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Characterization of Different Varieties of Castor Seed Oil Obtained From Zaria Metropolis, Nigeria

Oriah. V. N[*1], Bugaje. I. M[1], Mbabuike. I.U and Anya Uzo Anya[1]**

[1]National Research Institute for Chemical Technology (NARICT) Zaria, Kaduna State, Nigeria
[2]Akanu Ibiam Federal Polytechnic Uwana, Afikpo

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ABSTRACT

Castor seed in Nigeria have been classified into three different varieties based on sizes, they are classified as Nigerian big**(NB)**, Nigerian medium**(NM)** and Nigerian small**(NS)**. The objective of the present work is to characterize this varieties sourced locally within Zaria environs in northern part of Nigeria, using normal hexane, the oil was extracted and physicochemical analysis carried out on the oil derived from each seed variety. The GCMS results shows that the seeds contain **ricinoleic acid** of 82.8%, 89.7% and 85.6% for NS, NM and NB,FTIR analysis was also carried out which shows strong broad alcohol (O-H) functional group at absorptions of 3383.26cm^{-1} 3388.08cm^{-1} and 3393.86cm^{-1} for NB,NM, and NS. The physicochemical analysis carried out on the different seed oil shows no significant different in there chemical properties. The percentage oil yield of each species was also determined on dry matter basis which gives the following results 33.9%, 31.51% and 31.14% for NB, NM and NS.

KEYWORD; characterization, physicochemical properties and ricinoleic acid.

INTRODUCTION

Castor oil, sometime known as ricinus oil[1], is a triglyceride of fatty acids, which occurs in the seed of the castor plant. It has its botanical name as ricinuscommunis and belongs to the eurphorbiaceae family[7], it is a plant native to Ethiopian region of east African. The plant is now grown in tropical and warm regions throughout the world and is becoming an abundant weed in south western united state. Castor fruit carries three seeds arranged in swivels and buried inside a thick fibrous coat which is ductile, the seeds are oval/elliptical-shaped in three orthogonal direction. The oil derived from this seed is a pale amber viscous liquid which turn colourless or yellowish after refining and bleaching**,** it was reported by[5]that castor beans contain about 30-50% oil yield that could be extracted by either cold-pressing or solvent extraction process. Castor oil is unique among all fats and oils in that it is the only source of an 18-carbon hydroxylated fatty acid with one double bond and ricinoleic acid (12-hydroxyoleic acid) which comprises of approximately 90% of the fatty acid composition. Its industrial and medicinal purposes was reported [2] and [3], owing to the present of hydroxyl group and high concentration of ricinoleic acid in castor oil, they are found valuable as a chemical feed stock, the oil have been found useful in some medicinal applications were it is effective in preventing the growth of numerous species of viruses, bacteria and yeast**,** it's also successful in treatment of ringworm, skin inflammation, fungal infected finger –and toenails. On its industrial applications, the present of hydroxyl functional group enables it to react with isocyanate to produce polyurethane[9] use for elastomers and adhesive, castor oil have been successfully use in paint industries for the production of coating resins[8]through it modification with other drying oil and also in lubricant production, this is largely because of the unique properties that it posses. The oil is unique among all fat and oil in that(i) it is the only source of an acid 18-carbon hydroxylated fatty acid with double bond (ii) contain ricinoleic acid (12-hydroxyoleic acid) see (figure 1),which comprises approximately 90% of the fatty acid composition (iii) have product uniformity and consistency which are relative high for naturally occurring material (iv) they are non-toxic, biodegradable and renewable resource. This paper is aimed at extracting and characterizing castor seed oil derived from different variety sourced within our local environment, the seed have been classified base on seed sizes namely Nigerian small, Nigerian medium and Nigerian big[4]. The oil was extracted using solvent extraction method, physicochemical analysis was carried out and percentage oil yield of each variety was determined on dry matter basis.

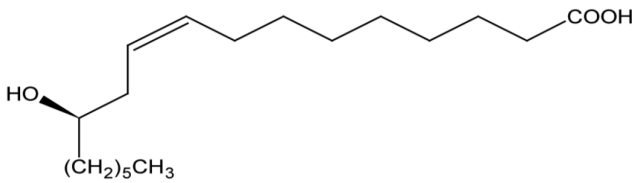

Figure 1; structure of Ricinoleic Acid (12-hydroxyoleic acid)

***Corresponding Author:** Anya Uzo Anya, National Research Institute for Chemical Technology (NARICT) Zaria, Kaduna state, Nigeria. Email: oriah_v@yahoo.com, anya_214@yahoo.com

MATERIALS AND METHODS

MATERIALS

Castor seed was sourced within Zaria environs in northern part of Nigeria. The average fatty acid composition in castor seed oil is given in table 1, analytical grade N-hexane, soxhlet set-up, heating mantle, mortar and pestle were all used in this study.

