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Chemical Composition and Oil Characterization of Some Accessions of *Ricinus communis* Seeds

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Abstract

Ten accessions of *Ricinus communis* were grown in derived agro-savannah ecology for two cropping seasons in randomized complete block design. The seeds harvested from them were subjected to chemical analysis with the aim of determining the chemical composition and characterizing the seed oil. The analyses were done at Springboard laboratory, Awka, Crop Science Department, University of Nigeria, Nsukka and National Research Institute for Chemical Technology, Zaria. The results showed free fatty acid compositions of linoleic 0.5%; stearic 1.3% and palmitic 1.5%; others are oleic, linolenic and ricinoleic with percentage values of 3.5%, 7.5% and 84.2% respectively while the result of physicochemical analysis showed that castor seed contains saponification value of 182.9 mg/g. Others include moisture content 4.4%, acid value 3.085 mg/g, viscosity 110.41 cP, pH 6.11, iodine value 8.46 mg/g, specific gravity 0.962 and refractive index of 1.477°C. Since seeds contain high nutrients with high potassium content, the use of the seeds as food condiment can be justified. However, one important limiting factor in the use of castor as a complementary nutrient is the presence of the poisonous ricin content of the seed. Therefore, it is advisable that the seeds should be well fermented and properly treated before they can be used either as food condiment or feed for animals.

Keywords: Castor oil; Ricinoleic acid; *Ricinus communis*; Euphorbiaceae

Introduction

The castor bean plant belongs to the family Euphorbiaceae. The spurge family (Euphorbiaceae) is one of the most diverse and numerous clades of the angiosperms, including several species of great economic importance as rubber tree (*Hevea brasilensis*), cassava (*Manihot esculenta*) and castor bean (*Ricinus communis*). Castor bean, the single member of the African genus *Ricinus*, presents a wide variation regarding vegetative traits such as leaf and stem colors, number and size of leaf lobes and presence of wax covering the stem [1]. Despite being a member of the family, Euphorbiaceae, a diverse and economically-important family of flowering plant, castor bean plant is regarded as one of the deadliest natural poison ever known to man according to Guinness Book of Records due to the presence of ricin. It is highly toxic to humans and other animals, including insects [2]. If the seed is swallowed without chewing and there is no damage to the seed coat, it will most likely pass harmlessly through the digestive tract. However, if it is chewed or broken and swallowed, the ricin toxin will be absorbed by intestines and will bring about abdominal pain, vomiting and diarrhea [3]. It originates from India and cultivated in the tropical and sub-tropical climates of the world [2]. India is the world's largest producer of castor seed and meets most of the global demand for castor oil; other major producers being China, Brazil and Ethiopia and Paraguay [4]. Castor bean oil is widely used for its lubricating properties and medicinal purposes in industry. It is also used for manufacturing of soaps, lubricants, hydraulic and brake fluids, paints, dyes, coatings, inks, cold resistant plastics, waxes and polishes, nylon, pharmaceuticals and perfumes [5].

The demand for vegetable oils has ever been widening in Nigeria as industrialists rely mostly on the popular vegetable oils like palm oil, palm kernel oil, groundnut oil and coconut oil for the preparation of their various products [6]. The increasing demand for vegetable oils and fats in Nigeria, for both domestic and industrial purposes, in recent times, is partly due to the nutritional needs of the teaming population and increasing number of industries that require oils and fats as their primary raw material. Nigeria, however, being a tropical country, has wide variations in climatic conditions and therefore has a wide variety of domestic plants that produce oil. Lack of information on the composition and utilization of the many and varied oil seeds, indigenous to Nigeria are more of a problem than shortage of these oils [7]. Hence the purpose of this work is to characterize *R. communis* genotypes for physicochemical properties and oil properties of the different genotypes.

Materials and Methods

Ten accessions of *R. communis* were obtained from various locations in Enugu state, Nigeria. They were planted in a randomized complete block design in the field for two consecutive years under rain fed conditions. The seeds harvested were used for these analyses at Springboard laboratory, Awka; Crop Science Department, University of Nigeria, Nsukka and National Research Institute for Chemical Technology, Zaria, respectively.

