Extraction And Characterization Of Castor Seed Oil

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Abstract

The castor seeds used for this work were obtained in a market at Esa-Oke town in the western part of Osun State of Nigeria. The seeds were prepared for use by removing the endocarp, sun-drying for five days and milled to flour. A soxhlet extraction was used for the extraction of the oil and the solvent used was hexane . The oil was recovered by simple distillation. The residual oil obtained was investigated for physicochemical parameters and fatty acid composition. The result shows that : moisture content (0.300± 0.01%), specific gravity (0.948± 0.02), refractive index @30C (1.792± 0.01) ,fire point (256.000± 1.20°C), flash point (225.000 ± 2.10°C), smoke point (215.000 ± 1.00°C), viscosity @ 28°C (0.425 ± 0.12), pH (5.800 ± 0.00), congealing temperature (-18.000 ± 1.50°C), turbidity (5.000 ± 1.00°C). Others were free fatty acid (7.400 ±0.07% oleic acid), acid value (14.800± 0.14 % oleic acid), saponification value (178.000± 0.42mgKOH/g oil), peroxide value (158.640 ± 2.20Meq/Kg), iodine value (58.390 ± 0.71wijs), The crude oil sample was determined according to AOAC,(1984), They are within acceptable standard. The yield of 48% makes the commercialisation of the seed in Nigeria possible and profitable. Also, the result of the analysis confirms the oil to be of good quality and can find application in food industry as food additives as well as industrial purposes.

INTRODUCTION

Castor oil pale amber viscous liquid derived from the seeds of the plant Ricinus commum's some- times known as ricinus oil. Marter, (1981). Castor oil is one at the few naturally occurring glycerides that approach being a pure compound, since the fatty acid portion is nearly nineteenths ricinoleic acid. Wood, (2001) A crude castor seed oil is pale straw colour but it turn colourless or yellowish after refining and bleaching. Rial et al,(1999). The crude oil has district odour, but it can easily be deodorized in the refining process like any other vegetable oils Salunke and Desai (1992). It is a triglycerides, which chemically is a glycerol molecule with each of the three hydroxyl groups esterified with a long clown fatty acids, its major fatty acids is the unsaturated fatty, hydroxylated 12-hydroxy, 9-octadecenic acid, known familiarly as the ricinoleic acid Robertus, (1991). The fatty acid composition of a typical castor oil contains between 87-90% ricinoleic acid. Rial et al ,(1999). Castor plant (Ricimus commum's) from which castor beans and oil are native to the Ethiopian region of east African . It is now grown in tropical and warm temperate regions throughout the world and is becoming an abundant weed in the south western united state. Salunke and Desai, (1992). It grows naturally over a wide range of geographical regions and may be activating under a variety of physical and climatic regions. Salunke and Desai, (1992), reported that castor beans contains about 30-35% oil which can be extracted by variety of processes such as pressing, and solvent extraction. The extraction and commercialization of oils from castor seeds have been carried out extensively for the oil, due to geographical origin and the method of extraction from oil bearing material. It becomes important to obtain the specific data for sample of oil from a particular area, because there exist a range of free fatty acid content of the oil due to geographical origin. Lucas,(2002). The characterization based on different fatty acid group gives an insight into the distribution of acid as in the unsaturated and saturated fractions. Though, it is not a conclusive pointer but it can be used to classified the oil under fatty acid group predominant in them such group can be itemized as milk fat, lauric acid, oleic-linoleic acid, ricinoleic acid and animal fat to mention but few Sandvig and van Deurs,(2002). Castor oil and its derivatives find outlet in industries and pharmaceutical because the ricinoleic acid, which predominate is unusual in that it has a hydroxyl functional group on the twelfth carbon. The func tional group causes ricinoleic acid to be unusually polar, and also allows chemical derivatization that is not practical with most other seed oil. It is the hydroxyl group which makes castor oil ricinoleic acid valuable as chemical feed stocks. Vitetta and Thorpe, (1991). Therefore,

