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EFFECT OF TRADITIONAL EXTRACTION METHODS ON THE PHYSICO-CHEMICAL PROPERTIES AND SENSORY ATTRIBUTES OF SUNFLOWER (*Helianthus annuus L*) SEEDS OIL

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Abstract
Effect of traditional extraction methods on the physicochemical properties and sensory attributes of sunflower seed oil were investigated. The sunflower seed was sorted, cleaned with water and dehulled before drying. Thereafter, the dried seed was roasted, milled into powder and then subjected to warm and cold press extraction method. The results showed that extracted oil from roasted sunflower seeds using warm press had the highest percentage yield of 18.05% as compared to cold pressed method which had a yield of 7.66%. Density was in the range of 0.96 g/ml to 0.98g/ml, moisture content from 2.69% to 3.49%, pH value from 7.02 to 7.17, free fatty acid from 3.92g/100g of oil to 8.39g/100gof oil, saponification value from 37.65mg of KOH/g of oil to 496.04 mg of KOH/g of oil, peroxide value from 2.10 meq of O_2/kg of oil to meq of O_2/kg of oil, iodine value from 5.71 g/100g of oil to 5.83g/100g of oil. Appearance was in the range of 7.20 to 7.50, viscosity from 6.5 to 7.30, flavor from 6.30 to 6.95, taste from 6.45 to 6.9 and Overall acceptability from 6.8 to 7.50 for all the samples. The results of the lipid profile showed that values obtained ranged from 3.22 to 5.75 mg/100g, 4.24 to 6.57 mg/100g, 4.96 to 6.88 mg/100g, 17.35 to 23.52 mg/100g, 15.31 to 17.87 mg/100g, 17.22 to 23.09 mg/100g, l29.17 to 35.04 mg/100g, 19.86 to 25.11 mg/100g, and 5.51 to 20.42 mg/100g for capric, lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids, respectively. There was significant ($p<0.05$) difference in all the parameters investigated among the samples. Oil extracted using warm press method was found to exhibit a better property in all the parameters investigated than the cold press extraction method.

Keywords: Cold pressed, fatty acid, iodine value, warm pressed, roasted.

Introduction

Sunflower (*Helianthus annuus*) is an annual plant that possesses a large inflorescence (flowering head) (Khaleghizadeh, 2011). Its name is derived from the flower's shape and image which is often used to depict the sun. The plant has a rough, hairy stem, broad, coarsely toothed, rough leaves and circular heads of flowers (Khaleghizadeh, 2011). The head consists of many individual flowers that mature into seeds on a receptacle base (Srilatha and Krishnakumari, 2003). Sunflower is the world's fourth largest oil-seed crop with the seed being used as food and its dried stalk as fuel as well as an ornamental plant (Harter *et al.,* 2004). In addition, parts of the plant are used in making dyes for the textile industry, body painting, making paints and cosmetics. Sunflower oil is used in salad dressings, for cooking and in the manufacturing of margarine and shortening (Kunduraci *et al.,* 2010). Due to its high content of linoleic acid and high ratio of polyunsaturated/saturated fatty acids, the oil is considered as nutritionally valuable food commodity. Sunflower seed oil plays an important role acting as an energy source by supplying the body with more than twice the calories per unit weight than those supplied by proteins and carbohydrates. Generally, vegetable oil act as carriers for fat-soluble vitamins (A, D, E and K) and helps the body to absorb other vital elements from food as well as act as a source of flavors to food (Bachmann, 2004). Sunflower seed oil is also one of the best sources of lecithin, tocopherols, carotenoids and polyunsaturated fatty acid linoleic (about 66.2%). It has been reported to have cleansing properties, being used both as diuretic (increasing the rate of urine excretion) and an expectorant (assisting the expulsion of phlegm) so is useful in the treatment of bronchial, laryngeal and pulmonary infections, whooping coughs and colds. Moreover, Sunflower oil is easily absorbed and moisturizes the skin and thus has potential for cosmo-nutraceutical applications (Bachmann, 2004).

