Insan Akademika Publications

INTERNATIONAL JOURNAL OF BASIC AND APPLIED SCIENCE

P-ISSN: 2301-4458
E-ISSN: 2301-8038

Vol. 01, No. 02
Oct 2012

www.insikapub.com

Extraction and Characterization of Cottonseed (*Gossypium*) Oil

Orhevba Bosede Adelola [1] and Efomah Andrew Ndudi [2]

[1] Department of Agricultural and Bioresources Engineering,
Federal University of Technology, PMB 65, Minna, Niger State, Nigeria
borhevba@yahoo.com; Phone: +2348061688880

[2] Department of Agricultural and Bioresources Engineering,
Federal University of Technology, PMB 65, Minna, Niger State, Nigeria
efomzy4reel@yahoo.com

Key words

Cottonseed, Cottonseed oil, Extraction, Characterization, Proximate composition

Abstract

This study investigated the extraction and characterization of cottonseed oil using solvent extraction method. Normal hexane was used as solvent in the extraction process. The AOAC method of Analysis was employed in the determination of the chemical, physical and proximate compositions of the oil. The chemical properties of the oil determined include the saponification value, free fatty acid, iodine value, peroxide value and acid value. The physical properties of the oil determined are viscosity, specific gravity, refractive index, color, odor, taste and pH. The values obtained are Saponification value (189mgKOH/g), free fatty acid (5.75mgKOH/g), iodine value (94.7gI/100g), peroxide value (9.25mEq/kg) and acid value (11.50mgKOH/g). The proximate compositions obtained are Carbohydrate (57.06%), lipid/fat (13.30%), crude fiber (0.5%), ash (1.5%), moisture content (7.21%), and crude protein (15.40%). The oil yield was 15.05%. From the results obtained it can be seen that cottonseed oil has great potential for use as domestic and industrial oil.

© 2012 Insan Akademika All Rights Reserved

1 Introduction

Cotton is a warm-weather shrub or tree of the *Malvaceae* family, the tribe *Gossypieae*, and the genus *Gossypium* that grows naturally as a perennial, but for commercial purposes it is grown as an annual crop (Wakelyn and Wan, 2003). Botanically, cotton bolls are fruits (Esau, 1997). The principal domesticated species of cotton of commercial importance are *hirsutum, barbadense, arboreum, and herbaceum* (Percival *et al*., 1999). Many different varieties of these species have been developed through conventional breeding to produce cotton plants with improved agronomic properties and with improved cotton fibre and cottonseed properties (Calhoun *et al.*, 1999).

Cottonseed oil is a cooking oil extracted from the delinted and decorticated cottonseed. The cleaned seed meats are first passed through a series of pressure rolls to produce thin flakes, after which the flakes are cooked under steam pressure, which ruptures the oil cells. Subsequently, the flakes are either pressed in

hydraulic presses or processed in continuous screw-type expellers which remove the oil under high pressure. There are various methods of extracting oil from oil producing seeds and these to a large extent determine the quality of the oil. The various methods include; mechanical extraction, traditional extraction, steam and high pressure method and solvent extraction.

The solvent extraction method is gaining acceptance, although not to as great an extent as in soyabean oil production. Average yield of oil is about 16 - 17 percent of the cottonseed (Encyclopaedia Americana, 2001). Treatment of the crude oil to produce refined grades is similar to that used for soyabean; it involves alkali refining to remove impurities, bleaching with activated clays and finally, steaming under vacuum conditions to remove traces of odour (Encyclopaedia Americana, 2001).

Various products can be derived from cottonseed of which cottonseed oil is very important. Crude cottonseed oil from the mill requires further processing before it is used in food. The first step in this process is refining. Treatment of the crude oil to produce refined grades is similar to that used for soyabean; it involves alkali refining to remove impurities, bleaching with activated clays and finally, steaming under vacuum conditions to remove traces of odour (Encyclopaedia Americana, 2001). The refining process also removes darker colouring materials present, leaving clear yellow oil.

Cottonseed oil finds application in the production of biscuits, crackers, doughnuts and potato chips and the preparation of ice cream substitutes (mellorines), in which process the oil replaces butter fat. Industrial uses of cottonseed oil include alkyl resins for interior paints, special lubricants and soft soaps (Encyclopaedia Americana, 2001).

