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Comparative Physicochemical Study of the Oils from the Seeds of *Cussonia Bateri* (JANSA) and *Brasssica Juncea* (MUSTARD)

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Abstract

The physicochemical analysis of the seed oils of *Cussonia bateri* and *Brassica juncea* (mustard) was investigated and compared. Dried pulverized seeds of the plant seeds were extracted using normal hexane (n-hexane). The yield of the oil from *Cussonia bateri* was 27.84 % while that from *Brassica juncea* was 33.1 %. The chemical properties of *Cussonia bateri* gave iodine value of 119.54 mg, saponification value of 106.28 mg, peroxide value of 20 mg, acid value of 1.4 % and free fatty acid of 2.8 % of which linoleic acid was 60.15 %, oleic acid 15.38 %, palmitic acid 12.42 %, stearic acid 10.59 %, linolenic 1.34 % and myristic acid 0.11%. The iodine, saponification, peroxide and acid values of the oil from *Brassica juncea* were 125.3 mg, 173mg, 5.8 mg and 3.9 % respectively; the oil contained 0.78% lauric acid, 0.39% myristoleic acid, 3.78% palmitic acid, 23.47 % stearic acid, 28.48% oleic acid, 19.87 % linoleic acid and 23.22 % linolenic acid. The oil from *Cussonia bateri oil was* semidrying compared to the oil from *Brassica juncea* which was a drying oil. The oils could be used in confectionaries, cosmetics, pharmaceauticals, food supplements, varnishes, oil paints etc.

Keywords: Drying, Extract, Fatty acids, Oil, Physicochemical, Seeds,

INTRODUCTION

The *Cussonia bateri* was/is known as *Jansa* in Cameroun in West Africa and in Nigeria, *Cussonia bateri* is known as *Ugbaokwe* in Igbo, *Takandagiwa* in Hausa, *Bumarlahi* in Fulani and *Shigo* in Yoruba languages.

The tree is common in Northern Nigeria [1]; it is a small twisted savanna tree with thick corky bark. The leaves are oborate with lateral nerves; the flowers are greenish-white, with whitish fruits and white and very soft and brittle wood.
The seed of *Cussonia bateri is* used in soup and has a pleasant aroma and sweet taste; the authors use the seed as spice in soups. This gave rise to the interest to investigate the contents of the plant seed especially the oil because the seed was discovered to become oily on storage.
On the other hand, *Brassica juncea* (Mustard) belongs to the family of cruciferae with tiny round edible seed and tasty leaves. The seed had been known as spice since earliest recorded times [2]. Mustard seed was used to relieve respiratory problem and rheumatism [3].
It was used to stimulate the kidneys and served as a laxative and emetic. The oil extracted from mustard seed was used for skin eruptions and in massaging. The oil could be substituted for olive oil, and was used for ulcers and tumours in China [4].
The seed contained glucosinolates which had anti cancer properties [5].
The compositions of the oils from the seeds of *Cussonia bateri* and *Brassica juncea* had not been studied extensively. In this article, the physicochemical tests: saponification value, free fatty acid content, iodine value, acid values as well as specific gravity of these oils were investigated and results obtained from the two plant seed oils were compared.

GENERAL EXPERIMENTAL PROCEDURE

All reagents used were of analytical grade purchased from BDH, Poole England. Weighing was done on Mettler P1210 and Model 770 Mak Keru. High performance liquid and gas chromatography was carried out using GC-HPLC Hewlett Packard 6890 series. Grinding was done electronically using Binatone blender model EC-101**.**

MATERIALS AND METHODS

Plant sample and collection:

The plant seeds were collected in the month of June 2011, identified and authenticated by the Applied Biology Department Unit, Ebonyi State University Abakaliki Nigeria. The seeds were washed with distilled water, sundried and pulverized. The milled sample was packaged in a tight polythene bag and stored until required.

Extraction:

Solvent extraction was done using 250 g of the ground sample of each seed in hexane by soxhlet. The solvent was removed by distillation to reveal yellow oils. The oils were dried in an oven between 50^{o}C -60^{o}C for 1 h and cooled and stored under a desiccant before weighing and physicochemical tests [6-8].

