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Extraction of oil from borasaus flabellifer, (Ice apple) seed and compared with coconut oil and palm oil

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Abstract
The objective of the study is to extract oil from borassus flabellifer and compare its properties with that of sunflower oil and palm oil. The oil was extracted by milling the borassus flabellifer. The borassus flabellifer oil was also tested for its physicochemical properties such as Acid value, Iodine value, Peroxide value and Saponification value. The results were 5.4, 6.4, 54.42 and 149 respectively. The free fatty acid was estimated to be 1.35g/100g. The peroxide value of the oil was found to be lower than that of sunflower oil and palm oil.

Keywords: extraction, milling, physicochemical properties, fatty acids, anti-oxidants, saturated fat

Introduction

Borassus flabellifer is a robust tree and can reach a height of 30 metres (98 ft). The trunk is grey, robust and ringed with leaf scars; old leaves remain attached to the trunk for several years before falling cleanly. The leaves are fan-shaped and 3 m (9.8 ft) long, with robust black teeth on the petiole margins. Like all Borassus species, B. flabellifer is dioecious with male and female flowers on separate plants. The male flowers are less than 1 cm long and form semi-circular clusters, which are hidden beneath scale-like bracts within the catkin-like inflorescences. In contrast, the female flowers are golfball-sized and solitary, sitting upon the surface of the inflorescence axis. After pollination, these blooms develop into fleshy fruits 15–25 cm wide, each containing 1-3 seeds. The fruits are black to brown with sweet, fibrous pulp and each seed is enclosed within a woody endocarp. Young palmyra seedlings grow slowly, producing only a few leaves each year (establishment phase), but at an as yet undetermined time, they grow rapidly, producing a substantial stem. The fruit (Palmyra fruit) measures 10 cm (3.9 in) to 18 cm (7.1 in) in diameter, has a black husk, and is borne in clusters. The top portion of the fruit must be cut off to reveal the sweet jelly seed sockets, translucent pale-white, similar to that of the lychee but with a milder flavor and no pit. The sweet jelly seed sockets occur in combinations of two, three or four seeds inside the fruit. The jelly part of the fruit is covered with a thin, yellowish-brown skin. These are known to contain watery fluid inside the fleshy white body. These seed sockets have been the inspiration behind certain sandeshes called jalbhora found in Bengal. The soft orange-yellow mesocarp pulp of the ripe fruit is sugary, dense and edible, rich in vitamin A and C. They also contain bitter compound called flabelliferrins, which are steroidal saponins. The conventional way this fruit is eaten is when the outer casing is still unripe while the seeds are eaten as the fruit. But if the entire fruit is left to ripen, the fibrous outer layer of the palm fruits can also be eaten raw, boiled, or roasted. When this happens, the fruit takes a purple-blackish hue and tastes similar to coconut flesh. The skin is also eaten as part of the fruit similar to how mango skins are often consumed along with the fruit.In Jaffna In the Indian states of Tamil Nadu, Andhra Pradesh, Telangana and Bihar, and, Sri Lanka, the seeds are planted and made to germinate and the fleshy stems (below the surface) are boiled or roasted and eaten. It is very fibrous and nutritious. The Borassus flabellifer leaves are used for thatching, mats, baskets, fans, hats, umbrellas, and as writing material. All the literature of the old Tamil was written in preserved Palm leaves also known as Palm-leaf manuscript. In Tamil Yaedu or Olai chuvadi. The palmyra tree is the official tree of Tamil Nadu. Highly respected in Tamil culture, it is called “katpaha tharu” (“celestial tree”) because all its parts have a use. Panaiveriyamman, named after panai, the Tamil name for the Palmyra palm, is an ancient tree deity related to fertility linked to this palm. This deity is also known as Taalavaasini, a name that further relates her to all types of palms. Several edible vegetable and animal oils, and also fats, are used for various purposes in cooking and food preparation. In particular, many foods are fried in oil much hotter than boiling water. Oils are also used for flavoring and for modifying the texture of foods (e.g. Stir Fry). Cooking oils are derived either from animal fat, as butter, lard and other types, or plant oils from the olive, maize, sunflower and many other species. Cooking oil is plant, animal, or synthetic fat used in frying, baking, and other types of cooking. It is also used in food preparation and flavouring not involving heat, such as salad dressings and bread dippings like bread dips, and may be called edible oil. Cooking oil is typically a liquid at room temperature, although some oils that contain saturated fat, such as coconut oil, palm oil and palm kernel oil are solid. Heating oil changes its characteristics. Oils that are healthy at room temperature can become unhealthy when heated above certain temperatures, especially when heating repeatedly. The toxic risk is linked to oxidation of fatty acids and fatty acids with higher levels of unsaturation are oxidized more rapidly during heating in air. So, when choosing a cooking