2 Materials and Methods`

2.1 Sample Collection and Preparation

The cottonseeds used as sample for the analysis were obtained from the seed unit, Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria, Kaduna State, Nigeria. The variety of cottonseed used is Samcot 11(bar 36). This variety is a long staple cotton having a yield of 2.0-3.0 tonnes/ hectare and a maturity of 130-140days. The collected seeds were properly cleaned so as to remove farm residues and other impurities.

The experimental process involved the following; collection of seeds, cleaning of seeds, drying, cooling, size reduction, weighing of the crushed seeds, solvent extraction, weighing of the cottonseed cake, recovery of solvent and recovery of crude cottonseed oil. The samples collected were properly cleaned in order to remove any foreign materials. They were oven dried in the laboratory at a temperature of 130^0C, to a moisture content of 12%. This was done because the lesser the moisture content, the more the oil yield (Taiwo *et al*., 2008). The seeds were then crushed into powder using Thomas Willey mill (Model ED-5). Twelve grammes (g) of the crushed sample was weighed and mixed with 5 ml of N-hexane. The mixed sample was placed on a filter paper and the filter paper was then properly folded and inserted into the assembled soxhlet apparatus. The weight of the filter paper and sample was recorded. One hundred and fifty milliliters (150ml) of the solvent (N- hexane) was measured using a measuring cylinder and then poured into a five hundred milliliters (500ml) round bottom flask which is the lower part of the soxhlet apparatus. This was now heated with a heating mantle at 60^oC for 6 hours. As the solvent boiled, it evaporated into the reflux condenser and this hot solvent vapour was cooled by the surrounding water which flowed continuously through the soxhlet arrangement. The cooled solvent then condensed back into the portion of the soxhlet containing the folded sample and this facilitated the extraction of the oil from the sample. The extracted solution in the round bottom flask was a combination of oil and solvent. The sample left after the oil had been removed was subjected to hot pressing using hydraulic press to remove the bulk of the oil remaining in the press cake. This sample was then weighed and the values obtained were incorporated into the formula given below which gave the value of the percentage oil yield.

$$\frac{\text{Weight of sample before extraction} - \text{weight of sample after extraction}}{\text{Weight of sample before extraction}} \text{ X } 100 \quad \ldots(1)$$

The oil was recovered by evaporating the solvent. It was heated to a temperature higher than that of the solvent until the solvent evaporated leaving behind the oil extracted (The cottonseed oil has a higher boiling point of 1018^0C while n-hexane has a boiling point of 50-70^0C).

2.2 Determination of Percentage of Cottonseed Oil Extracted

Twelve grammes (12g) of the sample was placed in the thimble and about 150ml of n-hexane was poured into the round bottom flask. The apparatus was heated at 60^oC and allowed for 3hrs continuous extraction using soxhlet apparatus. The experiment was repeated for different weights of the sample. At the end, the solvent was distilled and the percentage of oil extracted was determined.

2.3 Characterization of Extracted Cottonseed Oil

The physical, chemical and proximate compositions of the oil were determined based on the methods described by the Association of Official Analytical Chemists (AOAC, 2004).

3. Results and Discussion

3.1 Results

The results of the proximate compositions of cottonseed oil are presented in Table 1 while the results of the physicochemical properties are presented in Table 2.

Table 1: Proximate Compositions of Cottonseed Oil

Parameters	Values (%)
Cahbohydrate	57.06
Lipid/ Fat	13.30
Crude Fiber	0.5
Ash	1.5
Moisture Content	7.21
Crude Protein	15.40
Oil Yield	15.05

Table 2: Physiochemical Properties of Cottonseed Oil

Parameters	Values (%)
Free fatty acid	5.75mgKOH/g
Acid value	11.50mgKOH/g
Iodine value	94.7gI_2/100g
Saponification value	189mgKOH/g
Peroxide value	9.25mEq/kg
Refractive index	1.464
Specific gravity	0.92
Colour	Reddish brown colour
pH	4.82
Taste	Mild taste
Viscosity	74

3.2 Discussion

Table 1 shows the Proximate Compositions of cottonseed oil. The Carbohydrate content was found to be 57.06% %, lipid/fat (13.30%), crude fibre (0.5%), ash (1.5%), moisture content (7.21%), and crude protein (15.40%). The Oil yield obtained was 15.05%. The low moisture content of the oil is advantageous in terms of storage stability since the lower the moistiure content, the better the storability and suitability to be preserved for a longer period. The value (1.5%) obtained for ash falls within acceptable limits for edible oils (1.5-2.5%) from literature (Odufoye, 1998). The fairly high protein content of the oil has a good implication in a society with high protein deficiency. The percentage oil yield (15.05%) is close to the 17% stated in the Encyclopedia Americana (2001) for cotton seed oil.

