

---

## Physicochemical Properties and Characteristics of Soursop (*Annona Muricata L.*) Seed Oil

Chisanum King Wofuru-Nyenke<sup>1</sup>

<sup>1</sup> Department of Biochemistry, College of Natural and Applied Sciences, Faculty of Chemical Sciences, University of Port Harcourt, Rivers State, Nigeria.

\*Correspondence: [chisanumnyenke@gmail.com](mailto:chisanumnyenke@gmail.com)

Received: 1 May 2025 / Accepted: 29 May 2025 / Published: 2 June 2025

© The Author(s) 2025.

### Abstract

The physicochemical analysis of *Annona muricata* (soursop) seed oil was evaluated. The results showed that the test sample had 23.15% of oil in the seed; the seed also contained 37.1% moisture, a 16.76 g acid value, a pH value of 7.9, a saponification value of 44.00 mg KOH/g oil value, an ester value of 27.24, a % glycerin of 1.49, % F.F.A. of 8.43%, an iodine value of 3.233, and a density of 0.88 g/dm<sup>3</sup>. The physicochemical properties of extracted oil revealed that the oil is edible and could serve as feedstock for many industrial applications.

**Keywords:** Soursop, Physicochemical Properties, *Annona Muricata L.*, Seed Oil, Extraction.

### 1. Introduction

The The soursop (*Annona muricata L.*) is a fruit native to tropical North and South America belonging to the genus *Annona* of the family *Annonaceae*, which includes about 100 species of trees or shrubs. It is the most tropical of the group and the one bearing the largest fruit (Nagy and Shaw, 1980).

It is commonly known as 'chop-chop' in Edo State, Nigeria, which is a corrupted form of the English name soursop. It is foreign to some parts of Nigeria. It is, however, found in the rainforest and derived savannah zone in Nigeria, either domesticated or growing wild. The fully mature fruit is green or light greenish yellow. The ripe, mature fruit is soft to the touch; ripeness is better detected by touch than by color.

Soursops are irregular in shape, but most frequently the fruits are ovoid or heart-shaped. The largest of the fruits is 15-30 cm long, with the width varying from 10 to 20 cm. The skin is thick, leathery, and very dark green with many short, curved fleshy spines. The mesocarp contains numerous shiny dark brown seeds, ovoid in shape and measuring about 2 cm in length and about 1 cm in breadth (National Academy of Science, 1978).

It is mostly eaten as fresh fruit. It is cultivated mainly in home gardens. The tree yields up to 10 tons per hectare, and each fruit weighs 0.5 to 2 kg (Oyenuga, 1978).

Soursop has found its uses in many areas. It is consumed as a dessert fruit. It is made into a fruit jelly with the addition of some gelatin or used in the preparation of beverages, ice creams, and syrups. The fruit makes an excellent drink or ice cream after straining. Its white edible pulp contents are 80% water, 1% protein, 18% carbohydrate, and fair amounts of vitamins B1 and B2. The seeds are flat and hard and contain all that can be used for paint or insecticide (Rice et al., 1991).

The fruits contain significant amounts of vitamin C, vitamin B1, and vitamin B2. Laboratory and field research suggests that soursop-derived substances may have potential for various future applications, since they have shown

antileishmanial and cytotoxic, antinociceptive, anti-inflammatory, anti-diabetic, and anti-cancer effects in laboratory experiments (national academy of science, 1978).

A number of medicinal properties are attributed to the leaves and juice of the soursop. Toxic and insecticidal characteristics are reported for different parts of the tree and fruit (Rice et al., 1991).

The seed is about 4% of the whole fruit, and much has not been reported about the chemical and nutritional contents of the seed in recent times. The importance of the study is the evaluation of the proximate composition, mineral content, and toxicants of the seed.

## 2. Literature Review

### 2.1. Scientific Classification

**Kingdom:** Plantae

**(unranked):** Angiosperms

**(unranked):** Magnoliids

**Order:** Magnoliales

**Family:** Annonaceae

**Genus:** *Annona*

**Species:** *A. muricata*

**Binomial name:** *Annona muricata* L.

**Common names:** Chop-chop, Ebo, Jamaica soursop, and prickly custard apple.

The massive disposal of biomass wastes (skin, pulp, seeds, etc.) that always occurred in most fruit processing units and underutilization of products has become noticeable in recent years (Federici et al., 2009). Meanwhile, recent studies revealed that bio-recovery of valuable byproducts like ethanol, enzymes, pharmaceuticals, and essential oils from agro-biomass wastes like mango, beniseed, sorrel, pineapple, and papaya have been carried out (Arumugam and Manikandan, 2011; Betiku and Adepoju, 2012; Kumar et al., 2012; Adepoju and Abiodun, 2013). Soursop has emerged as a potential candidate for the production of essential oil. Soursop is a fruit of *Annona muricata*, a broadleaf, flowering, evergreen tree native to Mexico, Cuba, Central America, the Caribbean, and northern South America, primarily Colombia, Brazil, Peru, Ecuador, and Venezuela, as well as some parts of Africa, Southeast Asia, and the Pacific. It is in the same genus as the chirimoya and the same family as the papaya. The flesh of the fruit consists of an edible, white pulp, some fiber, and a core of indigestible, black seeds (Arumugam and Manikandan, 2011).

