EXTRACTION AND CHARACTERIZATION OF CASTOR SEED OIL

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ABSTRACT: Extraction and characterization of castor seed, the seeds were prepared for use by removing the endocarp, sun-drying for seven days and milled to flour. A soxhlet extraction was used for the extraction of oil, using hexane as solvent. The oil was recovered by simple distillation of the solvent. The residual oil obtained was investigated for physiochemical parameters and fatty acid composition. The physical parameters were: moisture content, specific gravity, refractive index, fire point, flash point, smoke point, viscosity, pH. For chemical parameters, were: free fatty acid (oleic acid), acid value, saponification value and iodine value. The extraction yield makes the commercialization 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 such as cosmetics, soaps, paint and even energy generation.

INTRODUCTION

Castor plant (*Ricinuscommunis*), from which castor beans and oil are native to the Ethiopian region of east Africa is now grown in tropical and warm temperate regions throughout the world (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.

The Vegetable fats or vegetable oils have an essential function in the industrial economy of a developing country as the seed oil provide a huge use in human daily life in order to complete and make the nowadays life more easier. The seed oils are one of the vegetable oil family members. Vegetable oils or vegetable fats are the lipid materials that been derived from the natural plants which physically oil are in liquid state in the room temperature whereas the fat exists in solid state in the room temperature (Ndiaye*et. al.,* 2006). The vegetable oil is composed of triglycerides which lack glycerin in its structure.

Several feedstocks from vegetable source such as soybean, rape seed, canola, palm, corn, Japtropha and castor seeds have been studied as an alternative to oil candidate. Among these sources, castor seeds are a potentially promising feedstock since among vegetable oils, castor oil is distinguished by its high content (over 85%) 2 of ricinoleic acid. There is no other vegetable oil contains so high a proportion of fatty hydroxyacids and castor oil is the most stable viscosity of any vegetable oil (Ogunniyi, 2006).

There are variety processes or the combination of the processes to obtain the oils from the castor seeds. The hydrate presses, continuous screw presses and also solvent extraction are the common methods to obtain the oils from the castor seeds. However, the most satisfactory approach to get the oil is hot pressing the castor seeds by using a hydraulic press and then followed by solvent extraction (Ogunniyi, 2006).

The leading producers of castor seed and the countries that seriously involve in the production of castor oils are India, China, and Brazil. Together, these countries account for 90% of the acreage and production of castor beans. It is grown in Costa Rica, Ecuador, Thailand, Philippines, Paraguay, Romania, Sudan, Mexico, Pakistan, Ethiopia, and Tanzania. The world-wide production stood at 1, 227, 669 tonnes in 2000 (FAO). However, India is the world's largest producer of

castor seeds and oils that meets most of global demand for castor oil. India contributes about 750, 000 tonnesannually, and accounting for 60% of the entire global production. Essentially, all the castor oil production in the U.S has been eliminated by a combination of economic factors, excessive allergenic reactions of field and the processing workers, and the toxicity of the seed meal. The toxic inside the castor seed which is known as ricin, is a very dangerous to human as it can kill adults if two or three castor seeds were chewed (Ogunniyi, 2006).

Due to the importance of the vegetable oils in the industrial, pharmaceutical, food industries, and also medical, there is an urgent need to produce more oil from the natural plant. In view of this, castor oil is a promising vegetable oil because it has several advantages; it is renewable, environmental friendly and produce easily in the rural areas, where there is an acute need for modern forms of energy. The primary use of the castor oils is as the basic ingredient in the production of nylon 11, sebacic acid, plasticizers and engine jet lubricant. Castor oil's high lubricity which reduces the friction is superior to other vegetable oils and petroleum-based lubricants. It is really clings to metal, especially hot metal, and the castor oils is used in production nylon 6-10, heavy duty automotive greases, coating and inks, surfactants, polyurethanes, soaps, polishes, synthetic resins, fibers, paints, varnishes, dyes, leather treatments, hydraulic fluids and also sealants(Ogunniyi, 2006). Specification for pharmaceutical use can be found in the European Pharmocoepia. The industrial type maybe divided into three types of quality. 'First' quality is the oil that obtains from only one pressed castor oil and extracted without solvent. This kind of oil normally produced in Europe, is virtually colorless and has very low acidity. 'Second' and 'third' quality of castor oil is commercial names, meaning that the oil has been extracted using solvent (Ogunniyi, 2006).

