Evaluation of the Effect of Roasting on the Physicochemical Properties of Cucumis Melo I Seed Oil

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Abstract

The need to identify cheaper sources of fats and oils to supplement the nutritional value of the largely carbohydrate based diets in developing countries including Ghana, motivated the research into the oil quality of Cucumismelo I seed oil. The seed oil of Cucumismelo I (yellow melon) was extracted using the soxhlet apparatus in the raw form and the roasted form of the seeds. The yield was higher (38.62%) in the roasted form than the unroasted form (33.78%). The color of the oil of the roasted seed was observed to pale brown while that of the unroasted was pale yellow. The pH for the oil from both roasted and unroasted seeds was slightly acidic (6.3 for both). The specific gravity of the oil was also found to be approximately the same for both the roasted and unroasted seeds (0.906 g ml^{-1} and 0.904 g ml^{-1} respectively). However there was significant difference in the values for the roasted and unroasted seed oil for Peroxide value (3.17 $mmolO_2/Kg$ and 6.36$mmolO_2/Kg$) respectively; Acid value (0.597 Mg KOH/g and 1.110 Mg KOH/g) respectively; Free Fatty Acid value (0.30 % and 0.56 %) respectively. All the values for the unroasted seed oil were about twice that of the roasted seed oil. The iodine value for both oils was almost the same. The saponification value was determined for only the oil from the unroasted seeds and was found to be less than 100 mg KOH/g. These properties when compared with that of edible oils indicate possible use as edible vegetable oil.

Keywords: Cucumismelo, physicochemical properties, unroasted seeds, Peroxide value, Acid value, saponification value

1. Introduction

The quest for developing countries to make progress in meeting the Millennium Development Goals (MDG's), especially in eradication of extreme poverty and hunger in particular has lead to aggressive research into some underutilized indigenous plants. An example of such a plant is *Cucumismelo* (Indorusgrop), also known as yellow melon in the Upper East Region of Ghana.

The plant *Cucumismelo I* belongs to the family cucurbitaceace. It has shallow and fibrous roots just like the plants that fall under its family. It has a slender stem-like structure by which it crawls or climbs other plants. Mostly in the savanna region of Africa, it is grown yearly and serves as an auxiliary crop along side yam, maize and millet (Mabelehae*t al.,* 2007).

Cucumismelo is considered as one of the important economically grown vegetable crops, grown in both the temperate and tropical regions of the world (Zohary, 1988). Its seed kernel is readily used in soup preparation as thickening and flavoring agents, since they are widely distributed and less expensive. As such they help in maintaining a balance diet for most people (Giwa*et al.*, 2010).

In recent times, vegetable oil and oils from the seeds of many plants are utilized in the food industry, cosmetic industry and pharmaceutical industry.

Even though there exist a vast range of vegetable oils world wide, the commonest of these oils consumed include palm, soybean, rape seeds and sunflower oils with 38.1, 35.7. 17.8 and 18.2 million tons consumed per year respectively (American soybean Association, 2007). This rise in demand for oil has also lead to increase in research towards underexploited promising plant species to serve as a source of dietary oils. The seeds of these plants contain high amounts of oil and a proportional amount of desirable fatty acids (Vanesa*et al.,* 2011). The fatty acids present in these oils play a very significant role in the human system especially in the growth of children (Bowen and Clandinin, 2005). Fatty acids are also known to have desirable properties such as antithrombotic, anti-inflammatory, antiarrhythmic and stabilizing plaque and hence very important in preventing cardiovascular diseases (Galli and Marangoni, 2006).

Research has shown that diets in developing countries are high in carbohydrates and relatively low in proteins and essential fatty acids (Kyari, 2008). This is because most developing countries, Ghana inclusive depend largely on starch-based foods. This has lead to the prevalence of protein deficiency in both adults and children (Akubugwu*et al.,* 2008). This has therefore made it necessary to explore the seeds of plants that are readily available to obtain cheaper alternative sources of fats and oils to help boost the nutrition of most individuals in the sub-region and other industries depending on the properties of the oil that will be extracted.

This work therefore sought to extract oil from the seeds of *Cucumismelo I* (yellow melon) and determine the physic-chemical properties and suggest possible applications for the oil extracted.