Soursop seeds constitute 20%-25% of the mass of the fruit and have the potential to produce 33.87% oil with nutritional and functional properties highly similar to those of edible oils (Okoro, 2013).

Ground seeds are used as a vermifuge and antihelminthic against internal and external parasites such as head lice and worms and to combat pea lice. Besides, the seeds have been used in order to kill moths and cockroaches (Jaramillo, 2000).

Onimawo, in 2000, carried out selected physicochemical properties of soursop seed oil and obtained the following statistics in the nutrient composition of soursop. The seed contained 8.5% moisture, 2.4% crude protein, 13.6% ash, 8.0% crude fiber, 20.5% fat, and 47.0% carbohydrate. The seed also contained 0.2% water-soluble ash, 0.79% titratable acidity, and 17.0 mg calcium/100 g. Selected physicochemical characteristics included a refractive index of 1.335 for the seed, a specific gravity of 1.250 for the seed, a pH value of 8.34 for the seed, and a soluble solid content of 1.5° Brix for the seed. (Onimawo, 2000).

Different extraction methods (aqueous enzymatic extraction, extrusion expelling process, and solvent extraction) have been examined for the recovery of oils from oilseeds (Lee et al., 2011; Adepoju et al., 2013; Okoro, 2013). Previous

researchers applied the solvent extraction technique for the extraction of oils from different plant oilseeds due to its cost-effectiveness, simplicity, remarkable reduction in solvent volume, and short time needed for the extraction (Tan et al., 2009; Betiku and Adepoju, 2012; Bimakr et al., 2012; Adepoju et al., 2013).

Moreover, the optimization of extraction conditions (extraction time, sample weight, solvent volume and particle size) in solvent extraction methods have been studied in order to obtain extra yield and better quality index of the product under the optimum extraction conditions (Mani et al., 2007; Li et al., 2009; Adepoju et al., 2013).

Nutrient evaluation of seeds of ripe and unripe soursop (*Annona muricata*) fruits was carried out at the University of Port Harcourt. In this experiment, the nutrient composition of ripe and unripe soursop was carried out, and the nutrient composition of ripe soursop was observed to be higher in moisture and protein and lower in total lipid/fat, ash, and dry matter. (Thomas, Alfred 2000).

Nutritional value per 100g (3.502)

<b>Energy</b>	276 KJ (66 Kcal)
<b>Carbohydrates</b>	16.84 g
Sugars	13.54 g
Dietary fibre	3.3 g
<b>Fat</b>	0.3 g
<b>Protein</b>	1g
<b>Vitamins</b>	
Thiamine (B1)	0.07 mg (6%)
Riboflavin (B2)	0.05 mg (4%)
Niacin (B3)	0.9 mg (6%)
Pantothenic (B5)	0.253 mg (5%)
Vitamin (B6)	0.059 mg (5%)
Folate (B9)	14 mg (4%)
Choline	7.6 mg (2%)
Vitamin C	20.6 mg (25 %)
<b>Trace Metals</b>	
Calcium	14 mg (1%)
Iron	0.6 mg (5%)

Magnesium	21 mg (6%)
Phosphorus	27 mg (4%)
Potassium	278 mg (6%)
Sodium	14 mg (1%)
Zinc	1.0 mg (1%)

### Units

µg = micrograms

mg = milligrams

IU = International units

Percentages are roughly approximated using US recommendations for adults.

Source: USDA Nutrient Database.

The Annonas are generally consumed as fresh fruits, but they are also widely used in semi-processed and processed products (ICUC, 2002).

All the fruits of the *Annona* species showed high moisture content; this is typical of fleshy fruits (Ereifej et al., 1997). This high moisture content indicates that the fruits are highly susceptible to degradation when not properly stored (Folorunso and Modupe, 2007).

### 2.2. Climate and Soil

The genus *Annona* includes, for the most part, tropical and subtropical plants, although a few species develop in temperate climates. Many species grow at low altitudes, and those with a wide adaptation to altitude are also the species most adapted to variations in latitude. The optimal range of latitude is between 27°N and 22.5°S (Nakasone & Paull, 1998).

