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PHYSICOCHEMICAL CHARACTERISTICS OF CASTOR OIL FROM LOCAL WILD CASTOR PLANT IN GHANA

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Abstract

Physicochemical characteristics of castor oil from seeds of the local wild castor plant (*Ricinus communis)* found in Ghana were determined to evaluate its suitability for exploitation for industrial purposes. The castor seeds were found to be rich in oil, containing 57 per cent castor oil of which 37 per cent was easily expressed by cold pressing. The physicochemical characteristics of the pressed oil were found to be comparable to those reported by others. The characteristics included iodine value, 82; saponification value, 177; acid value, 2.7; and hydroxyl value, 180. The rich oil content and its high quality suggest that the oil is suitable for commercial exploitation as an industrial raw material in various preparations such as in cosmetics and in paints.

Résumé

MENSAH, B. & OCHRAN, R.: *Caractéristiques physico-chimiques d'huile de ricin sauvage local au Ghana.* Les caractéristiques physico-chimiques d'huile de ricin des graines de ricin sauvages (*Ricinus communis*) découvert au Ghana étaient déterminées pour évaluer leurs qualités exploitatrices pour les besoins industriels. Les graines de ricin étaient découvertes d'être riches en huile, contenant 57 pour cent d'huile de ricin dont 37 pour cent était facilement extrait sous pression froide. Les caractéristiques physico-chimiques d'huile pressée étaient déterminés et constatés d'être comparables à celles citées dans la litérature. Les caractéristiques physico-chimiques comprennent: valeur d'iode, 82; valeur de saponification, 177; valeur d'acide, 2.7; et valeur de hydroxyle, 180. Le contenu rich d'huile et la qualité élevée d'huile suggèrent que l'huile est convenable pour exploitation commerciale comme matières premières industrielles pour des diverses préparations telles que les cosmétiques et les peintures.

Introduction

Castor oil, also known as ricinus oil, is a pale-amber viscous liquid extracted from the seeds of the castor plant, *Ricinus communis,* of the *Eurphoribiatae* family (Kirk-Othmer, 1993) The castor plant is cultivated on a large scale for the commercial production of castor oil in countries like Brazil and India. It also grows wild in many tropical countries where it is considered native. The plant varies greatly in its growth habits, seed size, oil content and colour, and other characteristics.

Castor oil is one of the few naturally occurring fatty oils that approaches being a pure compound, as the fatty acid portion of the oil comprises about 80 to 90 per cent ricinoleic acid (Hui, 1996). Castor oil is characterized by a high viscosity, owing to the hydrogen bonding of its hydroxyl group. It is an industrial oil used in many applications including paints, surface coatings, lubricants, and cosmetics (McGraw-Hill, 1997). Castor oil is extracted from castor seeds by mechanical expression and by solvent extraction. Commercially, the hydraulic or screw press is used for the mechanical expression of castor oil, and is often followed by solvent extraction to extract the residual oil in the pressed cake to less than 1.0 per cent (Kirk-Othmer, 1993).

The castor plant grows wild in Ghana and covers a large acreage. Some entrepreneurs have shown interest concerning the oil content in the castor seeds and also the quality of oil for commercial purposes.

This paper reports on the characteristics of oil collected from the local wild castor plant in Ghana to find out its suitability for industrial use. It is hoped the results would be used as basis for further exploitation of the oil for industrial purposes.

Experimental

Seed characteristics

Seeds investigated were collected from wild castor plants found at Okponglo, a suburb of Accra.

Castor seeds are nearly flattened and oval, but differ in size and colour. The seeds may be white, black, buff or brown, or several colours occurring as very attractive mottling on tests. The seeds investigated were of the mottling type with dark and light-brown colours. The size of the seeds ranged from 9 to 10 mm in length. The size of castor seeds have been reported to vary from a few millimetres long to about 2 cm in the giant species (Weis, 1971). The mean weight of 100 castor seeds has been reported to vary from 10 to 100 g (Weis, 1971). For example, seeds found in Kenya and Nigeria have been reported to weigh on the average 59.2 and 61.3 g per 100 seeds, respectively. The seeds investigated in this study have an average weight of 11.7 g per 100 seeds. Thus, the seeds are quite small but fall within the general wide range of 10 to 100 g per 100 seeds. Small-sized seeds weighing 16 g per 100 seeds have also been reported among the species found in India (Weis, 1971). It is noted that even in narrow geographical regions, different varieties of seeds can be found.

Extraction of castor oil

Castor oil was extracted from the seeds using the solvent extraction and cold pressing methods.