Two main processes mostly employed for oil extraction from seeds on local scale are cold and warm presses. Warm and cold presses extract oil from sunflower seeds with slightly different flavour in the finished product. In a cold press, the hulls are removed; they are broken into smaller pieces and run through steel rollers or a piston-

like cylinder to squeeze out the oil (Bachmann, 2004). The resulting oil is usually labelled "extra virgin" sunflower oil but the process leaves much of the oil behind in the seeds. Warm presses work much the same as cold presses but the seeds are heated slightly before passing through the press for extraction. The heat lowers the viscosity of the oil so it flows more easily from the seed when pressed. A warm pressing result in more extracted oil, but the flavours differs slightly similar to the difference between roasted and unroasted nuts (Bachmann, 2004). The objective of this study was to determine the yield, sensory attributes and physicochemical properties of sunflower seed oil extracted using warm and cold press method.

Materials and Methods

The sunflower seed (*Helianthus Annuus L.*) were purchased from Kure ultra-modern market Minna Niger State, Nigeria. All chemicals used were of analytical grade. Analysis of physicochemical properties and sensory evaluation were carried out at Food Science and Technology Department Laboratory, Federal University of Technology, Minna while fatty acid profile was carried out at International Institute of Tropical Agriculture, Ibadan, Nigeria.

Extraction of Oil Samples

The oils were extracted using standard methods outlined by AOAC (2005). Sun flower seeds were sorted to remove foreign materials like stones, weeds and thereafter dehulled using electric blender after which the husks were removed by winnowing. About 1500 g of the seeds were weighed into two separate containers labelled A and B. Each of the weighed samples were roasted at a temperature of 50^{o}C for 1h and milled using a corona milling machine into powder after which they were subjected to warm pressing using hot water at a temperature of 55^{o}C and cold pressing without the use of hot water to extract the oil.

Determination of Physicochemical Properties

Moisture content, pH, and density were determined using the method described by AOAC (2005).

Determination of Free Fatty Acids

Free fatty acid was determined using the method outline by Ibitoye, (2005). Two grammes (2g) of oil sample were weighed into a conical flask, 3 drops of phenolphthalein indicator was added and it was titrated against 0.1M potassium hydroxide (KOH) until a pink colour appeared. Free fatty acid value was calculated as shown below

$$\frac{\text{Titre value} \times 0.1\text{mKOH} \times 56.10}{\text{Weight of sample (g)}}$$

Determination of Saponification Value

The saponification value was determined using the method outline by Ibitoye, (2005). Five grammes (5g) of the oil sample was measured into a conical flask, 50ml potassium hydroxide was added and allowed to drain for 40s. A blank was also prepared by measuring 50ml of KOH and allowed to drain for 40s. A reflux condenser was connected to the flask and boiled gently for 30 min, after the flask and condenser get cooled, the inside of the condenser was rinsed with a little distilled water and the condenser was then removed. 1 ml of phenolphthalein was added. The mixture was then titrated with 0.5 M hydrochloric acid until the pink color just disappeared. The saponification value was calculated using the expression:

$$\frac{S \times 28.05}{\text{Weight of sample (g)}}$$

Where, S is the titre value of the sample.

Determination of peroxide value

Peroxide value was determined using the method outlined by Ibitoye, (2005). One gram (1g) of oil sample was weighed into a clean dry boiling tube and 1 g of powdered potassium iodide (KI) and 20 ml of solvent mixture (2:1 v/v glacial acetic: chloroform) was added, the tube containing the mixture transferred into boiling water and allowed to boil vigorously for 30s. Thereafter, the contents were quickly poured into a conical flask containing 20 ml of 5% potassium iodide (KI) solution; washed twice with 25 ml of water and collected into the conical flask. It was then titrated with 0.02N sodium thiosulphate ($Na_2S_2O_3$) and 0.5ml of starch added as an indicator till the blue color disappear. A blank determination was similarly prepared and peroxide value calculated as follows

$$\frac{T \times M \times 1000}{\text{Weight of sample (g)}}$$

Where, T is titre value of $Na_2S_2O_3$ (oil sample-blank), and M is molarity of thiosulphate ($Na_2S_2O_3$).