Soursop is the most tropical of the *Annona* species and is considered a plant of low altitudes and a hot and humid climate. It is grown primarily at altitudes lower than 900 m above sea level (Zayas, 1966).

However, good productive orchards are found at altitudes of up to 1100 m. (Pinto and Silva, 1994). Soursop adapts well to savannas and tropical humid regions. Two important climatic factors are rain, principally when out of season, and strong winds. Both, when they occur in great intensity and during flowering, greatly reduce pollination (Nakasone and Paul, 1998).

Soursop is very demanding of light, and shading the plants greatly reduces the production of fruits (Villachica et al. 1996). Soursop grows and produces well at 21 - 30°C, being very sensitive to severe changes in temperature range was between 15 and 25°C.

Soursop will grow in a wide variety of soils, from sandy to clay loams, but it prefers deep soils with good aeration (Melo et al. 1993; Ledo 1992). Good drainage is necessary for good root development and especially to avoid problems of root diseases. Soil pH should be between 6.0 and 6.5 (Pinto and Silva, 1994).

### 2.3. Medicinal Benefits

Soursop is not only a delicious and healthy fruit, but it is also used medicinally to treat illnesses ranging from stomach ailments to worms.

- The seeds, which have emetic properties, can be used in the treatment of vomiting.
- The leaf decoction is effective for head lice and bedbugs.
- The crushed fresh leaves can be applied on skin eruptions to promote healing.
- The juice of the fruit can be taken orally as a remedy for arthritis, hematuria, and liver ailments.
- The juice, when taken when fasting, is believed to relieve liver ailments and leprosy.
- To speed the healing of wounds, the flesh of the soursop is applied as a poultice unchanged for 3 days.
- A decoction of the young shoots or leaves is regarded as a remedy for gallbladder trouble, as well as coughs, catarrh, diarrhea, dysentery, fever, and indigestion.
- Mashed leaves are used as a poultice to alleviate eczema and other skin problems and rheumatism.
- The root bark is used as an antidote for poisoning.
- Soursop flowers are believed to alleviate catarrh.

A decoction of leaves is used as compresses for inflammation and swollen feet.

### 2.4. Compositional Characteristics of Soursop Seeds

The seeds of soursop fruit are rich in oil and protein and low in toxicants (tannins, phytate, and cyanide) and therefore could be harnessed in human and animal nutrition. Soursop seeds contained 22.10% pale-yellow oil and 21.43% protein. The oil was bland in taste and possessed an acid value of 0.93, a saponification value of 227.48, an iodine value of 111.07, and an acetyl value of 66.77. The oil consisted of 28.07% saturated and 71.93% unsaturated fatty acids. The seeds yield a yellowish-brown 70% unsaturated oil, which consists of 12-33% linoleic, 41-58% oleic, 16% palmitic, and 5% stearic with a trace of myristic. This oil may have economic value as an edible oil if some possibly toxic components can be removed. The table below shows some toxicants in the seed and seed coat of soursop. The seed has a higher content of magnesium and zinc than the pulp, and the pulp has a higher content of potassium and calcium than the peel or seeds.

Parameter	Seed	Seed Coat
Tannin (mg/100 g)	2.6	4.9
Phytate (mg/100 g)	620.5	188.0
Cyanide (mg/kg)	3.7	10.8

Source: International Centre for Underutilized Crops. (2002).

### 2.5. Fatty acid composition

The major saturated fatty acids in *Annona muricata* seed oil are palmitic (20.33%) and stearic (4.22%) acids. The main unsaturated fatty acids are oleic (41.41%) and linoleic (30.60%) acids. There was no significant difference in the amounts of the major fatty acids in the two oil samples. The

two oil samples of *Annona muricata* contained saturated and unsaturated acids (24.55% and 75.45%), respectively. *Annona muricata* oil can be classified in the oleic-linoleic acid group. Linoleic acid, which is one of the most important polyunsaturated fatty acids in human food because of its prevention of distinct cardiovascular diseases (Boelhouwer, 1983).

### 2.6. Major Saturated Fatty Acids Palmitic Acid

#### Palmitic Acid

Palmitic acid, or hexadecanoic acid, is the most common fatty acid (saturated) found in animals, plants, and microorganisms. As its name indicates, it is a major component of the oil from palm trees (palm oil), but it can also

be found in meats, cheeses, butter, and dairy products. Palmitate is a term for the salts and esters of palmitic acid. The palmitate anion is the observed form of palmitic acid at physiologic pH (7.4) (Westfechtel, Alfred 2006).