2. Materials and Methods

2.1 Sampling and Sample Treatment

Matured fruits of *Cucumismelo I* (yellow melon) were collected from Pwalugu, a district under Bolgatanga, the Upper East Region of Ghana. The average length of the fruit was 7.0mm whiles the average diameter was 3.0mm with an average weight of 140g. The fruits were first washed with distilled water and cut open to remove the seeds. The seeds were the washed with distilled waster and sundried. When the seeds were fully dried, they were divided into two groups and one group of the seeds was roasted. The two groups of seeds (roasted and unroasted) were then pulverized and stored in plastic containers, ready for use. All reagents used for this work were of analytical reagent grade unless otherwise stated. Distilled water was used in the preparation and dilution of solutions and the physic-chemical analysis were determined in triplicated.

2.2. Oil Extraction

The soxhlet extraction apparatus was used in the extraction of the oil. In the process, 70g of the powdered seed sample was measured into a porous thimble and placed in a soxhlet extraction apparatus, using 150 cm^3 of n-hexane (with boiling point of 68-70 ^{0}C) as extraction solvent for 6 hour. The oil was obtained after the solvent was removed under reduced temperature and pressure and refluxing at 80 ^{0}C to remove excess solvent from the extracted oil. The oil extracted was stored in a plastic container in a cool place for subsequent physicochemical analysis.

2.3. Determination of Percentage Yield

In determining the percentage yield, the oil obtained from the extraction was transferred into a measuring cylinder, which was then placed over a water bath for 30 minutes at 80 ^{0}C. This was to completely evaporate solvents. The volume of the oil was measured and expressed as oil content (%) as shown below;

Oil content (%) = $\frac{Weight\ of\ oil}{weight\ of\ sample}$x 100%

2.4. Determination of Specific Density of the Oil

A volume of 10 ml of the oil was measured in a pre-weighed measuring cylinder. The weight of the cylinder and oil were measured. The weight of the oil was then obtained from subtracting the weight of the cylinder from the weight of the oil and cylinder. The specific density of the oil was obtained using the expression below;

Specific Density of oil = $\frac{W1-W0}{V0}$, where W_1= Weight of oil and cylinder, W_0= weight of empty cylinder and V_0= volume of oil.

2.5. PH of the Oil

A universal indicator paper was used to determine the pH of the oil. 2 ml of the oil sample was measured into a clean beaker and the indicator paper placed into the oil. The indicator paper was then removed and its color was compared to the color chat of the universal indicator paper and the corresponding pH value noted.

2.6.1 Moisture Content of Seeds (Pre-Dried)

This was done to determine the moisture content of the fresh seeds. In the process, an aluminum foil was weighed and noted as W_1. 100 fresh seeds were placed on the aluminum foil and its weight noted as W_2. The aluminum foil and its content wasplaced in an oven at a temperature of 150 ^{0}C for 2 hours. The foil and its content was weighed after the two hours. This was repeated until a constant weight W_3 was obtained and recorded. The moisture content of the sample was then calculated as;

Moisture content (%), $S_0 = \frac{W2-W3}{W2-W1}$x 100.

2.6.2 Moisture Content of Seeds (Dried Stage)

This was done to determine the moisture content of the powdered seed samples. An empty petri dish was weighed and recorded as W_p. 10g of powdered seed sample was measured and transferred onto the empty petri dish and its weight recorded as W_c. The petri dish and its content were placed in an oven with temperature of 105 ^{0}C for 2 hours. After the two hours, the petri dish and its content were weighed and the process repeated until a constant weight is obtained and recorded as W_d. The moisture content was then calculated as;

Moisture Content (%), $S_1 = \frac{Wc-Wd}{Wc-Wp}$ x 100%

The total moisture content (%) of seed, $M= S_1 xS_0 – [\frac{S1-S0}{100}]$,

Where S_1= Moisture percentage loss at the dried stage, S_0=Moisture percentage loss at the pre-drying stage and M= Moisture content.

2.7. Free Fatty Acid

A 5g of the oil was weighted into a conical flask containing 10 ml of neutralized 95% ethanol. Three drops of phenolphthalein was then added. The resultant mixture was then titrated against 1.0M NaOH. The process was repeated three times and the average titre,V was recorded. The percentage free fatty acid was calculated using the expression below;

Percentage Free Fatty acid (% oleic) = $\frac{V\ x\ N\ x\ 2.77}{S}$, where V= volume of NaOH, N= normality of NaOH, S= sample weight and 2.77 is the conversion factor for oleic acid.