PHYSICOCHEMICAL ANALYSIS [9]

Percentage yield:

The total amount of oil extracted was determined and calculated by using the equation

$$\text{Percent yield} = \frac{W_2 - W_1 \times 100}{W_3}$$

Where

W_1= weight of flask alone in gram

W_2= weight of flask and oil in gram

W_3= weight of crude plant sample used in gram

Melting Point:

Classical method was used. The oils were separately introduced into capillary tubes and frozen. The frozen oils were allowed to stand at room temperature; the temperature at which the oils became liquid was observed and noted.

Specific Gravity:

The specific gravity was determined by using the using the density bottle; a 25 mL bottle was weighed and filled to mark with the oils and reweighed respectively. A blank experiment was performed with distilled water. The equation given below was used to calculate the specific gravity.

$$\text{Specific gravity} = \frac{W_1}{W_2}$$

Where

W_1 = weight of oil in gram

W_2 = weight of distilled water in gram

Saponification Value

25 mL of 10% ethanolic KOH was added to 2.0 g of each of the oil and refluxed for 30 min. The unreacted KOH was back titrated with 0.5 M HCl using 3 drop phenolphthalein [10]. Saponification value was calculated using the equation

$$\text{Saponification value} = \frac{Vb - Va \times 56.1 \times M}{W\ (g)}$$

Where

Va = titre value of the oil

Vb = titre value of the blank

M = molarity of the HCl

W = weight of the oil sample in gram

56.1 = molecular weight of KOH

Iodine Value:
The oil 0.5 g was weighed into a 250 mL conical flask to which was added 20 mL CCl_4 and 25mL Wijis solution and shaken. This was allowed to stand in the dark for 90 min. To this mixture were added 20 mL of 10% KI and 100 mL distilled water and titrated with 0.1M $Na_2S_2O_3$ until end point. The iodine value was calculated by the equation

$$\text{Iodine value} = \frac{(b-a) \times M \times 12.69}{W\ (g)}$$

Where
a = titre value of the oil
b = titre value of blank
M = molarity of $Na_2S_2O_3$

Free Fatty Acid:
The oil 1.0 g in weight was introduced into a 250 mL conical flask, to this was added 3 drops phenolphthalein followed by 20 mL ethanol. The mixture was titrated with 0.1 M NaOH solution until a pink colour developed. Free fatty acid was calculated thus;

$$\text{Free fatty acid} = \frac{T \times M \times 56.1 \text{ mg KOH / g}}{W\ (g)}$$

Where
T = titre value
M = molarity of the titrant
W = weight of oil in gram
56.1 = acid constant

Determination of acid value:
The same experimental procedure given above was used for the determination of acid value; this value was calculated by the equation

$$\text{Acid value} = T \times 0.0282 \times W$$

Where
T = titre value
0.0282 = constant
W = weight of oil used in gram

Determination of peroxide value:
Oil 1.0 g was weighed into a conical flask to which was added a solvent mixture made from glacial acetic acid and 10 mL $CHCl_3$. About 1.0 g of KI was added and the

content heated in a water bath for 5 min. To this whole mixture was added 20 mL of 5 % KI and titrated with 0.002M solution of $Na_2S_2O_3$ using starch solution as an indicator. The peroxide value was calculated using the equation

$$\text{Peroxide value} = \frac{V_2 - V_1 \times M \times 1000 \text{ meq/kg}}{W \text{ (g)}}$$

V_1 = titre value of the blank
V_2 = titre value of the oil
M = molarity of $Na_2S_2O_3$
W = weight of sample (oil) in gram

Gas- liquid chromatography:
The oil 0.8 g was weighed into a 250 mL flask. To this was added 2 mL methanolic KOH and refluxed for 1 h at 80^{o}C. To this mixture was added 2 mL methanolic HCl (4:1) and allowed to cooled, this reaction yielded the methyl esters. To this was added 10 mg/L n-hexane and 20 mL brine solution, and the oil after work up was inserted into the equipment and analyzed.

RESULTS

The physicochemical result of the seed of *Cussonia bateri* and *Brassica juncea* was shown in Table 1. The gas- Liquid chromatography of *Cussonia bateri* and *Brassica juncea* are shown on Tables 2 and 3 respectively.