### **Occurrence and production**

Palmitic acid mainly occurs as its ester in triglycerides (fats), especially palm oil but also tallow. The acetyl ester of palmitic acid (acetyl palmitate) occurs in spermaceti. It was discovered by Edmond Frémy in 1840 in saponified palm oil. Butter, cheese, milk, and meat also contain this fatty acid. Palmitic acid is prepared by treating fats and oils with water at a high pressure and temperature (above 200°C or 390°F), leading to the hydrolysis of triglycerides. The resulting mixture is then distilled. (Westfechtel, Alfred 2006).

### **Applications**

Palmitic acid is used to produce soaps, cosmetics, and release agents. These applications utilize sodium palmitate, which is commonly obtained by saponification of palm oil. To this end, palm oil, rendered from the palm tree (species *Elaeis guineensis*), is treated with sodium hydroxide (in the form of caustic soda or lye), which causes hydrolysis of the ester groups. This procedure affords glycerol and sodium palmitate. Because it is inexpensive and adds texture to processed foods (convenience food), palmitic acid and its sodium salt find wide use, including in foodstuffs. Sodium palmitate is permitted as a natural additive in organic products. (Westfechtel, Alfred 2006).

### **Stearic Acids**

Stearic acid is a saturated fatty acid with an 18-carbon chain and has the IUPAC name octadecanoic acid. It is a waxy solid. The salts and esters of stearic acid are called stearates. Stearic acid is one of the most common saturated fatty acids found in nature following palmitic acid. (Westfechtel, Alfred 2006).

### **Production**

As a component (esterified) of fats, stearic acid occurs in many animal and vegetable fats and oils, but it is more abundant in animal fat (up to 30%) than vegetable fat (typically <5%). The important exceptions are cocoa butter and shea butter, where the stearic acid content (as a triglyceride) is 28-45%. Stearic acid is prepared by the process of saponification of these fats and oils, using hot water (above 200°C), leading to the hydrolysis of triglycerides. The resulting mixture is then distilled. Commercial stearic acid is often a mixture of stearic and palmitic acids, although purified stearic acid is available. The triglyceride derived from three molecules of stearic acid is called stearin. In terms of its biosynthesis, stearic acid is produced from carbohydrates via the fatty acid synthesis machinery via acetyl-CoA (Susan Budavari, ed. 1989).

### **Applications**

Stearic acid is mainly used in the production of detergents, soaps, and cosmetics such as shampoos and shaving cream products. Soaps are not made directly from stearic acid but indirectly by saponification of triglycerides consisting of stearic acid esters. Esters of stearic acid with ethylene glycol, glycol stearate, and glycol distearate are used to produce a pearly effect in shampoos, soaps, and other cosmetic products. They are added to the product in molten form and allowed to crystallize under controlled conditions. Detergents are obtained from amides and quaternary alkylammonium derivatives of stearic acid. (Susan Budavari, ed. 1989).

## **2.7. Major Unsaturated Fatty Acids**

### **Oleic Acid**

Oleic acid is a fatty acid that occurs naturally in various animal and vegetable fats and oils. It is an odorless, colorless oil, although commercial samples may be yellowish. In chemical terms, oleic acid is classified as a monounsaturated omega-9 fatty acid. The term "oleic" means related to, or derived from, oil of olive, the oil that is predominantly composed of oleic acid. (Young, Jay A. 2002).

### **Production and Chemical Behavior**

The biosynthesis of oleic acid involves the action of the enzyme stearoyl-CoA 9-desaturase acting on stearoyl-CoA. In effect, stearic acid is dehydrogenated to give the monounsaturated derivative oleic acid. Oleic acid undergoes the reactions of carboxylic acids and alkenes. It is soluble in aqueous base to give soaps called oleates. Iodine adds across the double bond. Hydrogenation of the double bond yields the saturated derivative stearic acid. Oxidation at the double bond occurs slowly in air and is known as rancidification in foodstuffs or drying in coatings. Reduction of the carboxylic acid group yields oleyl alcohol. Ozonolysis of oleic acid is an important route to azelaic acid. A naturally occurring isomer of oleic acid is petroselinic acid. (Young, Jay A., 2002).

### **Uses**

Oleic acid (in triglyceride form) is included in the normal human diet as a part of animal fats and vegetable oils. Oleic acid as its sodium salt is a major component of soap as an emulsifying agent. It is also used as an emollient. Small amounts of oleic acid are used as an excipient in pharmaceuticals, and it is used as an emulsifying or solubilizing agent in aerosol products. (Thomas, Alfred 2000).

### **Linoleic Acid**

Linoleic acid (LA) is a polyunsaturated omega-6 fatty acid. It is a colorless liquid at room temperature. From the chemistry perspective, linoleic acid is a carboxylic acid with an 18-carbon chain and two cis double bonds, with the first double bond located at the sixth carbon from the methyl end. Linoleic acid belongs to one of the two families of essential fatty acids, which means that the human body cannot synthesize it from other food components (Piomelli, Daniele 2000).