dehydration process is carried out at about 250C in the presence of catalysts for example concentrated sulphuric acid or activated earth, and under an inert atmospheric or vacuum. The process is referred to as sulphonation.The hydroxyl group and an adjacent hydrogen atom from the C-11 or C-13 position of the ricinoleic acid portion of the molecule is removed as water. This yield a mixture of two acids each containing two double bonds results in an oil called Turkey-red oil having the properties of tung oil Dole and Keskar ,(1976). Thus, the oil can be used in the production of vanishes, lacquers, protective coatings, lubricants, soaps, Paints, inks, and it isprimary raw material for the production of nylon and other sythentic resins and fibfs and a basic ingredent in racing motor oil for high-performance automoobile motorcycle engines Wiley and Oeitmann, (1991). The castor meal or cake is mainly used as fertilizer, this is because it is un suitable as an animal feed because of the presence of toxic protein called ricin and toxic allergen often referred to as CBA (castor bean allergen). However, it is noteworthy that none of the toxic components is carried into the oil Sandvig and van Deurs,s (2002). This paper is however aimed at extraction and characterization of castor seed oil. These will be achieved through the realization of the following objectives: Extractive of castor oil from castor bean through solvent extraction process; determination of physicochemical parameters and fatty acid composition of crude castor seed oil.

MATERIALS AND METHODS

The castor seeds in a used for this work were purchased in a market at Esa-Oke town in the western part of Osun State of Nigeria. They were prepared for use by removing the endocarp, sun-drying for five days yo reduce the moisture contents , winnowing to separate the shell from the nibs (cortyledon). This was carried out using tray to blow away the cover in order to achieve very high yield and milled to flour using hand grinding machine. A Soxhlet extractor was used for solvent extraction of the oil. The solvent used was hexane and it was repeated several times and at the end of the extraction the resulting mixture called miscella containing the oil was heated to recover the oil. The residual oil was collected and used for analytical work. The PH, moisture content, specific gravity, were determined according to AOAC, (1990). Refractive index was determined by Abbe Refractometer coupled with thermometer, calibrated specimen and light source. The colour was determined using lovibond tintometer and half inch cell. The colour which was in unit was calculated based on this formula (5R+Y-B), where R is the red pigment Carson, (1995). The congealing temperature was determined crudely by putting a 20ml of dried oil sample in a 100ml beaker and inserting a thermometer into the oil and out it in a freezer. The oil sample was closely monitored as the temperature reduced. The temperature at which the initial fluid oil sample start getting jelly was noted and the temperature at which gelation took place within the oil was also noted. The average of the two gave the congealing temperature. The flash and fire points were determined using Gallenkamp Automatic Pensky-Martens Flash points American Standard of Testing Materals ASTM, (1984).The equipment used for the determination of the smoke point was SETA 104000 Smoke Point Apparatus and (ASTM D1322), the sample was introduced into the candle stand, the SETA wick trimmer inserts wick and automatically set to correct length. The measuring scale was viewed through the SETA mirror of the lamp body and chimney to detect the first indication of smoke. The temperature was recorded as the smoke point. Turbidity was determined using Palin test Turbidity Tube . The tube was held vertically over a white surface and viewed downward , gradually pour the sample until the black cross was no longer visible . The graduation corresponding to heigth of the sample in the tue was recorded as Jackson Turbidity Units (JTU).The viscosity was determined using an equipment called Viscometer , A clean ,dried viscometer with a flow time above 200 seconds for the fluid to be tested was selected. The chemical properties of oil sample was determined by official method of analytical chemist AOAC, (1990). The chemical properties determined includes free fatty acid, acid value, Iodine value, saponification value and peroxide value. Fatty acid composition of the oil was determined as described by Akintatyo, (1995). Analytical test method for fatty acid methyl esters, the fatty acid methyl esters were analysed using Agilent 6890 series Gas chromatography filled with a flame ionization detector and enhanced integrator. Helium gas was used as carrier gas. The column initial temperature was 250C rising at 10C/mm to a final temperature at 300C while the integrator and the detector were maintained at 250C respectively. A polar capillary column(30mX0.25mm) was used to separate the esters. The peaks were identified by comparism with standard fatty acid methyl esters obtained from Johnson wax west African limited, Isolo-Lagos.

RESULTS

Figure 1

Table 1 shows the physicochemical parameters of castor seed oil.