Table 1: Physicochemical Result of the oils from *Cussonia Bateri* and *Brassica juncea*

Properties	*Cussonia Bateri*	*Brassica juncea*
percentage yield of oil (g)	27.845 ± 0.050	33.1 ± 0.2
melting point (^{o}C)	10 ± 0.020	10 ± 0.01
Specific gravity (g/ml)	0.917 ± 0.010	0.90 ± 0.4
Saponification value (mg/g)	161.28 ± 0.030	173 ± 0.03
Iodine value (g/100g)	119.54 ± 0.002	125.3 ± 0.32
Peroxide value (meq/kg)	18.8 ± 0.010	5.8 ± 0.02
Free fatty acid (mg/g)	2.8 ± 0.030	0.95 ± 0.21
Acid value	1.4 ± 0.060	3.9 ± 0.32

Table 2: Gas-Liquid Chromatography of the oil from *Cussonia Bateri*

		Cussonia	*bater*i			
Peak	1	2	3	4	5	6
Retention Time	6.28	8.96	11.63	12.65	14.56	18.63
Width (min)	0.208	0.537	0.468	0.616	0.879	1.002
Area (ρA*s)	65.358	7255.23	6181.87	8981.62	3.512	783.10
Area (%)	0.111	12.424	10.586	15.380	60.156	1.341
Fatty acid	C_{14}	C_{16}	C_{18}	$C_{18.1}$	$C_{18.2}$	$C_{18.3}$

Table 3: Gas –Liquid Chromatography of the oil from *Brassica juncea*

		Brassica	*juncea*				
Peak	1	2	3	4	5	6	7
Retention Time	3.81	6.10	8.61	11.53	12.41	14.15	17.03
Width (min)	0.261	0.310	0.321	1.029	0.665	0.563	1.127
Area (ρA*s)	4147.05	2102.02	2.04	1.26	1.53	1.07	1.25
Area (%)	0.770	0.390	3.789	23.476	28.480	19.873	23.219
Fatty acid	C_{12}	$C_{14.1}$	C_{16}	C_{18}	$C_{18.1}$	$C_{18.2}$	$C_{18.3}$

DISCUSSION

The percent yield of *Brassica juncea* was 33.1% compared to *Cussonia bateri* that was approximately 28 %, showing that for the quantity of crude sample *Brassica juncea* had more oil. The melting point and the specific gravity were the same for both oils. Both oils were lighter than water having an approximate value of 0.9 g/ml. There was presence of lower fatty acids in *Brassica juncea* looking at the saponification value of 173 mg compared to 161 mg of *Cussonia bateri*. The iodine value of *Cussonia bateri* at 119 mg showed that the oil was semi-drying; hence hardened partially on exposure to air like corn, sesame and grape seed oils [11].

While the oil from *Brassica juncea* did harden on exposure to air; what is known as auto oxidation, a polymerization cross linking brought about by atmospheric oxygen. It was a drying oil like linseed, tung and walnut oils; both oils could be used in confectionaries, paints etc. *Cussonia bateri* had peroxide value of 18.8 meq/kg which was an indication that the oil was more prone to rancidity compared to the oil obtained from *Brassica juncea* which had a peroxide value of 5.8 meq/kg, though the peroxide value could change as a result of oxidative rancidity or ketonic rancidity brought about either by the action of air or microorganisms.

From the peroxide values, the oil from *Brassica juncea* would be more useful in foods and drugs. Acid value is a measure of the extent to which the glycerides in the oil have been decomposed by lipase action. Thus there was more lipase action in

Brassica juncea with an acid value of 3.9 ± 0.32 than that of *Cussonia bateri*, 1.4 ± 0.060; therefore the level of rancidity in Brassica *juncea* was higher. Both oils were of good quality because of the low percentage of their free fatty acids; *Brassica juncea* (0.95 ± 0.21) and *Cussonia bateri* (2.8 ± 0.030) but the free fatty acids in *Brassica juncea* was lower [12-15].

