Evaluation of Paw-Paw Seed as A Renewable Source of Edible Vegetable Oil

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Abstract

The objective of this study was to evaluate the potential of paw-paw seeds as a source of edible vegetable oil. Sun-dried seeds (SDS) and oven-dried seeds (ODS) of paw-paw was subjected to Soxhlet extraction using petroleum ether as the solvent. The physicochemical parameters of the oil were investigated. Results revealed the parameters; Oil yield, Acid value, Saponification value, Iodine value, Peroxide value, Melting point and Smoke point were 47.5%, 4.635 mg/g, 32.721 mg/g, 1.269 mg/g, 0.737 mg/g, 10.55 °C, 37.33 °C and 32.1%, 4.208 mg/g, 12.805 mg/g, 0.850 mg/g, 2.337 mg/g, 9.50 °C and 36.34 °C for ODS and SDS oils respectively. The oil from paw-paw seed is a non-drying oil. It is edible and can be used as an edible source of vegetable oils. Its use in soap making is also encouraged. As a waste-to-wealth project, processing paw-paw seeds into oils could serve as a source of income to farmers.

Keywords: *paw-paw seed, edible oils, Soxhlet extraction, physicochemical parameters*

INTRODUCTION

The pawpaw, scientifically known as Carica papaya, is a widely distributed plant in tropical regions [1]. Typically, people dispose of the papaya fruit's seeds (as shown in figure 1), which results in the improper disposal of waste materials. This practice contributes to environmental pollution and has detrimental effects on the health of individuals in the community [2]. Nevertheless, it is necessary to explore the potential of using papaya's seeds as an oil source to optimize its utilization [3].

Figure 1: Image of Pawpaw fruit showing the seeds

Plant seed oils are any oil extracted from a plant's seeds. Oil extraction commonly uses seeds from various plants, including sunflower, sesame, pumpkin, flax, and hemp. The process of extracting oil from the seeds involved crushing or pressing the seeds to extract the oil. You can use the extracted oil for cooking, skin care, and nutrition [4].

Describe the usefulness and potential of Carica papaya seed oils for various purposes. This is very important for creating wealth in Northern Cross River communities like Yala, Okpoma, Kukelle, Igede, and Yache, where farmers depend on pawpaw for some of their income. This study aims to identify the ideal extraction conditions that impact the oil's yield and quality. The results will contribute to the existing data bank, which can assist potential industrialists interested in extracting oils from *Carica papaya* seeds.

Bio-oil derived from organic waste sources has several applications in medicines, dietary supplements, and other products [5]. Seed oils provide numerous health advantages. For example, sunflower seed oil is rich in beneficial lipids and Vitamin E, which can aid in lowering inflammation, boosting cardiovascular health, and strengthening the immune system. Sesame seed oil is high in antioxidant which can help in the prevention of cellular damage and reduce the risk of chronic diseases. Flax seed oil is high in Omega -3-fatty acids which can help lower cholesterol, reduce inflammation and improve brain function [6]. Overall studies shows that seed oils are versatile, nutritious and offers a range of benefits for the body, skin, hair, etc. However, it is important to use them in moderation and consult with a healthcare provider before adding them to your diet or skin care routine. Various methods, including Soxhlet extraction, ultrasound-assisted extraction, and the extraction of supercritical liquid have been employed to extract oil from pawpaw seeds [7]. However, among these methods, Soxhlet extraction has proven to be more efficient than ultrasound-assisted extraction and supercritical fluid extraction [8].

METHODOLOGY

Sample Collection and Treatment

Pawpaw (*Carica papaya*) was purchased from Afokang market, Calabar South, Cross River state, Nigeria. The fruits were fully ripened, fresh and whole. The fruits were divided into two longitudinal parts equally and the seeds removed and divided into 2 parts. The first part was sundried and labelled as sun-dried seeds (SDS) while the second part was oven-dried and labelled as Oven-dried seeds (ODS) respectively. For sun-drying, seeds were removed from the fruits of *Carica papaya* and placed under the sun for seventy-two (72) hours to remove the moisture content in the seeds, while for oven-drying, the seeds were removed from the fruit and dried in the oven at 100°C for thirty (30) minutes. The dried seeds were pounded to powder separately using mortar and pestle. After pounding, the powder was packed in two different containers and labeled as SDS and ODS and stored in a dried place for extraction.

Extraction of the Oil

The Soxhlet extraction method describe by Musa *et al* (2015) was used in the extraction of oil from *Carica papaya* seeds. Two hundred millimeters (200 ml) of petroleum ether as solvent was poured into a round bottom flask. Twenty-three grams (23g) of ODS and SDS was introduced into a separate thimble and were placed at the center of the Soxhlet extractor. The extractor was then heated to 60°C and was held at that temperature throughout the duration of extraction (2 hours). After extraction, the oil was kept open for 2 days to aid evaporation of any residual solvent in the mixture. The oil samples obtained were labelled and packaged in an air tight container and stored in a refrigerator for further analysis.