RESEARCH METHODOLOGY

Castor Beans Process

The castor beans undergo various processing in the course of its preparation for extraction. The unit operation involved are

1. Clearing
2. Drying
3. Winnowing and
4. Granding

Material and Solvent

Hexane (C_6H_{14}) is the solvent that will be used to extract the castor oil. The mixture of diethyl ether (C_2H_5)2O and ethanol (C_2H_5OH) and few drop of phenolphthalein with the titration process using 0.1M NaOH is used to determine the acid value of oil. After that, 0.1N ethanolic potassium hydroxide with few drop of phenolphthalein will be used to obtain the saponification value of the oil. The carbon tetra chloride (CC_{l4}) will be added with Wijs solution and aqueous potassium iodide (KI) and then be titrating with 0.1M sodium-thiosulphate solution ($Na_2S_2O_3$) to determine the iodine value of the oil. The starch indicator is added when the process to determine the iodide value of the oil. HCl is used to active the clay in the refining process of extracted castor oil. NaOH and the sodium chloride are added in the neutralization process of the extracted oil. Concentrated sulphuric acid (H_2SO_4) is used in the modification process of the oil that obtains from the extraction process and then be neutralizing using sodium hydroxide (NaOH).

Apparatus

The apparatus used in this experiment are oven, soxhlet extractor and viscometer.

METHODS

Operation of soxhlet extractor

300 ml of Hexane was poured into a round bottom flask. 10 g of the sample was placed in the thimble and was inserted in the centre of the extractor. The soxhlet was heated at 40-60_C. When the solvent was boiling the vapour rose through the vertical tube into the condenser at the top. The liquid condensate dripped into the filter paper thimble in the centre which contained the solid sample to be extracted. The extract seeped through the pores of the thimble and filled the siphon tube, where it flowed back down into the round bottom flask. This was allowed to continue for 30 min. It was then removed from tube, dried in the oven, cooled in the desiccators and weighed again to determine the amount of oil extracted. Further extraction was carried out at 30 min intervals until the sample weight at further extraction and previous weight became equal. The experiment was repeated by placing 5 g of the sample into the thimble again. The weight of oil extracted was determined for each 30 min internal. At the end of the extraction, the resulting mixture containing the oil was heated to recover solvent from the oil.

Determination of saponification

Procedure

Two grammes of the castor oil were weighed into a flask. Then 25 $cm^3$of the alcoholic potassium hydroxide solution was added and the mixture was boiled for 1 hour gently but contained under a reflux condenser. The content of the flask was swirled at frequent intervals. Then 1 cm^3 of phenolphthalein indicator was added, it was titrated with standard 0.5 M HCL to permanent pink colour. The titrations were done when the solution was still hot.

Blank was also determined under the same condition

Determination of acidity

Procedure

Four grammes of oil/fat were weighed according to the color and degree of acidity into a flask. Then added into another flask 50 cm^3 of ethanol was boiled and neutralized with 0.1 M NaOH using 0.5 cm^3 of phenolphthalein as indicator. The neutralized ethanol was poured into the oil in the first flask and the content mixed.

Determination of iodine value

Iodine value is the amount of iodine measured grammes, taken up by 100 g of fat/oil. It has also been defined as the percentage by weight of halogen, calculated as iodine, taken up by fat/oil.