Parameter	Results.
Moisture content(%)	0.300± 0.01
Specific gravity	0.948± 0.02
Refractive Index @ 30^{o}C	1.792± 0.01
Fire point (^{o}C)	256.000± 1.20
Flash point (^{o}C)	225.000 ± 2.10
Smoke point (^{o}C)	215.000 ± 1.00
Viscosity @ 28^{o}C	0.425 ± 0.12
Colour (unit)	14.000 ±0.00
pH	5.800 ± 0.00
Congealing temperature (^{o}C)	-18.000 ± 1.50
Turbidity (JTU)	5.000 ± 1.00
Free fatty acid (% oleic acid)	7.400 ±0.07
Acid value (% oleic acid)	14.800± 0.14
Saponification value (mg KOH/g oil)	178.000± 0.42
Peroxide value (Meq/kg)	158.640 ± 2.20
Iodine value (wijs)	58.390 ± 0.71
The yield (%)	48.390 ± 2.00

Mean ± standard deviation of triplicate determination.

Figure 2

Table 2 shows the result of fatty acid

Composition of castor seed oil

Fatty acid	Carbon number	Result (%)
Ricinoleic	18:1	81.94
Palmitic	16:0	0.46
Oleic	18.1	2.28
Linoleic	18.2	0.61
Linolenic	18.3	0.30
Stearic	18.0	0.50
Dihydroxylstearic	18.0	0.24

DISCUSSION

Table 1 presents the result of the yield and the physicochemical parameters of castor seed oil. The result obtained for the percentage oil content was 48%. This high yield may be as a result of environmental factor which enhance the growth and productivity of the seed. This value fall within the range value of 30-55% reported by Aldrich, (2003). This yield makes the industrial practice of the oil recovery a profitable venture. The moisture content of the crude oil was 0.30% ,the low moisture content might be as a result of effectiveness of the distillation apparatus used for oil recovery. Again, the low moisture content is an indication of good shelf life characteristic. In fact, the positive economic implication stated that other deduction can be made by careful look at the parameters available Mc Garey and Willian, (1993). The specific gravity was 0.948±0.02. This was in line with0.9587 reported by Salunke, (1992). The refractive index was determined to be 1.792±0.00. This value is an indication of the level of saturation of the oil. The fire, flash and smoke points of the oil has linear relationship with the content of the free fatty acid present in the oil AOAC, (1990). The viscosity was determined at 28C using viscometer. The value obtained was 0.425± 0.12, The high value might be as a result of suspended particles still present in the crude oil sample. The colour was determined using lovibund tintometer and the value was 14.00unit. The high value was as a result of the presence of high number of red pigment. The PH of the sample was 5.8±0.00, the low level was an indicative of the presence of reasonable quantity of free fatty acid in the oil, which is a good indicator of the advantageous utilization of the oil in soap making. The congealing temperature was -18.0±1.50^{o}C, which was a pointer that the oil is more of unsaturated oil than saturated oil. Turbidity of the oil was 5.00±1.00JTU AOAC, (1990). All this physical parameters is an attribute of the oil to be used for industrial purposes. The free fatty acid and acid values was determined to be 7.4±0.07 % oleic acid and 14.8±0.14% oleic acid respectively. This can be used to check the level of oxidative deterioration of the oil by enzymatic or chemical oxidation. These values fall within the free fatty acid of oil is expected to range between 0.00 -3.00% before it find application in corking, but on the contrary the value is high for the oil under study . However, the free fatty acid can be modified to edible oil by subjecting it to refining and this will also improve its quality for industrial usage. The saponification value of the oil was 178± 0.42 mg KOH/g oil. This projects the oil as good in such an areas as soap making and in the detection of adulteration in the oil. However, it was within the range value of 156 to 185 mgKOH/g oil reported by weisis, (1971). The iodine value is a measure of the degree of unsaturation and it an identity characteristic of native. Hamilton, 1999. The value determined for castor seed oil was 58.39 ±0.71 wijs. This value could be used to quantify the amount of double bond present in the oil which reflects