Characterization of the Oil

The oil was analyzed for certain physiochemical properties such as acid value, saponification value, iodine value, peroxide value.

acid value: 1g of both (ODS AND SDS) were weighed into a clean conical flask. 250ml of distill water was added to dissolve the oil and was well shaken, two drops of phenolphthalein indicator, 10 ml of petroleum ether followed by 10 ml of ethanol and 2 ml of sulphuric acid was added and the resulting mixture was titrated against a standardized Potassium Hydroxide (KOH) in the burette until the appearance of permanent pale pink color. The acid value was then calculated using equation 1.

$$\text{Acid value} = \frac{56.1\ x\ V\ x\ C}{m} \qquad \text{[equation 1]}$$

Where 56.1 = weight of KOH; volume in ml of standard KOH solution used for titration; C is the molar concentration of KOH solution; m = weight of the oil

Saponification value

Exactly 0.5 grams of both ODS and SDS were measured and placed in a clean conical flask. Then, 5 milliliters of PET Ether and 10 milliliters of ethanol were added. The mixture was continuously stirred and gently boiled for 30 minutes. A reflux condenser was positioned on the flask carrying the mixture. The heated solution was supplemented with 2 ml of phenolphthalein indicator and subsequently titrated until the appearance of the pink color of the indicator. Saponification value was calculated using equation 2 below.

$$saponification\ value = \frac{b-a\ X\ 56.1}{weight\ of\ oil\ sample\ (g)} \qquad \text{[equation 2]}$$

B = blank titre value; a = actual titre value

Acid value

A burette was filled with 50ml of Hubi's iodine, and the initial reading was recorded. A dry porcelain dish was used to hold 50ml of chloroform. Then, 2 drops of Hubi's iodine were added to act as a control for the color composition. A total of 5ml of chloroform was transferred to a separate porcelain dish. Then, 0.5ml of both ODS and SDS oils were added individually and dissolved by gently swirling. Iodine from the burette was gradually introduced into the solution until the color became visible. The measurement from the burette was recorded and the experiment was repeated. Iodine value was calculated using equation 3:

$$\text{Acid Value} = \frac{12.69\ \text{X M X}\ (\text{V}_0 - \text{V}_1)}{\text{m}} \qquad \text{[equation 3]}$$

where: V_o = Volume of sodium thiosulphate used in blank titration; V_1= Volume of sodium thiosulphate used in. original titration; M = Molarity of sodium thiosulphate; m = mass of the oil.

Peroxide Value

Precisely 0.5 grams of both ODS and SDS oils were accurately measured and placed into a conical flask each. Then, 2 milliliters of acetic acid and 1 milliliter of chloroform were added to the flask. The mixture was violently shaken, covered, and stored in a dark place for 2 minutes. First, 3 milliliters of distilled water were added, then a single drop of iodine solution and 5 milliliters of starch indicator were added. The resultant purple solution was titrated using a 0.02N Sodium Thiosulphate solution until a white color appeared. Peroxide value is given as equation 4:

$$\text{Peroxide value} = \frac{(S-b)\ x\ M\ x\ 1000}{weight\ of\ oil} \qquad \text{[equation 4]}$$

Where: S = titre value of the oil sample; b = titre value of the blank sample

Melting Point

Ten (10) cm³ of both ODS and SDS oils were measured in separate test tubes and placed in a cup with ice cubes to solidify. The congealed oil in the test tubes was extracted from the ice block, and the temperature at which the oil commenced to liquefy was documented.

Smoke Point

Ten (10) cm³ of both (ODS and SDS) were weighed into clean dry crucibles and cooked on a hot plate. The temperature at which the samples started to generate bluish smoke was monitored using a thermometer.

RESULT AND DISCUSSION

Table 1: Physico-chemical properties of oils from paw paw seeds

Parameters /unit	ODS Proportion mg/g	SDS Proportion mg/g
Yield	47.5%	32.1%
Acid value mg/g	4.635	4.208
Saponification value mg/g	32.721	12.805
Iodine value mg/g	1.269	0.850
Peroxide value mg/g	0.737	2.337
Melting point °C	10.55	9.50
Smoke point °C	37.33	36.34

The assessment of oil content in seeds is crucial as it enables the estimation of the prospective use of a specific seed as a source of oil and/or biofuels [9]. Table 1 presents the quantities of oil obtained from oven-dried paw-paw seed (ODS) oil and sun-dried seed (SDS) oil. A high oil content in seeds indicates that processing these seeds for oil extraction would be economically feasible.