Iodine is only slowly absorbed for fat/oil directly, but is very rapidly taken up from Wijs' solution, which consist of a solution of Iodine monochloride (ICI) in glacial acetic acid and carbon tetrachloride. The unsaturated bodies present take up iodine to saturate the double bonds; the amount of Iodine unabsorbed being titrated by means of sodium thiosulphate.

Thus, iodine value is a measure of the amount of unsaturation present in fat/oil. The method employed is called HANU's method.

Procedure

Approximately 0.5 g of oil/fat was accurately weighed and dissolved in 10 cm^3 of chloroform in clean dried bottle of 500 cm^3 capacity provided with a well-fitted stopper. Then 25 cm^3 of the Hanu's Iodine solution was added and then allowed to stand for 30 minutes and then shaken. 15 cm^3 of 10% KI solution was also added and then 100 $cm^3$of distilled water used to wash down any free iodine that could be found on the stopper. The iodine was titrated with the standardized sodium thiosulphate solution; addition was gradual, while constant shaking was

employed until the yellow colored disappeared. A few drops of starch indicator were added and the titration continued until the blue color entirely disappeared. At the end of the titration, the bottle was Stoppard and shaken violently, so that any iodine remaining in solution in the chloroform may be taken up by the potassium iodide solution. Two blank's were determined and the mean found.

RESULT AND DISCUSSION

Obtained results for various test carried out on the sample are tabulated below. **The percent of oil extracted =33.4% percent moisture content =4.15%**

Table-1. Determination of moisture content

Time (h)	0	2	4	6	7
Weight (g)	420	412.52	406.55	402.58	402.57

Table -2.The physical properties of castor seed oil

PropertyCrude castor oil	
Specific gravity	0.9587
Viscosity at 28^{o}C	9.42477
Refractive index at 28^{o}C	1.4686
pH	6.11
Colour	amber

Table-3.Chemical properties of crude castor oil

Property	Crude castor oil
Acid value [mg NaOH/g of oil]	1.148
Saponification value [mg KOH/g of oil]	185.83
Iodine value [g I_2/100g of oil]	87.72

Table -4.Determination of percentage oil extracted

Determination	value(g)
Weight of empty flaks (M_1)	108.6
Weight of thimble (W_1)	3.13
Weight of sample + thimble (W_2)	33.13
Weight of sample (M_2-M_1)	30
Weight of empty flask +oil(M_2)	160.15
Weight of oil	51.55
2nd weight of sample	35.1
3rd weight of sample	40.2
4th weight of sample	50

Table -5. ASTM Specification for Quality Cast Oil

Property	Range	selected
Specific gravity 20/25^{o}C	0.957-0.968	0.962
Refractive index n_D	1.476-1.479	-
Saponification value	175-187	181
Un-Saponification value	0.3-0.7	0.7(max%)
Iodine value	82-88	85
Hydroxyl value	160-168	160 (minimum)
Viscosity 25^{o}C	6.3-8.8	-
Acid value	0.4-4.0	3
Colour (Gadner)	Not dark than 2-3	3.0 (maximum)

DISCUSSION OF RESULT

The result obtained for the percentage oil content was 33.4%. The high yield may be as a result of environmental factors which affect the growth and productivity of the seed. This value falls within the range of 33-55%(Aldrich, 2003). This yield makes the industrial practice of the oil recovery a profitable venture.

CONCLUSION

The percentage oil content of castor seed was found to be 33.4%. The castor oil produced in this research work was analyzed for specific gravity, viscosity at 40 and 100^{o}C, acid value, saponification value and iodine value. Most of the values obtained comply with the standard specified by ASTM (195) indicating a good quality that can be modified

The results of the investigation carried out on crude castor seed oil confirm the presence of ricinoleic acids, oleic acids, palmitic acids, stearic acids and dihydroxylstearc acids; thus indicating some good qualities that can be modified so as to be useful in food industry as additives in food as well as in transportation, cosmetics and pharmaceutical industries. The results also support the classification of the oil, 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 high

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