The castor beans were ground into a paste. A soxhlet extractor was used for solvent extraction of the oil. The solvent used was hexane and it was repeated several times, at the end of the extraction, the resulting mixture called miscella containing the oil was heated to recover the oil [8]. The residual oil was collected and used for analytical work. The chemical properties investigated were fatty acid composition,

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pH, moisture content, specific gravity, viscosity and saponification. The fatty acid composition of castor oil was determined by Gas Chromatography equipped with capillary column Bp × 70 and FID detector. The column temperature was programmed at 120°C per minute for 57 min whereas the injector and detector temperature was set at 260°C and 280°C, respectively. Fatty methyl ester was prepared according to PORM Official Test Method [9]. The identification of the peaks was performed by comparing the retention times with standard methyl ricinoleate and other individual fatty acid methyl ester. The pH was obtained by pouring two gram of the sample into a clean dry 25 mL beaker and 13 mL of hot distilled water was added to the sample in the beaker and stirred slowly. The pH electrode was standardized with buffer solution and the electrode immersed into the sample and the pH value was read and recorded [10]. Fourty gram of the cleaned sample was weighed and dried in an oven at 80°C for 7 h and the weight was taken after every 2 h. The procedure was repeated until a constant weight was obtained to determine the moisture content [10]. Density bottle was used to determine the density of the oil [11].

Result and Conclusion

The result of fatty acid composition of the seed oil showed that ricinoleic acid comprised 84.2% of the total fatty acid composition. Other fatty acids present are linoleic acid (0.5%), stearic (1.3%), palmitic acid (1.5%), dihydrostearic acid (1.5%), oleic acid (3.5%) and linolenic (7.5%). The unsaturated fatty acid content was 97.6%. The ricinoleic acid content from these accessions agrees with reports on Malaysian accessions (84.2%) but differs from those obtained in India (94.0%) and Brazil (90.2%). Jumat et al. reported that difference in climatic conditions might have effect on the ricinoleic acid of castor accessions [9]. There was difference in the unsaturated fatty acid content which is 97.5%, 98.3%, 97.6% and 97.6% for Malaysia, Brazil, India and the Nigerian accessions used in this study (Table 1).

The result of physicochemical analysis showed that castor seed contains saponification value of 182.9 mg/g. Others include moisture content 4.4%, acid value 3.085 mg/g, viscosity 110.41 cP, pH 6.11, iodine value 8.46 mg/g, specific gravity 0.962 and refractive index of 1.477°C (Table 2). The results of physicochemical characteristics of castor oil showed high iodine value of 84.6 mg/g. This is due to its high content of unsaturated fatty acid. The iodine value in this work compares well with Malaysian accessions [9]. The oil can be used extensively as lubricants and hydraulic brake fluids. The saponification value was 182.9 mg/g which is close to the upper value (177-182 mg/g) reported by Ogunniyi [3]. The high saponification value of the oil implies that it consists primarily of high molecular weight fatty acid glycerides. Ogunniyi reported that solvent-extracted oil was high in acid value (10 mg/g) [3]. The difference in acid value can be attributed to the quality of the oil and factors such as immature seeds and poor storage conditions. The acid value also compared favorably with that obtained for crude Jatropha oil (3.38) and Africa oil bean seed (3.25) [7]. Physically, castor oil is a viscous, pale yellow, clear liquid at room temperature (27°C) and showed no solid fat content at 0°C. The oil is high in viscosity although this is unusual for a natural vegetable oil. The pH of the sample 6.11 is 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 moisture content of the crude oil was 4.4. The low moisture content might be as a result of effectiveness of the distillation apparatus used for oil recovery [12]. Equally, the low moisture content is an indication of good shelf life characteristics. The specific gravity value obtained in this study is in line with Mensah et al. [13]. These results show that castor oil can be used in production of soap, lubricants, hydraulic brake fluids, paints etc.

Fatty acid	Value (%)	Brazil*	India**	Malaysia***
Linoleic	0.5	0.2	0.2	0.5
Stearic	1.3	0.9	1.0	1.2
Palmitic	1.5	0.7	-	1.3
Dihydrostearic	1.5	-	-	-
Oleic	3.5	2.8	-	5.5
Linolenic	7.5	4.4	4.3	7.3
Ricinoleic	84.2	90.2	94.0	84.2
Saturated fatty acid	2.4	1.6	1.0	2.5
Unsaturated fatty acid	97.6	97.6	98.3	97.5

*Conceiao et al., 2007;

**Gupta et al., 2006;

***Jumat et al., 2010.

Table 1: Free Fatty acid composition of castor seed oil of the Nigeria accessions in comparison with literature reports.

Parameters	Value
Saponification (mg/g)	182.9
Moisture content (%)	4.4
Acid value (mg/g)	3.085
Viscosity	110,41
pH	6.11
Iodine value (mg/g)	8.46
Specific gravity	0.962
Refractive Index at 25°C	1.477

Table 2: Physicochemical characteristics of castor seed oil.

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