Determination of Iodine Value

Iodine value was determined using the method outline by Ibitoye, (2005). About 0.5g of oil sample was weighed into iodine flask and it was dissolved in 10ml of chloroform, 25ml of Hanus Iodine Solution was added using a pipette which was drained in a definite time; it was mixed thoroughly and allowed to stand in the dark for 30 min with occasional shaking. It was titrated against 0.1M sodium trioxo thiosulphate (VI) until the yellow solution turns almost colorless. 10ml of 15% potassium iodide was added and it was shaken thoroughly, 100ml of fresh boiled and cooled water was added washing any free iodine on the stopper. 0.5ml of starch was added as indicator and it was titrated until the blue colour completely disappears. Blank was also run without the sample.

The expression below was used for calculation:

$$\text{Iodine value} = \frac{(b\text{-}a)\, M \times 1.269}{\text{Weight of sample (g)}}$$

Where, a is titre value, b is blank (ml), M is molarity of $Na_2S_2O_3$solution.

Evaluation of Sensory Attributes
Sensory attributes (appearance, viscosity, flavor, taste and over acceptability) were determined using 9-point hedonic scale ranging from 9=liked extremely to 1=disliked extremely described by Yadav *et al.* (2009).

Determination of Fatty Acid Profile
Lipid profile was determined using the method outlined by AOAC, (2001).

Statistical Analysis
All analyses were carried out in triplicate. Means were separated using one-way analysis of variance (ANOVA) and significant differences determined using the T-test at 5% significance level.

Results and Discussion
The result of physicochemical properties of the oil is presented in Table 1.The percentage yield of the oil was in the range of 7.65% to 18.08%. The samples showed a significant difference ($p \leq 0.05$) in percentage yield with the warm pressed sample having the higher value. This higher yield recorded in warm pressed sample could be as a result of addition of warm water to the sample during extraction process (Ahmad and Hassan, 2000). Density ranged from 0.96 g/ml to 0.98 g/ml. This range of value is in line with value of 0.96g/cm^3 reported by SON, (2000). There was no significant difference ($p \geq 0.05$) in the density of the samples. However, the cold pressed oil had a slightly higher value than the warm pressed oil sample. Density of substances is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance (Dorrell and Vick, 1997). It is used in the determination of concentration of solutions (Dorrell and Vick, 1997).The moisture content of the samples shows a significant difference ($p \leq 0.05$) with values ranging from 2.61% to 3.49%. The high moisture content value observed in the warm pressed sample might be due to the addition of warm water in the extraction of the sample (Bamgboye and Adejumo, 2007).

The pH value of the samples in the range of 7.06 for warm pressed oil to 7.17 for cold pressed oil shows no significant difference ($p \geq 0.05$). pH is a measure of the acidity or alkalinity of a solution (Zahir *et al*., 2014). The range of pH values obtained in this research shows that the oil can command a better usage and stability. Free fatty acid value of the oil ranged from 3.92 g/100g for warm pressed oil sample to 5.57 g/100g for cold pressed oil sample. The significant difference ($p \leq 0.05$) observed in the free fatty acids value could be attributed to variation in processing method (Sharma *et al.,* 2009). Free fatty acids are produced by the hydrolysis of lipids. Hence, lower value indicates that the oil is edible and could have a long shelf life (Sharma *et al.,* 2009).

Significant difference ($p \leq 0.05$) was also observed in the saponification values in the range 37.65 mg of KOH/g to 53.72 mg of KOH/g. The value recorded for the warm pressed sample was significantly ($p \leq 0.05$) higher than that of the cold pressed sample probably due to the variation in the extraction method because warm pressed method gives a higher yield than the cold pressed extraction method (Sharma *et al.,* 2009). Lower saponification value is an indication that the mean molecular weight of the fatty acids is lower or the number of esters bond is less and this implies that the fat molecules do not interact with each other (Sharma *et al.,* 2009). Saponification value is a measure of the alkali-reactive groups in fats and oil and is defined as the milligram of potassium hydroxide needed to saponify 1 g of oil (Shahidi, 2005). Similarly, higher peroxide value was recorded for the warm pressed sample in the range of 5.71 meq of O_2/kg of oil to 5.74 meq of O_2/kg of oil. Peroxide value is a measure of the extent to which rancid reactions have occurred during storage of oil. It is an indicator of the quality and stability of lipids (Firestone, 1994). No significant difference ($p \geq 0.05$) was recorded in the iodine value of the samples of 2.10 g/100g of oil to 3.99 g/100g of oil. Iodine value is a measure of the degree of unsaturation of oil and it can be used to determine the amount of double bonds present in oil which reflects the susceptibility of oil to oxidation (Marinova *et al.,* 2012). Higher iodine value shows higher degree of unsaturation and it contributes to the functionality and reactivity of the oil (Murphy, 2012). However, lower iodine values are desirable in oils meant for food uses and biodiesel production (Ogunniyi, 2006).