2.8. Iodine Value

A 0.2g of the oil was dissolved in a 25 ml 1:1 cyclohexane/acetic acid in a 100 ml conical flask. 25 ml of Wijs iodine solution was added to the flask, warmed and allowed to stand for 1 hour in the dark at 25 ^{0}C. After the 1 hour period, 25 ml of potassium iodide (KI) solution and 1000 ml of water was added and the mixture was then titrated against 0.1 M solution thiosulphate, using starch indicator and the titre value, S was recorded. The same procedure was repeated for the blank titration and was recorded as B. The iodine value was calculated as shown;

Iodine value =$\frac{(B-S)x\ N\ x\ 12.69}{sample\ Weight}$, where B = volume of sodium thiosulphate solution used for the blank, S= volume of sodium thiosulphate solution use in titration, N= normality of sodium thiosulphate.

2.9. Peroxide Value

A 5.0g of the oil was dissolved in 20 ml 3:2 acetic acid/isooctane in 250 ml conical flask. 0.5 ml of freshly prepared saturated potassium iodide solution was added to the flask. 30 ml of distilled water was then added to the content of the flask. The result was titrated with 0.1M sodium thiosulphate solution using starch as an indicator. The same procedure was repeated for the blank titration. The peroxide value was then calculated as shown;

Peroxide value=$\frac{(A-B)x\ N\ X\ 1000}{Sample\ Weight}$, where B= volume of sodium thiosulphate used for the blank, volume of sodium thiosulphate solution used in the titration, N= normality of sodium thiosulphate.

2.10 Acid Value

A 5g of oil sample was weighed into a conical flask which already contain 10ml neutralized 95% ethanol and three drops of phenolphthalein was added. The resultant mixture was then titrated against 0.1M NaOH. The average titre value for three trials was recoded as V. The percentage free fatty acid and acid value was then calculated as follows;

Percentage Free Fatty Acid (%Oleic) = $\frac{V \, x \, N \, x \, 2.77}{S}$, where V= Average titre value (i.e volume of NaOH), N= Normality of NaOH, S= weight of sample.

The Acid Value is then calculated as, Acid Value = % Free Fatty Acid x 1.99

Where 1.99 is a conversation factor.

2.11 Saponification Value

A 2g of the oil sample was weighed into a 250ml conical flask. 30ml of 0.1M ethanolic potassium hydroxide solution was then added to the oil in the conical flask. The content was stirred and allowed to boil for 60 minutes. A reflux condenser was placed on the flask containing the mixture and the mixture was allowed to cool. A few drops of phenolphthalein was added to the mixture and titrated against 0.1M hydrochloric acid. A blank was prepared using the same reagents without the oil sample. The saponification value was then calculated as follows;

Saponification Value = $\frac{(B-A)x \, M \, x \, N}{Sample \, Weight}$, where B = titre value of HCl in blank titration, A = titre value of HCl for actual titration, M = molarity of HCl and N = molecular mass of Potassium hydroxide.

3. Results and Discussion

The results of the physicochemical analysis of the *Cucumismelo I* seed oil is summarized in Table 1. The color of the oil was observed to be pale brown color for the roasted seeds (RS) and a pale yellow color for the unroasted seeds (URS). The oil yield was recorded as 38.82% and 33.78% respectively for the roasted seeds (RS) and unroasted seeds (URS) respectively. Both percentages were observed to higher than those of Luffaaegyptiaca seed oil, reported as 25.7±0.70% by Elemo*et al.*,2011) and that of garlic oil which is 22.5% (Gafar*et al.*, 2012). On the other hand, the yield was lower than that obtained for *J. carcas* seed oil, 48% (Warra et al., 2012), and cotton seeds, also 48% (Warra*et al.*, 2011). Since the oil that was extracted from the *CucumismeloI* seed was done without dehulling the seeds, and considering the oil yield, *Cucumismelo I* seeds could be exploited for oil extraction.