oil, it is important to match the oil's heat tolerance with the temperature which will be used. And to change frying oil a few times per week. Deep-fat frying temperatures are commonly in the range of 170–190 °C (338–374 °F), less commonly, lower temperatures ≥ 130 °C (266 °F) are used. Palm oil contains more saturated fats than canola oil, corn oil, linseed oil, soybean oil, safflower oil, and sunflower oil. Therefore, palm oil can withstand deep frying at higher temperatures and is resistant to oxidation compared to high-polyunsaturated vegetable oils. Since about 1900, palm oil has been increasingly incorporated into food by the global commercial food industry because it remains stable in deep frying, or in baking at very high temperatures, and for its high levels of natural antioxidants, though the refined palm oil used in industrial food has lost most of its carotenoid content (and its orange-red color).

Problem Statement

The fruit of the borassus flabellifer is never totally consumed or processed because the seed is protected by a hardened shell. This seed is usually disposed of after consumption or industrial processing. Due to the large utilization of borassus flabellifer, more than one million tons of seeds being produced as waste annually. If these seeds could be utilized one way or another, it would eliminate wastage and also birth the production of new products. The usefulness of the whole seeds, especially the oil, in comparison with, is yet to gain rural and industrial attraction in African countries including Nigeria. This underutilization could be partly due to the limited knowledge of the composition of the seed oil and its toxicology status. Hence, this research work is necessary so as to provide more knowledge on the required experimental conditions for optimum production of seed oil and on the properties of the oil.

Arrangement of Materials

1. **Overview of seed oil:** Seed is a single flat oblong seed that can be fibrous on the surface, depending on the cG the seed coat 1 – 2 mm thick is a thin lining covering a single embryo, 4 – 7 cm long, 3 -6 cm wide, and 1 cm thick. Seed consists of a tenacious coat enclosing the seed. The seed content of different varieties of and their ranges are shown the Table 1.

Table 1: Seed composition range

Seed composition	Values in %
Seed in fruit	3-4
Melting Point	30.0± 1.20
Moisture	33 – 86
Protein	11.34+0.09
Crude fiber	1.7 – 7.6
Ash	2.66+0.87
Total carbohydrate	70 – 76
Phenolic compounds	0.1 – 6.4
Crude fat	1.40+0.19a

Seed oil is an oil that is obtained from the seed by extraction. The oil is semi-solid at room temperatures, but melts on contact with skin, making it appealing for baby creams, heat-care balms, hair products and other moisturizing products. seed oil has been used in the cosmetics industry as an ingredient in soaps, shampoos and lotions because it is a good source of phenolic compounds including microelements like selenium, copper and zinc.In addition, the extract of BORASSUS FLABELLIFER inhibition activities compared with methyl gallate and phenolic compounds from the seed kernel and methyl gallate in emulsion affected the stability of the cosmetic emulsion systems. Composition of oil-The major saturated fatty acids in borassus flabellifer seed oil were stearic and palmitic acids and the main unsaturated fatty acids are oleic, linolenic and linoleic acids (Table 2.2). The comparison of the composition in fatty acids of borassus flabellifer seed oil with that of vegetable oils indicates that this plant is rich in acids stearic and oleic. The fatty acid composition of jack frit seed fat shows a wide variation which may be attributed to differences in the variety and location.