The HPLC-Gas chromatogram in Table 2 shows that the oil from *Cussonia bateri* contained six fatty acids: 0.111 % myristic acid (C_{14}), 12.424 % palmitic acid (C_{16}), 10.586 % stearic acid (C_{18}), 15.380 % oleic acid ($C_{18.1}$), 60.156 % linoleic acid ($C_{18.2}$) and 1.341 % linolenic acid ($C_{18.3}$). In Table 3, Brassica *juncea* contained lauric acid (C_{12}), myristoleic acid ($C_{14.1}$) 3.789 % palmitic acid (C_{16}), 23.476% stearic acid (C_{18}), 28.480 % oleic acid ($C_{18.1}$), 19.873% linoleic acid ($C_{18.2}$) and 23.219 % linolenic acid ($C_{18.3}$). From Tables 2 and 3, *Cussonia bateri* had a higher percentage of palmitic acid and a very high percentage of linoleic acid an eighteen carbon chain fatty acid with two double bonds while *Brassica juncea* had a higher percentage composition of stearic acid, oleic acid and linolenic acid an eighteen carbon chain fatty acid with three double bonds.

CONCLUSION

linoleic and linolenic acids are omega-3 and omega-6 fatty acids; therefore these two oils could be useful and alternative sources of omega-3 and omega- 6 fatty acids aside fish oil and could be incorporated in food, confectionaries and supplements.

REFERENCES

[1] Keay R.W, Onochie, F.A. and Stanfield, D.P., 1960, Nigerian Trees Federal Department of Forest Research, vol.1, pp: 33-40.

[2] Macea, R; Robinson, R.K and Salder, M., 1986. Encyclopedia of Food Science and Technology, vol.5 pp: 3178-3181.

[3] Simon, J.E., Chadwick, A.F. and Cracker L.E., 1994, Herbs an Index Bibliography 1971-1980, The Scientific Literature on Selected Herbs and Aromatic and Medicinal Plants of the Temoerate Zone, Hamden, pp: 770-787.

[4] Pryde, E.H. and Doty, H.O., 1981, "World Fats and Oils Situation". In Pryde, E.H and Mukherjea, K.D. Eds. New Source of Fats and Oils. Amer. Oil Chem. Soc., (AOCS), pp: 270-274.

[5] Ensminger, A.H., 1986, Food for Health; A Nutritional Encyclopedia, Cloves California Pregues Press, pp: 50-52.

[6] Nwokonkwo, D.C. 2009, "Extraction and Characterization of Oils from Orange (*Citrus Sinensis*) Lemon (*Citrus Limon*) and Lime (*Citrus Aurantifolia*)" J. Chem. Soc. Nig., vol 34 (1), pp: 45-53.

[7] Nwokonkwo, D.C., 2013, "Physicochemical and Phytochemical Studies of the Constituents of the Seeds of *Cussonia Bateri* (Jansa Seeds)", Am. J. Sci. and Ind. Res., **4** (4): 7-12. doi:10.5251/ajsir.2014.5.1.7.12.

[8] Nwokonkwo, D.C., 2008, "Characterization of Mustard Seed Oil (*Brassica Juncea*)", J. Chem. Soc. Nig. 33 (3), pp: 197-200.
[9] AOOC.1984, Official Methods of Analysis, 14th Ed., Association of Official Analytical Chemists, Arlington, VA. pp: 437-441.
[10] Rosales, M.T., 1992, Analysis of Fats and Oils. Garred Press, Champaign, USA, pp: 113-120.
[11] Cock, L and Rede, V., 1995, Laboratory Handbook for Oil and Fat Analysis Academic Press: New York, pp: 121-128.
[12] Egan, H., Ronald, K.S. and Sawyer, R., 1990, Pearson Chemical Analysis of 18th Ed, Longman Scientific and Technology, pp: 13-514.
[13] Jambunathan, C. and Reddy, P.S., 1991, Storage of and Determination of Oils, 3rd Ed. Cannon Press, pp: 85-98.
[14] Rossel, J.B., 1984, Vegetable Oils and Fats C.M.E Casterberg, pp: 263-265.
[15] Ulrich, P., 2002, Drying Oils and related Products in Ullmann's Encyclopeadia of Industrial Chemistry, Wiley-VCH Weinheim, pp: 9-55.