The acid value provides information about how much fatty acid is in the oil sample [10]. The acid value of pawpaw seed oils obtained in this study was 4.635 ± 1.03 for ODS and 4.208 ± 1.05 for SDS oils respectively mg/g. This value is lower than 6.42 mg in Moringa oil; 9.27 ±

0.01/13.30 ± 0.01 in ripe/unripe pawpaw seed oil and slightly higher than 2.810 ± 1.040 in sun-dried paw-paw seed oil presented by Kukwa *et al* [10], Aladekoyi *et al* [11] and Adeleke *et al* [12] respectively. The acid value of pawpaw seeds reported in this study was slightly higher than the permissible limit of 3.0 mg KOH/g for edible oils, thus indicating that the oil is edible and good for consumption if properly refined. Kukwa *et al* [10] opined that the acid value of an oil is directly related to its pH value. Specifically, as the acid value increases, the pH of the oil falls.

The use of fat or oil in soap manufacture is justified by a high saponification value. It is also regarded as an indicator of the mean molecular weight (or length) of all the fatty acids present. The saponification value of paw-paw seed oils obtained in this study was 32.721 ± 0.03 for ODS and 12.805 ± 1.09 for SDS oils respectively. It was observed that the oil from the oven-dried seeds had a higher saponification value. This could be attributed to the fact that an oven temperature of 100^{o}C may have denatured and or broken down the organic content of the seed, thus increasing the surface area for oil extraction and bleaching. The saponification value of paw-paw seed oil obtained in this study was lower than 192.82 mg of KOH/g in Moringa oil, 121.90 ± 0.02 and 111.80 ± 0.02 in ripe and unripe pawpaw seeds reported [10, 11, 16]. The difference in saponification value might be due to environmental factors and the genetical composition of the oilseeds. Anwar and Rashid [13] concluded that oils with a high saponification value are suitable for making liquid soap, shampoos, and lather shaving creams.

The iodine value is a measure of the level of unsaturation in oil. It is a valuable indicator for estimating the number of double bonds that exist in the oil, which indicates how easily the oil can undergo oxidation. The iodine value in this study was 1.269 mg/g in ODS and 0.850 mg/g in SDS oils respectively. These values were significantly lower than 22.00 mg/g in sun-dried paw-paw seed oil reported by Adeleke *et al* [12] as well as 52.44 ± 0.02 and 47.62 ± 0.01 in ripe and unripe paw-paw seed oil researched by Aladekoyi *et al* [11]. The oil exhibits a comparatively low iodine value as a result of its elevated concentration of saturated fatty acids. The iodine value achieved is comparatively lower than that of regularly utilised seed oils such as maize oil, olive oil, palm oil, and soybean oil [14]. Oils with iodine values less than 100 mg/g are known as non-drying oils. This suggested that *Carica papaya* oil is a non-drying oil and could be useful in the manufacture of soaps and can be regarded as liquid oil. The iodine values of both ODS and SDS pawpaw seed oils were below the CODEX standard range of 104-120 g/100g [15].

The peroxide value is a quantitative measure of the level of rancidity in oils. Consequently, a high peroxide value shows that the oil has a low resistance to peroxidation, which might occur during storage. The peroxide value of pawpaw seed oils in this study was 0.737 for ODS and 2.337 mg/g for SDS. These values compare favourably with 2.00 mg/g in unripe paw-paw seed oil reported by Aladekoyi *et al* [11]. However, the peroxide value of paw paw seed oils obtained in this study was slightly lower than 4.42 mg/g reported in Moringa seed oil by Kukwa *et al* [10]. The low peroxide value in this study implied that the oil is stable and would not go rancid during storage

The melting point of oil refers to the temperature at which the oil changes from one state to the other. The melting point of oil is important in cooking as it influences the texture, flavor and ability to fry foods. Oils with low melting point are liquid at room temperature and are not suitable for deep frying. The melting point of paw-paw seed oils revealed in this study was 10.55°C in

ODS and 9.50°C in SDS. The smoke point of paw-paw seed oil in this study was 37.33°C for ODS and 36.34°C for SDS. The results obtained were lower than 50.00 ± 0.02 and 60.00 ± 0.01 in ripe and unripe pawpaw seed oil presented by Aladekoyi *et al* [11].

Conclusion

The seeds of the *Carica papaya* fruit make up around 20% of the overall weight of the fruit when it is fresh. During fruit processing, people typically discard the seeds despite their edibility as agricultural waste products. Owing to their high lipid content, the seeds have the potential to serve as an innovative edible oil source. This study's findings suggest that the physiochemical characteristics of Carica papaya seed oil meet the requirements for vegetable oil, suggesting its potential use as a vegetable oil after appropriate refining processes. The study results also indicated that papaya seed oil possesses a higher saponification value, making it well-suited for industrial uses. Carica papaya's seeds have a high oil yield, making them economically viable for commercial oil production in Nigeria. The chemical analysis also indicated that the seed samples were suitable for both residential consumption and industrial applications. The oils derived from this research have a low acid value, indicating that they are suitable for consumption. Low peroxide levels showed that the oil had little vulnerability to oxidative rancidity and degradation, while low iodine readings showed that the oil is non-drying and may have few unsaturated bonds.

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