Table 2: Composition of seed oil

Fatty acid	Composition
Palmitic acid	3-18
Stearic acie	0.62g
Oleic acid	0.66g
Carboxylic acid	0.65g
Linolenic acid	0.2-5.333
Saturated	27-75
Unsaturated	34.2-74.3

2. ***Physical and Chemical Properties of Seed Oil:*** Physical Properties-The physical properties of seed oil include specific gravity, total oil yield, refractive index, melting point and colour of seed oil. The values of these properties are shown below

Table 3: Physical Properties of seed oil

Physical Properties	Values
Amount of oil (%)	12.5± 0.2
Moisture of kernel content (%)	8.5± 0.1
Specific gravity at 40 degree celsius	0.900± 0.03
Refractive index at 40 degree celsius	1.443± 0.01
Refractive index at 40 degree celsius	30.0± 1.20
Colour	Slite Yellow

Chemical Properties-The chemical properties of seed oil include the free fatty acid composition, peroxide value, iodine number, saponification number and unsaponifiable matter. The chemical properties of oil are amongst the most important properties that determines the present condition of the oil. Free fatty acid and peroxide values are valuable measures of oil quality. The iodine value (IV) is the amount of iodine (in grams) necessary to saturate 100g of oil sample and is a measure of the amount of unsaturation in fats and oils. The saponification value is the milligrams of KOH necessary to saponify 1g of oil sample and shows the capacity of forming soaps of oil. The peroxide value (PV) is a measure of the extent of oxidation of a fat or oil. Unsaponifiable matter is the component of an oily mixture which fails to form soap when blended with NaOH. The unsaponifiable matter in vegetable oils is of great importance for oil characteristics and stability.

Table 4: Chemical properties of seed oil

Chemical Properties	Extract
Acid Value(mg KOH/g oil)	5.4
Peroxide value	6.4mg/kg
Iodine number	54.42g
Saponification number	149.00KOH/g

3. ***Seed processing and analysis of oil:*** Seed processing-The seed consists of the endocarp (a tenacious coat) and the seed of the Borassus flabellifer. The oil that is extracted is located in the kernel. The seed has to be processed before it is ready for oil extraction..The process of elimination of moisture from the seed is called drying. Seed drying should reduce the seed moisture content to safe moisture limits to maintain its viability and vigour during storage, which may otherwise deteriorate quickly owing to mold growth, heating and enhanced microbial activity. The processing method which was followed for extracting oil from borassus flabellifer seeds is 'milling.' This is a traditional method in which the seeds are first dried under the sun and then placed in between two rotating stone and ground. The oil obtained is then filtered to remove impurities. The benefit of this method is that at each stage of the milling process, no harmful chemical is added or no modification is done. After the milling process, The first product to be prepared is the borassus flabellifer seed oil. About 6kg of the seed was obtained to extract 2L of oil. The oil was extracted using the traditional method which involves grinding the dried seeds in between two stones. This oil does not undergo any processing but is just filtered to remove impurities.