Table 1: Physicochemical Characteristics of *Cucumismelo* Seed Oil

Parameters	Roasted seed oil	Unroasted seed oil
Oil yield (%)	38.62	33.78
Specific Density (g/ml)	0.906	0.904
Moisture Content (%)	5.1	6.4
pH	6.3	6.3
Color	Pale Brown	Pale Yellow
Iodine Value (Ig/100g)	76.40	75.50
Peroxide Value (mmolO_2/Kg)	3.17	6.36
Acid value (MgKOH/g)	0.597	1.110
Free Fatty Acid (%)	0.30	0.56
Saponification value (mgKOH/g)	-	79.101

Note: Values are expressed as mean ± standard deviation.

The moisture content of the RS and the URS of *Cucumismelo I* was quiet low, 5.1% and 6.4% respectively. Oyenuga (1986), reported the moisture content of shelled lima beans to be 4.42% and 1.41% for castor bean (Olaniyan, 2010). The low moisture content of the seeds serves to be advantageous in terms of shelf life. The specific density of both RS and URS oil of *Cucumismelo I* were 0.906 gml^{-1} and 0.904 gml^{-1} respectively. These values were observed to be lower than 0.93±0.14 gml^{-1} and 0.92±0.10 gml^{-1} reported for dehulled and whole seed oil respectively of *Luffaaegytiaca* (Elemo*et al.*, 2011), but within the range of 0.90 g ml^{-1} of garlic (Allium sativum L.) oil (Gafar*et al.*, 2012).

Since Cucumismelo seed oil has a maximum density of 0.906 g ml^{-1}, then it means that the oil contains low molecular weight fatty acids and those pose less or no health risk should the oil be considered for consumption.
The saponification value of the oil was determined for only unroasted seeds (URS) and the value was 79.10 mg KOH/g, which is lower compared to 112±0.27 mg KOH/g obtained for *Luffacylindraca* Linn seed oil (Gafa*et al.*, 2012), 199.42±0.53 mg KOH/g for cotton seeds oil (Warra*et al.*, 2011). High saponification value indicates the availability of short chain fatty acids (Gafar et al., 2012) and also means that the oil is very suitable for soap production. Since the saponification value for *Cucumismelo I* seed oil is less than 100, it will not serve a good purpose for soap production.

The acid value of oil tells the free fatty acid (FFA) content of the oil. High acid value of oil affects the quality of the oil negatively since it will contain high FFA content (Warra*et al.*, 2011). The acid for the RS and URS oil of *Cucumismelo I* is 0.6 mg KOH/g and 1.11 mg KOH/g respectively, which are lower than 10.1±0.57 mg KOH/g and 9.36±0.51 mg KOH/g of dehulled and whole seed oil respectively of *Luffaaegyptiaca* Mill (Elemo et al., 2011), 2.34±0.9 mg KOH/g of *J. Curcas* seed oil (Warra*et al.*, 2012). The low acid values obtained for the oil indicated good qualitysince it will have a low FFA value which are 0.30% and 0.56% for RS and URS respectively.

The iodine value is used to determine the amount of unsaturation in the fatty acids present in the oil. It is expected that oils with higher iodine values will have high unsaturation in their fatty acids. Also oils with iodine value below 100 g I/100g are considered as non-drying oils (Gafar*et al.*, 2012). The iodine values for RS and URS *Cucumismelo I* are 76.40 g I/100g and 75.50 g I/100g respectively. Since the values obtained for this oil is less than 100, it means that when exposed to open air it will not harden which is a good attribute.

The peroxide value for *Cucumismelo I* RS and URS oil are 6.36 meq.O_2 Kg^{-1} and 3.17 meq. O_2 Kg^{-1} respectively. The peroxide value is used in the measurement of oxidation of the oil during storage and also the freshness of the lipid matrix (Warra*et al.*, 2011). High peroxide value indicates that the oil will oxidize quickly during storage and this can be link to high degree of unsaturation of fatty acids (Warra et al., 2011). This can reduce the quality of the oil since it can easily go rancid. With the values obtained for the *Cucumismelo I* seed oil, it can be presumed that the oil will last during storage.

4. Conclusion

The results obtained from this work showed that roasting improved the yield, moisture, peroxide value; acid value and FFA value of*Cucumismelo I* seed oil. The properties determined showed that the oil is non-drying, have a low fatty acid content, low unsaturation in the fatty acids and have a good storage period without going rancid. This oil may however not serve the purpose of soap production effectively due to the low saponification value.

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