Table 1.Average fatty acid composition in crude castor seed oil[10]

FATTY ACID	SYSTEMATIC NAME	COMPOSITION RANGE
Linoleic	Cis-9, cis-12- Octadecedianoic	3.5-6.8%
Oleic	Cis -9-octadecenoic	3-6%
Palmitoleic	Cis-9-hexadecenoic	?%
Palmitic	Hexadecanoic	0.8-1.8%
Stearic	Octadecanoic	0.8-2%
Ricinoleic	12-hydroxyloleic acid	82-95%

PRE-TREATMENT OF THE CASTOR SEED

The harvested castor seed was sun dried in the open, after which the seed was then shelled using shelling machine before subjecting it to clearing, the clearing was done by hand picking, were foreign bodies and dirt was isolated from the seed. The seed was further dried in an oven @ 70^{o}c for 2hr to remove moisture and aid in cracking the casing, on gentle pressure by hand the casing was separated from the inner seed, using tray the cover was blown away. The seed was then subjected to grinding; this was achieved by using mortar and pestle for size reduction prior to extraction.

OIL EXTRACTION

The oil was extracted using soxhlet extraction method, about 40g of the grind castor seed was placed in a thimble, were it was extracted upon with about 250ml N-hexane. The sample was allowed to reflux for 6hr at a regulated temperature of (55-60^{0}c), the heating was stopped when the reflux time is complete. Using a distillation set-up, while keeping the temperature between (55-60^{0}c), the solvent was evaporated and the extracted oil concentrated, this was repeated severally until about 100ml of the oil was obtained. The oil was stored in an amber bottle prior to its physiochemical determination.

Table 2. Physiochemical properties of three varieties of castor seed oil

Parameter	Nigerian big	Nigerian medium	Nigerian small
Acid value(mgKOH/g)	5.01	5.34	5.83
Specific gravity@25^{0}c	0.9581	0.9521	0.9511
Oil yield (%)	33.9	31.51	31.14
Peroxide value(meq/kg)	13.94	13.86	12.98
Hydroxyl value(mgKOH/g)	163.8	161.4	162.1
Saponification value(mgKOH/g)	171.4	169.6	170.3
Free fatty acid(mgKOH/g)	2.51	2.67	2.92
Iodine value(wijs method)	81.98	83.05	82.31

FATTY ACID COMPOSITION

Table 1, shows the average composition of fatty acid in castor seed oil and the result in table 3 indicate ricinoleic acid content of 82.8%, 89.7% and 85.6% for NS, NM and NB. Other fatty acid such as palmitic, stearic, palmitoleic and linoleic are also present.

Table 3. Percentage Fatty acid composition of the three different varieties of castor seed oil

Fatty acid	Nigerian small	Nigerian medium	Nigerian big
Palmitic;$C_{16.0}$	1.8	1.6	0.7
Stearic;$C_{18.0}$	1.1	1.0	1.2
Palmitoleic;$C_{16.1}$	3.6	3.1	2.8
Oleic;$C_{18.1}$	3.8	3.3	4.2
Linoleic;$C_{18.2}$	5.53	-	3.5
Ricinoleic;$C_{18.1}$	82.8	89.7	85.6
Saturated fatty acid	2.9	2.6	1.9
Unsaturated fatty acid	97.1	97.4	98.1

Table 4.Percentage fatty acid composition of castor seed oil from three different country

Fatty acid	Malaysia	Brazil	India
Palmitic	1.3	0.7	-
Stearic	1.2	0.9	1.0
Oleic	5.5	2.8	-
Linoleic	7.3	4.4	4.3
Linolenic	0.5	0.2	-
Ricinoleic	84.2	90.2	94.0
Saturated fatty acid	2.5	1.6	1.0
Unsaturated fatty acid	97.5	97.6	98.3

RESULT AND DISCUSSION

The physicochemical analysis carried out on the three different varieties of the castor seed oil shows similar results which defer with (±2) in all chemical analysis, It was reported by [6]that oil content was affected by both geographical location and castor seed genotypes, environmental conditions such as change in soil texture and relative humidity tend to affect the physicochemical properties of the oil. The acid value obtained is≥5mgKOH/g in all three varieties, the percentage oil yield obtained was 33.9%, 31.51% and 31.14% for NB, NM and NS, this fall within the range of (30-50%) oil yield for castor seed. Results obtain for hydroxyl value was≥160mgKOH/g for all three varieties and the FTIR analysis shows a very strong broad (O-H) functional group which further depicts strong present of a hydroxyl functionality. The hydroxyl group in castor oil account for it unique combination of physical properties, such as having relatively high viscosity and specific gravity, limited solubility in aliphatic petroleum solvent and also soluble in alcohol in any proportion. The percentage composition of ricin oleic acid is ≥82% in all three varieties, this falls within range as in table 1, the iodine value (IV) result for all three species is≥81mg/g, this shows a reasonable present of high un-saturation, saponification value for all three was ≥168mgkKOH/g thus this result fall within the standard. From the physicochemical analysis carried and the fatty acid composition of the castor seed oil, when compared with other varieties in other geographical locations the product shows good uniformity and consistencies which are quite high for a naturally occurring material.

CONCLUSION

This work is aimed at characterizing the different varieties of castor seed oil obtain from northern part of Nigeria, the physicochemical analysis carried out in all the three varieties shows similar results which only defer in value by (±2) in all its chemical analysis and when compared with other castor oil from other countries, it shows relative product uniformity that is uncommon for a natural occurring product. The analysis results show high ricinoleic acid content, un-saturation, high density and the presence of hydroxyl functional group, based on the physicochemical properties obtained from the three varieties, it is recommended that oil obtain from any of the seed varieties be used as a chemical feedstock for akyde resins production use in paint industries, lubricant industries and polyurethane production.

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