Analaysis of oil: Chemical analysis-There is no organized, foolproof scheme for the qualitative analysis of fats, and the problems of identifying individual fats and oils is quite complicated. This is particularly true in the case of mixtures and processed fats. Even with the most sophisticated instruments, it is quite possible to encounter mixtures that defy identification of the source of the oil. Admittedly, the availability of more specific, meaningful, and reliable instrumental techniques has simplified identification and detection of adulteration. Also chromatographic procedures and spectrophotometry are used most commonly in combination with the determination of physical and chemical constants (saponification value, iodine value, acid value, peroxide value and others) that are constant and typical for individual fats and oils. During storage, fats may become rancid due to peroxide formation at their double bonds by atmospheric oxidation and their hydrolysis by microbes with the liberation of free acids. The amount of free acids associated with fat gives a fair indication of its quality and age. The acid value is defined as the number of milligrams of KOH required to neutralize the free fatty acids present in 1g fat. The measure of fat acidity normally reflects the amount of fatty acids hydrolyzed from triacylglycerols. Free fatty acid (FFA) is the percentage by weight of a specified fatty acid (e.g., percent oleic acid). In addition to FFAs, acid phosphates and amino acids also can contribute to acidity. In samples containing no acids other than fatty acids, FFA and acid value may be converted from one to the other using a conversion factor equation. %FFA as oleic × 1.99 = acid value. Acid value conversion factors for lauric and palmitic are 2.81 and 2.19, respectively (Nielsen *et al* 2010). FFA is calculated as free oleic acid on a percentage basis for most fats and oils sources, although for coconut and palm kernel oils it is usually calculated as lauric acid and for palm oil as palmitic acid. Free fatty acid is an 16 important fat quality indicator during each stage of fats and oils processing. Crude vegetable oils may have abnormally high FFA levels if the seed has been field damaged or improperly stored. Seed and fruit enzyme lipases are activated by moisture, and hydrolysis is initiated, which increases the FFA content. Higher crude oil FFA levels equate to higher refining losses. FFA is the result of hydrolysis of the fat or oil. Moisture must be present for hydrolysis to develop. This reaction is accelerated with heat and pressure, as are most reactions (O'Brien, 2008).When fats and oils are heated with an alcoholic solution of KOH, free fatty acids and glycerol are liberated. The refluxing with an alkali causes the hydrolysis of glyceryl esters, yielding glycerol and potassium salts of fatty acids (soaps). Subsequently, the test sample as well as the control is titrated against HCl to determine the amount of KOH used in the saponification process. The saponification value is the number of milligrams of KOH required to neutralize the fatty acids resulting from the complete hydrolysis of 1g fat. It is a measure of the alkali-reactive groups in fats and oils and it was used to predict the type of glycerides in a sample. The saponification value gives an indication of the nature of fatty acids in the fat, since the longer the carbon chain is, the lesser is the amount of acid liberated per gram of fat hydrolyzed (Nigam, 2007). Hence, glycerides containing short-chain fatty acids have higher saponification values that those with longer chain fatty acids. The saponification value is an indication of the average molecular weight of fat. For pure fatty acids, the saponification value equals the acid value. The ester value is the difference between the saponification value and the acid value. In oils and fats, the ester value is a measure of the amount of glycerides present (Pomeranz, 2002) [2]. The saponification value, along with the iodine value determination, were useful screening tests both for quality control and for characterizing types of fats and oils. However, the results overlap too much to identify individual fats or oils; for example, both domestic vegetable oils and animal fats have saponification values in the 180 to 200 range. Saponification value analysis has been replaced almost exclusively in edible fats and oils processing by fatty acid composition analysis by gas/liquid chromatography (GLC) (O'Brien, 2008). The amount of iodine a fatty acid can take up indicates it degree of unsaturation, and is termed its iodine value. The iodine value is a chemical constant for a fat or oil. It is a valuable characteristic in fat analysis that measures unsaturation, but does not define the specific fatty acids. Iodine value analyses are very accurate and provide nearly theoretical values, except in the case of conjugated double bonds or when the double bond is near a carboxyl group. However, unless the history of fat or the type of fat in the product is known, an iodine value may be somewhat meaningless by itself. For example, a product prepared with a meat fat with consistency and performance characteristics similar to a vegetable oil-based product will have a considerably different iodine value. Further, even vegetable oil-based product will have a considerably different iodine value. Further, even vegetable oil products with comparable functionality, but different source oils will not have like iodine values. Iodine value is a useful tool for process control and product specification. Iodine value is a measure of the unsaturation of fats and oils and is expressed as the number of centigrams of iodine absorbed per gram of sample. Iodine value of oil can be determined using Wijs reagent (iodine chloride), a Fourier transform-near infrared (FT-NIR) spectroscopy procedure, differential scanning calorimetry and other techniques (O'Brien, 2008). Oxidation of lipids is a major cause of their deterioration,

