). Magnesium is a micro nutrient; adequate intake of magnesium supports a healthy immune system, keeps the heart beat steady, and helps bone remain strong. It is very necessary for optimum function of human cell in both children and adults (European Food Safety Authority, 2015). Getting enough of it can help to prevent or treat Alzheimer's disease, type 2 diabetes, cardiovascular disease, and migraine. Its daily recommended allowance (RDA) are: 19-30 years, 400mg/day (men) and 310mg/day (women); 31 years and older is 420mg/day for men, and 320mg/day for women. For pregnant women age 14-18 years, the RDA is 400mg /day; 19-30 years, 350mg/day; 31-50 years, 360mg/day (Bailey *et al*., 2011). The use of these gums in food product stabilization may not supply the recommended daily allowance, but will contribute to it.

The calcium contents of the ofo and raffia gum samples were 16.03mg/100g and 101.40mg/100g respectively (Table 2). Calcium plays essential role in human body. It helps in muscle contraction, building strong bones and teeth, blood clothing, regulating heartbeat, and fluid balance within the cells (Balk *et al.,* 2017). The recommended amount for most adults is 1000mg/day and increased to 1200mg/day for women over 50 years and men over 70 years old (Food and Nutrition Board, 2010).

The Iron contents of the gum samples were 2.09mg/100g and 4.66mg/100g for the ofo and raffia gums respectively. The average daily or recommended iron intake from foods and supplements is between 13.7 - 15.1mg/day in children aged 2-11years , 16.3mg/day in children and teenagers aged 12-19years , 19.3-20.5mg/day in men and 17.0 - 18.9mg/day in women older than 19 years (Hurrel and Egli, 2010). Iron is known to support immune function, and excess of iron in the body is reported to increase the risk of cardiovascular disease, colorectal cancer and some neurodegenerative diseases like Alzheimer's disease (Revella, 2018).

The potassium contents of the gum samples were 5.05mg/100g and 8.05mg/100g for the raffia and ofo gum respectively (Table 2). Potassium is required in amounts not less than 100mg/day (Murray *et al.,* 2000). Deficiency of potassium causes impaired neuromuscular function of the skeletal, smooth and cardiac muscles together with muscular weakness, paralysis, mental confusion and inability to concentrate (Murray *et al.,* 2000).

The sodium contents of the gum samples were 3.26mg/100g and 3.72mg/100g for raffia and ofo respectively (Table 2). Thus raffia gum contains lower sodium compared to ofo gum. Sodium is an essential electrolyte that helps to maintain the balance of water in and around the cell. Its major role is maintaining blood volume and blood pressure by attracting and holding water. The lower levels of sodium in these gum samples made the gums appealing considering that low sodium diets are encouraged these days to control high blood pressure (WHO, 2012).

Functional properties of ofo and raffia gum samples

The values of the bulk density of the gum samples were 0.86g/ml and 0.84g/ml for raffia gum and ofo gum respectively (Table 3). There was no significant ($p>0.05$) difference between the gum samples in terms

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of bulk density. The value (0.86g/ml) for raffia gum was almost the same value (0.895g/ml) obtained by Steven and Usoro (2016) on characterization of raffia gum. The bulk density 0.86 g/ml of the raffia gum sample was comparable with 0.81g/ml reported by Sarker *et al*. (2018) on bulk density of exudates gum. The water absorption capacity (WAC) of the gum samples were 65.23water/100g and 68.64water/100g for the ofo and raffia gum respectively. There was a significant ($p<0.05$) difference between these samples with respect to their water absorption capacity. The water absorption capacity property is the amount of water taken up by flour to achieve the desired consistency and create a quality end product. It is an important processing parameter as it ensures the consistency of food products (Niba *et al*., 2001). It is the ability of a substance to combine with water under restricted conditions (Singh, 2001). It should be noted that the water absorption capacity of gums depends not only on the functional group of the polysaccharide fractions which are hydrophilic groups, but also on the protein fraction present in the gums. The absorption capacity has complete industrial applications to produce gels or highly viscous solutions (Ramasway *et al*., 2013).

Antinutrients of raffia and ofo gum samples

Significant difference ($p<0.05$) was observed between the oxalate contents of the gums. The values were were 2.11mg/100g and 2.6mg/100g for raffia and ofo gum respectively (Table 4). The oxalates have been implicated in the formation of complexes that enhance the formation of kidney stones but according to Dean (2019) oxalate intake below 200mg/100g may not pose any health challenge. Therefore the gum samples could be consumed or used for production of foods without the fear of health hazard. On the other hand, people suffering from coronary heart disease are encouraged to consume moderately, oxalate rich foods as it helps to reduce blood cholesterol (Savage *et al*., 2000).