### **In Physiology**

Linoleic acid is a polyunsaturated fatty acid used in the biosynthesis of arachidonic acid (AA) and thus some prostaglandins, leukotrienes (LTA, LTB, LTC), and thromboxane (TXA). It is found in the lipids of cell membranes. It is abundant in many nuts, fatty seeds (flax seeds, hemp seeds, poppy seeds, sesame seeds, etc.), and their derived vegetable oils, comprising over half (by weight) of poppy seed, safflower, sunflower, corn, and soybean oils. Linoleic acid is an essential fatty acid that must be consumed for proper health. A diet only deficient in linoleate (the salt form of the acid) causes mild skin scaling, hair loss, and poor wound healing in rats. (David F. Horrobin 1993).

### **Uses**

Linoleic acid is used in making quick-drying oils, which are useful in oil paints and varnishes. These applications exploit the easy reaction of the linoleic acid with oxygen in air, which leads to cross-linking and formation of a stable film. Reduction of linoleic acid yields linoleyl alcohol. Linoleic acid is a surfactant with a critical micelle concentration of  $1.5 \times 10^{-4}$  M at pH 7.5.

Linoleic acid has become increasingly popular in the beauty products industry because of its beneficial properties for the skin. Research points to linoleic acid's anti-inflammatory, acne-reductive, and moisture-retentive properties when applied topically on the skin. Linoleic acid lipid radicals can be used to show the antioxidant effect of natural phenols. Experiments on linoleic acid subjected to 2,2'-azobis (2-amidinopropane) dihydrochloride induced oxidation of linoleic acid, hence producing lipid radicals, and then the use of different combinations of phenolics show that binary mixtures can lead to either a synergetic antioxidant effect or to an antagonistic effect towards the lipid radicals. Research like this is useful in discovering which phenols prevent the autoxidation of lipids in vegetable oils. Linoleic acid may be linked to obesity by promoting overeating and damaging the arcuate nucleus in the brain's hypothalamus. (Kinsella et al., 1990).

The aim of this research is to discuss the physicochemical profile of soursop seed in order to throw more light on the utilization potentials of this seed in the areas of the food industry and, possibly, animal feed formulation.

### 3. Materials and Methods

#### 3.1. Sample Collection

Soursop seeds were collected from Choba market, Rivers State, Nigeria. The seeds were washed to remove particles and dried at room temperature for 1 week. The black, hard epicarp seeds were cracked manually, and the fleshy part was removed. The fleshy part was sun-dried for 3 days. The cleaned seeds were milled to powder by grinding with a grinding machine. All chemicals and reagents used for this extraction work were of analytical grades and needed no further purification.

#### 3.2. Laboratory Materials

<b>Apparatus</b>	<b>Brand/Model/Make</b>
Soxhlet apparatus	
Filter paper	
Heating mantle	
PH Meter	B-Bran scientific & exact instrument
Thermostatic water bath	HH-W 420
Micropipette	AVISHKAR International PVT. LTD.
Weighting balance	SYLT
Spatula	
Glassware: glass rod, round-bottom flask, beakers, conical flask, burette, measuring cylinder, glass funnel, wash bottle, pipette, Kjeldahl flask, reagent bottles, and volumetric flasks.	

#### Reagents

Distilled water  
 $H_2SO_4$   
 Phenolphthalein  
 Chloroform  
 Hanus's solution  
 Potassium iodide  
 n-hexane  
 Sodium thiosulphate (0.1N)  
 Starch solution  
 Acetic acid  
 Diethyl ether  
 Ethanol  
 Sodium hydroxide (NaOH)

#### Description of Oil Extraction

A 250-ml Soxhlet extractor apparatus and n-hexane as a solvent were used for this work. The apparatus was charged with a known weight of the oilseed powder in a thimble made with filter paper and staples placed in a thimble of the apparatus. A reactor containing a known volume of n-hexane was stationed at the end of the apparatus, and a condenser was tightly fixed at the bottom end of the extractor. The whole setup was heated up in a heating mantle at a constant temperature of 70°C, and the seed oils were collected in the flask. The excess solvent in the seed oils was recycled by heating at the same temperature. The quantity of the seed oil yield was determined gravimetrically as the ratio of the

weight of the extracted seed oils to the weight of the soursop seed powder sample used (Eq. 1). The obtained oil was kept properly for further processing.

$$\text{Oil yield \%} \left( \frac{W}{W} \right) = \frac{\text{weight of seed oils produced}}{\text{Weight of soursop oilseed powder used}} \times 100$$

### Physicochemical Analysis of the Soursop Seed oils

The physicochemical properties of the crude seed oils, namely, moisture content, density, acid value, pH, iodine value, crude oil %, saponification value, peroxide value, % FFA, ester value, and % glycerin, were determined using AOAC (1990) methods.