Solvent extraction. Solvent extraction, using di-ethyl ether, was used to determine the oil content of the seeds. The percolation method was also used (Hui, 1996), and 150 g of seeds were used in each case. The seeds were crushed in a laboratory grinding mill, followed by grinding into a fine meal in a porcelain mortar. The castor meal was fed into a 5-cm diameter glass column and 500 ml of the di-ethyl ether was poured onto the meal, covered, and left overnight. The pregnant liquor was then drained. The residual meal was treated with two more batches of the fresh solvent. The three pregnant liquors were combined and the solvent distilled off. The extraction procedure was repeated three times.

Cold pressing. Three batches of 4 kg of castor seeds were fed whole into a locally manufactured hydraulic press. The seeds were pressed whole at room temperature. The oil collected was warmed to 35-40 °C, filtered, and then weighed.

Physicochemical analysis

The cold-pressed oil was used for the physicochemical analysis. An Abbé refractometer was used to determine the refractive index, and a specific gravity bottle was used to determine the specific gravity of the oil. Acid and saponification values were determined by the methods described in AOAC (1975), using accurately weighed amounts of oil ranging from 9.000 to 10.000 g for the acid value, and a range of 4.555 to 5.555 g for the saponification value. The Hanus method described in AOAC (1975) was used to determine the iodine value of the oil (weight of oil used ranged from 0.1955 to 0.2055 g). The hydroxyl value was also determined by the method described in AOAC (1975) (weight of oil used ranged from 0.995 to 1.055 g).

Results and discussion

Yield of castor oil

Castor seeds have been reported to contain an average oil content of 40 to 60 per cent by weight (Weis, 1971). The oil content in the seeds depends on the seed variety, climatic conditions, and

whether it grows wild or under cultivation. The solvent extraction method had an oil yield of 57 per cent; and this, compared to the reported range of 40 to 60 per cent, indicates that the seeds investigated had a high oil content. The cold pressing method had an oil yield of 21 per cent. It has been reported that cold pressing recovers 25 to 35 per cent of the oil content in the castor seeds (Kirk-Othmer 1984). The oil yield of 21 per cent for the cold pressing method indicates a recovery of 37 per cent of the oil content in the seeds. It also shows a high recovery rate by the cold pressing method, and that locally manufactured presses can be used to obtain a high degree of oil recovery. The residual oil in the pressed cake can then be extracted with a solvent.

Physicochemical characteristics

Table 1 shows the physicochemical characteristics of the cold-pressed castor oil. The oil was clear pale-yellow with a slight greenish tint.

The refractive index of 1.477 at 25 °C falls within the reported range of 1.476 to 1.479 at 25 °C for pressed oil (Kirk-Othmer, 1993).

The specific gravity value of 0.962 also falls within the reported value range of 0.955 to 0.965 at 25 °C (Kirk-Othmer, 1993).

The acid value of pressed castor oil varies widely, ranging from 0.4 to 4.0 (Weis, 1971). Analysis of local species of castor oil in Nigeria and Kenya indicates acid values ranging between 1.3 and 1.9 (Weis, 1971). The acid value of 2.7 for the oil investigated in this study, though higher than the values for the local species found in Nigeria and Kenya, still falls within the reported range. It is further reported that the maximum permissible acid value is 2.0 for commercial castor oil (Kirk-Othmer, 1993).

The saponification value of 177 falls within the 176-184 range reported for pressed oil (Kirk-Othmer, 1993).

Castor oil is characterized by a high hydroxyl value because its fatty acid portion comprises about 80 to 90 per cent of hydroxyl fatty acid, ricinoleic acid. Hydroxyl values in the range of 160 to 168 have been reported for the oil (Kirk-Othmer, 1993). The value of 180 for the oil investigated in this study is, therefore, quite high. A high hydroxyl value of 215 has been reported for oil from wild seeds found in Ethiopia (Weis, 1971).

Conclusion

The study has indicated that seeds of wild castor plant, *R. communis,* found in Ghana contain 57 per cent oil of which 37 per cent can be expressed

TABLE 1
Physicochemical characteristics of cold-pressed castor oil

Characteristic	*Value*	*Literature value* [1]
Acid value (mg KOH/ g)	2.7	1.99
Saponification value (mg KOH/ g)	177	176-184
Iodine value (Hanus method)	82	82-88
Hydroxyl value	180	161-168
Refractive index at 25 °C	1.477	1.476-1.479
Specific gravity at 25 °C	0.962*	0.955-0.965

*Calculated from specific gravity value at 28 °C using the following:
G = G′ + 0.00064(28-25) where G′ is sp. gravity at 28 °C and G sp. gravity at 25 °C (AOAC, 1990). Literature values from Kirk-Othmer (1993), p. 304.

by cold pressing.

The physicochemical characteristics of the oil indicated a high oil quality which suggests the suitability of the oil for various industrial uses such as in cosmetics, paints and as lubricants. Because the castor plant grows widely, it can easily be harnessed and exploited for its oil to be used as industrial raw material.

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