Table 2 shows the physico-chemical properties of the extracted cottonseed oil. The free fatty acid was found to be 5.75 mgKOH/g which is low, signifying that the oil is edible and can stay for a long time without getting rancid. The acid value was obtained by multiplying the free fatty acid by 2 giving a value of 11.50 mgKOH/g. It is reported that oils with low free fatty acid usually have high saponification value which is in accordance with the result obtained for the saponification value (189mgKOH/g). As such cottonseed oil is good for soap production. The iodine value which gives the degree of unsaturation in vegetable oils was found to be 94.7g/100g for cottonseed oil. This value classifies the oil as non-drying; Duel (1951) proposed that iodine value above 100 makes an oil to be classified as drying while below 100 is non-drying. The value obtained is close to that of pumpkin seed oil with an iodine value of 100g/100g (Markovic and Bastic, 1976). The peroxide value which is used as an indicator of deterioration of oils was found to be 9.25 meq/kg indicating that the oil is fresh. This is because fresh oils usually have peroxide values well below 10 meq/kg (Ewing, 1971). The pH of cottonseed oil was found to be 4.82; this may be due to the various chemicals used to control the cotton pests. The refractive index was obtained to be 1.464 at 20^{o}C which is close to neem oil of 1.466 at 30^{o}C (Soetaredjo *et al.*, 2007). The specific gravity was obtained to be 0.92 which is close to pumpkin seed oil of 0.918 (Pearson's, 1981). The value of viscosity at 20^{o}C was determined to be 74. The extracted cottonseed oil has a reddish brown colour with a mild taste and a bland odour. This reddish brown colouration is because the oil is unrefined.

4 Conclusion

In conclusion, low moisture content of the oil is advantageous in terms of storage stability since the lower the moisture content, the better the storability and suitability to be preserved for a longer period; the oil can be classified as non-drying based on the value obtained for Iodine value. Also, the result obtained for the saponification value portends that the oil is good for soap production. Thus, the oil has great prospects in terms of its edibility, storability and also suitability for soap production

References

AOAC (2004). Official Methods of Analysis of AOAC (15th Edition); Association of Official Analytical Chemists. Washington DC, USA, P. 858

Calhoun D.S. and Bowman D.T., in Smith, C.W., and Cothren, J. T., eds., (1999). Cotton Origin, History, Technology and Production. John Wiley & Sons, New York. Pp 361-414

Duel, H.J. (1951). The Lipids: Their Chemistry and Biochemistry. 1:53-57.

Encyclopedia Americana International Edition, Volume 20. 2001.

Esau, k. (1997). Anatomy of Seed Plants, John Wiley & Sons, Inc., New York

Ewing G. W. (1971). Tropics in Chemical Instrumentation. Easton, Chemical Education Publishers

Markovic, V. V. and Bastic, L. V. (1976). "Characteristics of Pumpkin Seed Oil". *Journal of the American Oil Chemists Society.* 53, 42-44

Odufoye, C.F. **(**1998**).** Extraction and Chemical Analysis of Oil from Tubers of Sweet Potato, Cassava and Yam. *Food Industries Manual.* 1998: 12-20.

Percival A.E., Wendel J. E., and Stewart J.M., in Smith C.W. and Cothrem J.T., eds., (1999). Cotton Origin, History, Technology and Production. John Wiley and Sons. New York. Pp. 33-63

Pearson's, D. (1981). "Chemical Analysis of Foods", in Egan, H., Kirk, R. S., and Sawyer, R. (eds.), 8th Edition 520-547

Felycia Edi Soetaredjo, G. M. Budijanto, R. I. Prasetyo, and N. Indraswati (2008.) Effects of Pre-Treatment Condition on the Yield and Quality of Neem Oil Obtained by Mechanical Pressing. *ARPN Journal of Engineering and Applied Sciences. 3:45-49.*

Wakelyn P.J. and Wan P.J., Inc.Tzia, Ed., (2003). Extraction Optimization, Marcel Dekker, New York, Pp. 391-427

Wikipedia (2011): http://en.wikipedia.org/wiki/cottonseedoil, (html documents)