and hydroperoxides formed by the reaction between oxygen and the unsaturated fatty acids are the primary products of this reaction. Hydroperoxides have no lavor or odour but break down rapidly to form aldehydes, which have a strong, disagreeable lavor and odour. The peroxide concentration, usually expressed as peroxide value, is a measure of oxidation or rancidity in its early stages. Peroxide value measures the concentration of substances (in terms of milliequivalents of peroxide per 1000 grams of sample) that oxidize potassium iodide to iodine (O'Brien, 2008). Peroxide value measures a transient product of oxidation, (i.e., after forming, peroxides and hydro peroxides break down to form other products). A low value may represent either the beginning of oxidation or advanced oxidation, which can be distinguished by measuring peroxide value over time or by using a procedure that measures secondary products of oxidation. For determination in foodstuffs, a disadvantage of this method is the 5g fat or oil sample size required; it is difficult to obtain sufficient quantities from foods low in fat. This method is empirical and any modifications may change results. Despite its drawbacks, peroxide value is one of the most common tests of lipid oxidation. High-quality, freshly deodourized fats and oil will have a peroxide Physical analysis-Smoke point is the temperature at which fumes start coming from the surface of the oil when heated. This can be measured by inserting a thermometer into the oil at the time when fumes start apappearing. A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electrons emitted by atoms excited by the electron beam are detected using a secondary electron detector (Everhart-Thornley detector). The number of secondary electrons that can be detected, and thus the signal intensity, depends, among other things, on specimen topography. Some SEMs can achieve resolutions better than 1 nanometer. The seed contains around 55% moisture and is a good source of starch and protein. A 100-gram serving, or about 3.5 ounces of jackfruit seeds, provides about 184 calories, 7 grams of protein and 38 grams of carbohydrates, including 1.5 grams of fibre. The main raw material used in this research is borassus flabellifer for the extraction of the oil. These seeds were procured and the oil was extracted using the traditional method which involves grinding the dried seeds in between two stones. About 6kg of the seed was obtained to extract 2L of oil. This oil does not undergo any processing but is just filtered to remove impurities. The oil was then analysed based on the physicochemical properties and sensory evaluation was done for both samples on a 5 point Hedonic scale. Since the iodine value of the oil is 14.15, we can infer that the degree of saturation in the oil is higher. Lower value of peroxide indicates that the oil is less prone to oxidation and rancidity and is more stable. Oils with saponification value greater than 150 contain short chain fatty acids. Hence borassus flabellifer. oil contains short chain fatty acids.Extraction of oil from borassus flabellifer is done and analysis of the physicochemical properties of the same is carried out

Result and Discussion

In this chapter the result of the experiments carried out in the laboratory are outlined and described in various sections.

Table 5: Comparison of physicochemical properties of extracted oil

Parameter	Extracted seed oil	Sunflower oil	Palm oil
Acid value	5.4	0.055	10.0
Iodine value	54.42g	126g	54g
Peroxide Value	6.4mg/kg	2.54mg/kg	6.9mg/kg
Saponification value	149.00KOH/g	189.00KOH/g	251.00KOH/g

Conclusion

Since time immemorial, borassus flabellifer seeds have been thrown away once the fruit has been consumed. Little did we know about the benefits that this seed had? This thought paved way for the research to be carried out on the oil extraction from borassus flabellifer and its comparison with another vegetable oil. Researches done in the past convey the possibility of oil extraction from borassus flabellifer. The functional properties of the starch indicate that the seeds have the potential for use in foods. The seed contains around 55% moisture and is a good source of starch and protein. A 100-gram serving, or about 3.5 ounces of jackfruit seeds, provides about 184 calories, 7 grams of protein and 38 grams of carbohydrates, including 1.5 grams of fibre. The main raw material used in this research is borassus flabellifer for the extraction of the oil. These seeds were procured and the oil was extracted using the traditional method which involves grinding the dried seeds in between two stones. About 6kg of the seed was obtained to extract 2L of oil. This oil does not undergo any processing but is just filtered to remove impurities. The oil was then analysed based on the physicochemical properties and sensory evaluation was done for both samples on a 5 point Hedonic scale. Since the iodine value of the oil is 14.15, we can infer that the degree of saturation in the oil is higher. Lower value of peroxide indicates that the oil is less prone to oxidation and rancidity and is more stable. Oils with saponification value greater than 150 contain short chain fatty acids. Hence borassus flabellifer. Oil contains short chain fatty acids. Extraction of oil from borassus flabellifer is done and analysis of the physicochemical properties of the same is carried out.

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