The values of the concentrations of phytate obtained in the gum samples were 2.75 – 3.26%. The ofo gum sample had a higher (3.26%) phytate value while the raffia gum had the lower (2.75%) value. Phytate is a stored form of phosphorus, and has a high mineral (iron and zinc) binding capacity. The inhibitory effect of phytate on zinc and iron absorption is dose-dependent. The maximum allowable dosage of phytate in juman system is 500mg per day although the inhibitory effect of phytate starts at the concentration of 2 – 10mg/meal (Gibson *et al*., 2018). The phytate concentration of the gums is safe for human systems.

The saponin contents of the gum samples were 1.44% and 1.84% for the raffia and ofo gums respectively. There was no significant ($p>0.05$) difference. Foods and none food sources of saponin have come into renewed focus in recent years due to increasing evidence of their health benefits such as cholesterol lowering, anticancer properties, and lowering of blood glucose level (Balwinder *et al*., 2017).

The gum samples were found to contain alkaloid in the range of 0.93% to 1.05% with the raffia gum sample having the least (0.93%) value while ofo gum sample had a higher (1.05%) value. There was a significant ($p<0.05$) difference in the gum samples in terms of alkaloid contents. The biological roles of alkaloids include protection against allergies, inflammations, free radicals, microbes, virus and tumors (Yadav, 2008).

Conclusion and Recommendation

This research showed successful extraction of gum from both raffia palm exudate and ofo

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seed. It was discovered that raffia palm exudate and ofo seeds have very high percentage gum yield and the gums respectively were found to have appreciable micro nutrients and low antinutrient concentrations. The functional properties of the gums revealed their potential suitability in food formulations. These findings should be disseminated to food gum manufacturers.

Also the commercial extraction of gum from raffia exudate and ofo seeds and their respective incorporation in food production are therefore recommended. Also the gums should be used in the production of foods to ascertain their performance and acceptability to the consumers.

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APPENDICES

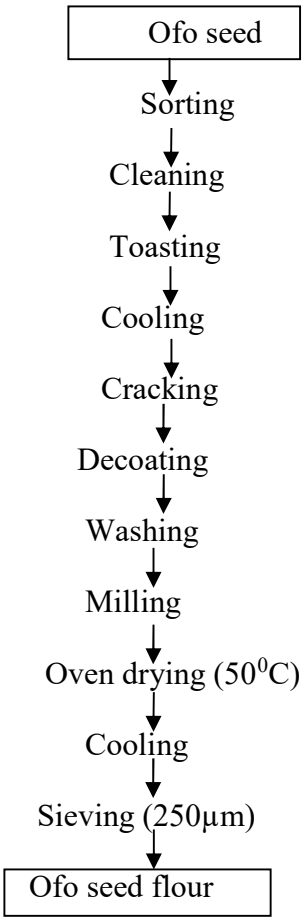

Fig. 1: Processing of *Detarium microcarpum* (ofo) seed flour.

Source: Nwosu (2012)

Table 1: Gum yield of raffia palm exudate and ofo seeds

Samples	**Percentage gum yield (%)**
Raffia exudate	50
Ofo seed (flour)	79

Note: The percentage data are means of triplicate determinations

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Table 2: Mineral contents of raffia palm and ofo gum samples

Samples	Magnesium mg/100g	Calcium mg/100g	Iron mg/100g	Potassium mg/100g	Sodium mg/100g
Raffia gum	9.37a+0.03	101.40a+0.07	4.66a+0.01	5.06b+0.04	3.26b+0.06
Ofor gum	7.94b+0.02	16.03b+0.03	2.09+0.01	8.05a+0.04	3.72a+0.05

Values are means and standard deviations of triplicate analysis. Means with different superscript along the columns are significantly ($p<0.05$) different

Table 3: Bulk density (BD) and water absorption capacity (WAC) of raffia and ofo gum samples

Sample	Bulk density (g/ml)	Water absorption capacity (water/100g)
Raffia gum	0.86a + 0.02	68.64a + 0.04
Ofo gum	0.84a + 0.03	65.23b + 0.04

Values are means and standard deviations of triplicate analysis. Means with different superscript along the columns are significantly ($P < 0.05$) different.

Table 4: Antinutrients of raffia and ofo gum samples

Sample	Oxalate (mg/100g)	Saponin (%)	Alkaloid (%)	Phytate (%)
Raffia gum	$2.11^{b}\pm0.01$	$1.44^{a}\pm0.05$	$0.93^{b}\pm0.03$	$2.75^{b}\pm0.05$
Ofo gum	$2.64^{a}\pm0.04$	$1.84^{a}\pm0.05$	$1.05^{a}\pm0.05$	$3.26^{a}\pm0.07$

Values are means and standard deviations of triplicate analysis. Means with different superscript along the columns are significantly ($P < 0.05$) different.