the susceptibility of oil to oxidation. Also ,it enables us to classify the oil in non-drying groups which can be regarded as liquid oil. Thus, the oil may find its application in the manufacturing of lubricants, hydraulic fluids and coating Ibiyemi et al ,(1992). The peroxide value was found to be 158.64 ±2.20Meq/kg. The high peroxide value of the oil sample shows that the oil is prone to rancidity and thus less stable.Table 2 depicts the result of fatty acid composition of castor seed oil. The saturated fatty acid detected in the sample were palmitic, stearic and hydroxylstearic acids. The values were 0.46%, 0.52%,and 0.24% respectively.The unsaturated fatty acids detected were ricinoleic acid (81,97%), and oleic acid (2.28%). The total fatty acids detected was 85.43%, this is to say that we have 14,57% fatty acids undetected. The reason might be as a result of impurities that is present in the crude castor seed oil Cooper and Johnson,(1994).

CONCLUSION

The result of the investigation carried out on crude castor seed oil confirms the presence of ricinoleic acids ,oleic acid, palmitic acid, stearic acid and dihydroxylstearic acid, this is an indication of good quality that can be modified so as to be useful in food industry as additives in food as well as transportation, cosmetics and pharmaceutical industries. The result also that the oil can be classified as drying oil which can be hydrated by sulphonation to give semi-drying or drying oil which can be used extensively in paint and vanishes. Considering the percentage yield of the castor seed oil (48%) from western part of Nigeria ,I wish to recommend the commercialization of castor seed to enhance the economic growth of individual and the country at large.

References

1. Aldrich(2003) Handbook of Fine Chemical Laboratory Equipment, Sigma- Aldrich.
2. Akintayo, E. T.,(2004). Characteristics and composition of Parkia biaglobbosa and Jatropha curcas oil and seeds. Bioresour. Technol., 92: 307-310.
3. AOAC (1990): Official Method of Analysis. 14th Edn. Vol. 67, Association of Official Analytical Chemists Arlington, VA, pp 1-45. Washington D.C., U.S.A
4. ASTM,(1984). American Standard of Testing Material (ASTM,s D1322 , ASTM ,D93)
5. Carson, K.F., (1991), Fat and Oil processing INFORM.
6. Dole K.K., Keskar V. R.,(1976)"Dehydration of castor oil",Curr Sci., pp242-243
7. Hamilton R. J., and Cast, J.,(1999), Spectral properties of lipid.
8. Ibiyemi S.O., Adepoju T.O., Okanlawon S.o., and Fadipe V.O.,(1992), "Emulsion preparation and stability, journal of nutritional science. 13,(1-2), 31-34.
9. Lusas, E.W., (2002), Oil seeds and oil bearing materials, In handbook of cereal science and technology, K., Kulp and J.G.,Ponte, Jr (Ed), Marcel Dekker, Inc, NewYork, pp297-362.
10. Mater A.D.,(1981), Castor market . Utilization and prospects, Tropical Product Institute, G 152,p 55-78.
11. Mc Garey, William G. (1993), "The oil that heals: A physicalan successes with castor oil treatment A.R.E." press. P 225-340.
12. Rial , Ghetie, Victor and Lauterbach, Brenda,. (1999), "Selection of castor for divergent concentrations of ricin and ricinus communis Agglutinin and references therein"(PDF).crop science 39: 353-357.
13. Robertus, J.D., (1991). "The structure and action of ricin, A cytoxic N-glycoside" Seminar in cell Biology 2: 23-30.
14. Salunke D.K.,Desai B.B.,(1992), "Post- harvest Biotechnology of oil seeds" CRC Press, p.161-170.
15. Sandvig, K.,and van Deurs.(2002,) "Transport of Protein Toxins Into Cells: Pathways Used by ricin, cholera toxin." FEBS Letter 529: 49-53
16. Vitteta E.S., and Thorpe P.E., (1991), " Immunotoxins containing ricin or it A chain" Seminar in cell Biology 2 : 47-58.
17. Wiley, R,G., and Oeitmann T.N.,(1991),"Ricin and related plant toxins : Mechanisms of action and neurobiological applications" In Handbook of natural toxins (vol)6.
18. Wood M.,(2001), "High-Tech castor plants May Open Door to domestic production" Agricultural Research magazine 49 (1).

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