#### Determination of iodine value

The iodine value was determined using the AOCS method.

#### Procedure

The weight of the sample was approximately 0.275 g of the seed oil into a 250 mL conical flask. 10 ml of chloroform was added, and 30 ml of Hanus solution was also added to the mixture, and the flask was then closed completely with foil paper, and the solution was left for 30 minutes in a dark cupboard.

10 ml of potassium iodide solution was added; 100 ml of distilled water (DW) was also added to the mixture. 0.1 N Sodium thiosulfate solution was titrated till a yellow color formed, then 2-3 drops of starch solution were added till a blue solution formed, and then titration was continued till the blue color disappeared.

#### Determination of free fatty acid content (FFA)

Free fatty acid (FFA) was calculated using the AOCS method.

#### Procedure

The weight of the sample used was 0.502 g of the seed oil in a conical flask. 25 ml of diethyl ether, 25 ml of ethanol, and 1 ml of phenolphthalein solution were prepared. The mixture was titrated with 0.5 N NaOH, which was shaken vigorously until a permanent faint pink color appeared at 0.3 ml and persisted for 5 seconds.

$$\%F.F.A = \frac{\text{Titration (ml)} \times 0.141 \times 100}{\text{Weight of sample used}}$$

#### Determination of saponification value (SV)

The saponification value is the number of mg of potassium hydroxide required to neutralize the free acids and to saponify the esters in 1 g of the substance. Saponification is the process of breaking down a neutral fat into glycerol and fatty acids by treatment with alkali.

The saponification value of seed oil was determined according to the method reported by Pearson.

#### Procedure

This was done by dissolving 0.505 g of seed oil in 12.5 ml of 0.5% ethanolic KOH. One milliliter of phenolphthalein was added to the mixture as an indicator before titration with 0.5 N HCl.

A blank determination was also carried out under the same conditions; 1.2 ml was used for the pink color to disappear. Saponification value was calculated using

$$SV = 5.61N \frac{(Q - Z)}{W}$$

Where N is the normality of HCl, Q is the volume (ml) of H<sub>2</sub>SO<sub>4</sub> for the blank (ml), Z is the volume (ml) of H<sub>2</sub>SO<sub>4</sub> for the sample (ml), W is the weight of the oil (g), and 56.1 is a constant, which is equivalent to the weight of potassium hydroxide.

#### Determination of Moisture content

The air-oven method (AOAC, 1984) was used to calculate percentage moisture content.

#### Procedure

This was based on the air-oven method. 2.654 g of the sample was weighed and used. The weighed sample was placed in the oven at 105°C for 6 hours. The sample was allowed to cool in a desiccator and reweighed to a constant weight. The difference between the initial and final weights gives the moisture content. The formula used to calculate percentage moisture content

$$\% \text{ moisture content} = \frac{W_1 - W_2}{W_1} \times 100$$

#### Determination of pH

The pH value was determined by the use of a pH meter. The pH meter was dipped into the seed oil to get its pH value.

## 4. Results and Discussion

### 4.1 Physicochemical properties and other characteristics of soursop seed oil

Table 1 shows the physicochemical properties and other characteristics of soursop seed oil.

Table 1: Physicochemical properties and other characteristics of soursop seed oil.

Parameters	Composition
<b>Physical properties</b>	
Physical state at 28°C	Pale yellow in colour
pH value	7.9
Moisture content (%)	37.1
Density	0.88
% Crude oil	23.15
<b>Chemical properties</b>	
%FFA	8.43
Acid value (mg KOH/g oil)	16.76
Saponification value (mg KOH/g oil)	44.00 KOH/g oil

Ester value	27.24
% Glycerin	1.49
iodine value (12 g/100 g oil)	3.233

In order to evaluate the quality of soursop oil, the content and compositions of the oil were subjected to physicochemical analysis, and the results obtained are shown in chapter three. At room temperature, the oil was pale yellow in color with a moisture content of 37.1, and a pH value of 7.9 indicates that the oil is alkaline in nature. Observations on the color and moisture content of the oil agreed with a previously published report by Okoro (2013).

The chemical properties of crude soursop oil. Low FFA content (8.43%) of the seed oil indicated good resistance to hydrolysis. The small acid value (16.76 mg KOH/g oil) of the seed oil showed that it is not only edible but could also have a long shelf life. A high saponification value of 44.00 (mg of KOH/g of oil) obtained suggested a high concentration of triglycerides. The iodine value of the seed oil was low at 3.233 g, which signified the oil contained a substantial level of unsaturation. This observation is supported by the high level of unsaturated fatty acids present in the seed oil. The low iodine value suggests that the oil could also be stored for a long period without deterioration. These also demonstrate that the oil possesses the desirable qualities of edible oils. The soursop oil could therefore be used for food purposes and as a feedstock in the industries.