The result of the sensory characteristics of the oil as presented in Table 2 shows there was no significant difference ($p \geq 0.05$) in the values for all parameters evaluated. However, the warm pressed oil was found to be better than the cold pressed oil in terms of overall acceptability.

The fatty acids composition of the sunflower seed oil samples as presented in Table 3 shows significant variation ($p \leq 0.05$) in the concentration of palmitic, oleic, linoleic and arachidic acids while capric, lauric, myristic, stearic and linolenic acid shows no significant difference ($p \geq 0.05$).The concentrations are in the range of 3.22 to 5.75 mg/100g, 4.24 to 6.57 mg/100g, 4.96 to 6.88 mg/100g, 17.35 to 23.52 mg/100g, 15.31 to 17.87 mg/100g, 17.22 to 23.09 mg/100g, l29.17 to 35.04 mg/100g, 19.86 to 25.11 mg/100g, and 5.51 to 20.42 mg/100g for capric, lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids, respectively. The Differences observed in the concentration of some of the acid could be attributed to variation in extraction method (Poiana *et al*., 2009).

Table 1: Physicochemical properties of warm and cold-pressed sunflower seeds oil

Parameters	warm-pressed	cold-pressed
Percentage yield (%)	18.08±0.02[a]	7.65±0.02[b]
Density (g/ml)	0.96±0.00[a]	0.98±0.01[a]
Moisture content (%)	3.49±0.01[a]	2.61±0.01[b]
pH	7.17±0.01[a]	7.06±0.01[a]
Free fatty acid (g/100g of oil)	3.92±0.02[b]	5.57±0.05[a]
Saponification value (mg of KOH/g of oil)	53.72±1.01[a]	37.65±0.50[b]
Peroxide value (meq of O_2/kg of oil)	3.99±0.01[a]	2.10±0.10[b]
Iodine value (g/100g of oil)	5.71±0.01[a]	5.74±0.01[a]

Values are mean ± standard deviation of triplicate determination. Means in the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 2: Sensory attributes of warm and cold-pressed sunflower seeds oil

Parameters	warm-pressed	cold-pressed
Appearance	7.50±1.61[a]	7.25±1.12[a]
Viscosity	7.30±1.03[a]	6.5±1.39[a]
Flavor	6.95±1.70[a]	6.30±1.38[a]
Taste	6.90±1.74[a]	6.45±1.32
Overall acceptability	7.50±1.19[a]	6.80±1.01[a]

Values are mean ± standard deviation of triplicate determination. Means in the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 3: Fatty acid profile of warm and cold-pressed sunflower seeds oil

Fatty acid (mg/100g of oil)	warm-pressed	cold-pressed
Capric acid	3.22±0.02[a]	3.59±0.02[a]
Lauric acid	4.24±0.02[a]	6.13±0.01[a]
Myristic acid	6.46±0.00[a]	6.88±0.01[a]
Palmitic acid	17.35±0.00[b]	23.52±0.01[a]
Stearic acid	15.31±0.01[a]	17.56±0.01[a]
Oleic acid	17.22±0.21[b]	21.08±0.01[a]
Linoleic acid	29.17±0.01[b]	33.78±0.01[a]
Linolenic acid	19.86±0.01[a]	20.42±0.01[a]
Arachidic acid	5.51± 0.01[b]	20.42 ± 0.01[a]

Values are mean ± standard deviation of triplicate determination. Means in the same row with different superscripts are significantly different ($p \leq 0.05$).

Conclusion

The result of the study shows varying differences in the physicochemical and sensory attributes of the extracted oil. Warm pressing extraction method recorded a higher yield as well as exhibited a better property in all the parameters investigated. The use of warm pressing extraction method is hereby recommended so as to obtain optimum yield and qualities.

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