## 5. Conclusion

The present study shows the physicochemical properties of soursop seed oil. The study also reveals that the seed of soursop, *Annona muricata*, is rich in oil and protein and low in toxicants (tannins, phytate, and cyanide) and therefore could be harnessed in human and animal nutrition. Physicochemical analysis of the seed oil advocates it could serve as a useful oil for food purposes and as a feedstock in many food and chemical industries. The relatively low moisture content indicates that, when dried, the flour prepared from *Annona muricata* seeds should have good keeping quality without encouraging the growth of molds.

Some of the limitations encountered during this research project include:

- i. Inadequate water supply.
- ii. Unavailability of certain reagents and materials.
- iii. Power failure.

Further research should be carried out on the stems and leaves of the soursop (*Annona muricata* L.) plant to ascertain its nutritive value and health benefits for humans and animals.

## References

- Adepoju, T. F., & Abiodun, A. (2013). Statistical approach to oil extraction from sorrel seed (*Hibiscus sabdariffa* L.) and its quality characterization. *International Journal of Science and Engineering Research*, 9(4).
- Arumugam, R., & Manikandan, M. (2011). Fermentation of pretreated hydrolysates of banana and mango fruit wastes for ethanol production. *Asian Journal of Experimental Biological Sciences*, 2, 246–256.
- Association of Official Analytical Chemists (AOAC). (1990). *Official methods of analysis of the Association of Official Analytical Chemists* (15th ed.). Washington, DC: AOAC.

- Bimakr, M., Abdul Rahman, R., Taip, F. S., Adzahan, N. M., Sarker, M. Z. I., & Ganjloo, A. (2012). Optimization of ultrasound-assisted extraction of crude oil from winter melon (*Benincasa hispida*) seed using response surface methodology and evaluation of its antioxidant activity, total phenolic content, and fatty acid composition. *Molecules*, *17*, 11748–11762.
- Boelhouwer, C. (1983). Trends in the chemistry and technology of lipids. *Journal of the American Oil Chemists' Society*, *60*(2), 457–462.
- Horrobin, D. F. (1993). Fatty acid metabolism in health and disease: The role of  $\Delta$ -6-desaturase. *American Journal of Clinical Nutrition*, *57*, 732–747.
- Federici, F., Fava, F., Kalogerakis, N., & Mantzavinos, D. (2009). Valorization of agro-industrial by-products, effluents, and waste: Concept, opportunities, and the case of olive mill wastewaters. *Journal of Chemical Technology and Biotechnology*, *84*, 895–900.
- Jaramillo, M., Monghata, N. C., & Peter, P. (2000). Cytotoxicity and antileishmanial activity of *Annona muricata* pericarp. *Fitoterapia*, *71*, 183–186.
- International Centre for Underutilized Crops. (2002). *Fruits for the Future* (Newsletter No. 5). Institute of Irrigation and Development Studies, University of Southampton, UK.
- Kinsella, J. E., Lokesh, B., & Stone, R. A. (1990). Dietary *n*-3 polyunsaturated fatty acids and amelioration of cardiovascular disease: Possible mechanisms. *American Journal of Clinical Nutrition*, *52*(1), 1–28.
- Mani, S., Jaya, S., & Vadivambal, R. (2007). Optimization of solvent extraction of moringa (*Moringa oleifera*) seed kernel oil using response surface methodology. *Food and Bioproducts Processing*, *85*, 328–335.
- Melo, G. S., Gonzaga Neto, L., & Moura, R. J. M. (1983). *Cultivo da gravioleira* (Instruções Técnicas No. 13). Empresa Pernambucana de Pesquisa Agropecuária (IPA), Recife.
- Nagy, S., & Shaw, P. E. (1980). *Tropical and subtropical fruits: Composition, properties, and uses* (pp. 375–406). AVI Publishing Company, Westport, CT.
- Nakasone, H. Y., & Paull, R. E. (1998). *Tropical fruits* (pp. 45–75). CAB International, London.
- National Academy of Sciences. (1978). *Underexploited tropical plants with promising economic value*. Washington, DC: National Academy Press.
- Okoro, C. K. (2013). Influence of moisture content variation on the percentage oil yield of soursop (*Annona muricata*) seeds. *International Journal of Science and Engineering Research*, *4*(7).
- Onimawo, I. A. (2002). Proximate composition and selected physicochemical properties of the seed, pulp, and oil of soursop (*Annona muricata*). *Plant Foods for Human Nutrition*, *57*, 165–171.
- Onimawo, I. A., Momah, A. H., & Usman, A. (1998). Proximate composition and functional properties of four cultivars of bambara groundnut (*Vigna subterranea*). *Plant Foods for Human Nutrition*, *53*, 153–158.

- Oyenuga, V. A. (1978). *Nigeria's foods and feeding-stuffs: Their chemistry and nutritive value*. Ibadan University Press, Ibadan, Nigeria.
- Piomelli, D. (2000). Arachidonic acid. In *Neuropsychopharmacology: The fifth generation of progress*.
- Pinto, A. C. de Q. & Silva, E. M. (1994). *Graviola para exportação: aspectos técnicos da produção*. Embrapa-SPI, Brasília.
- Pinto, A. C. de Q. (1996). Enxertia: Operações e cuidados (pp. 21–28). In A. C. de Q. Pinto, *Produção de mudas frutíferas sob condições do ecossistema de Cerrados* (Documentos No. 62). Embrapa Cerrados.
- Pinto, A. C. de Q. & Ramos, V. H. V. (1997). Graviola: formação do pomar e tratos culturais (pp. 94–104). In A. R. São José, I. V. B. Souza, O. M. Morais & T. N. H. Rebouças (Eds.), *Anonáceas: Produção e mercado*.  
*Anonáceas: produção e mercado*. Universidade Estadual do Sudoeste da Bahia, Vitória da Conquista, Bahia.
- Pinto, A. C. de Q., Silva, E. M. da, Ramos, V. H. V. & Rodrigues, A. A. (2001). Tratos culturais (pp. 26–33). In M. A. S. Oliveira (Ed.), *Graviola: Produção*. Embrapa Informação Tecnológica, Brasília.
- Rice, R. P., Rice, L. W. & Tindal, H. D. (1991). *Fruit and vegetable production in warm climates* (p. 383). Macmillan Education Ltd.
- Silva, H., Silva, A. Q. da, Cavalcante, A. T. & Malavolta, E. (1984). Composição mineral das folhas de algumas fruteiras do Nordeste (pp. 320–325). In *Anais do 7º Congresso Brasileiro de Fruticultura* (Florianópolis). Sociedade Brasileira de Fruticultura.
- Silva, E. M. da, Pinto, A. C. de Q. & Azevedo, J. A. (1996). *Manejo da irrigação e fertirrigação na cultura da mangueira* (Série Documentos No. 61). Embrapa Cerrados, Brasília.
- Silva, A. Q., & Silva, H. (1997). Nutrição e adubação de anonáceas (pp. 118–137). In A. R. São José, I. V. B. Souza, O. M. Morais & T. N. H. Rebouças (Eds.), *Anonáceas: Produção e mercado*. Universidade Estadual do Sudoeste da Bahia, Vitória da Conquista, Bahia.
- Silva, D. J., Quaggio, J. A., Pinto, P. A. C., Pinto, A. C. de Q., & Magalhães, A. F. de J. (2002). Nutrição e adubação (pp. 193–221). In P. J. de C. Genu & A. C. de Q. Pinto (Eds.), *A cultura da mangueira*. Embrapa Informação Tecnológica, Brasília.
- Budavari, S. (Ed.). (1989). *The Merck Index: An encyclopedia of chemicals, drugs, and biologicals* (11th ed., p. 8761). Merck & Co., Inc., Rahway, NJ. ISBN 978-0-911910-28-5.
- Thomas, A. (2000). Fats and fatty oils. In *Ullmann's Encyclopedia of Industrial Chemistry*. Wiley-VCH.
- Tan, C. H., Ghazali, H. M., Kuntom, A., Tan, C. P. & Ariffin, A. A. (2009). Extraction and physicochemical properties of low-free-fatty-acid crude palm oil. *Food Chemistry*, 113, 645–650.
- Villachica, H., de Carvalho, J. E. U., Muller, C. H., Diaz, S. C. & Almanza, M. (1996). *Frutales y hortalizas promisorios de la Amazonía*. Tratado de Cooperación Amazónica, Secretaría Pro-Tempore, Lima.

Westfechtel, A. (2006). Fatty acids. In *Ullmann's Encyclopedia of Industrial Chemistry*. Wiley-VCH, Weinheim.  
[https://doi.org/10.1002/14356007.a10\\_245.pub2](https://doi.org/10.1002/14356007.a10_245.pub2)

Young, J. A. (2002). Chemical laboratory information profile: Oleic acid. *Journal of Chemical Education*, 79, 24.  
<https://doi.org/10.1021/ed079p24>

Zayas, J. C. (1966). *Las frutas anonáceas*. Ediciones Fruticuba, Havana.