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Preliminary Studies on Potential Industrial Applications of *Conorandos panados* Seed Oil

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Conorandus panados plant known in Higgi language as 'Mnizee' in Michika Local Government of Adamawa State, Nigeria, was found to be a plant of some industrial importance. The hexane extract of the seed oil was Physico-chemically analyzed; functional groups determined using IR, fatty acid composition qualitatively determined using GC-MS. The oil yield was 120 cm^3/400g of the grounded seed and the colour of the oil was yellow. The results of the physicochemical analysis revealed the following; Acid value 0.052 mgKOH/g, iodine value 107/100 g, Peroxide value 2.600 meq H_2O_2, Saponification value 788 mgKOH/g, relative density 0.906 g/ml (sp = 0.906), Refractive index 1.47, the percentage yield is 27.18%. The fatty acids detected were 2-Methyl-4-heptenal/$C_8H_{18}O$,4-Heptanal/$C_7H_{12}O$, 1,5-Hexadiene/C_6H_{10}, 2-isononenal Zinc/$C_9H_{15}ZnO$, 9,12-OctadecadienoicAcid/ $C_{18}H_{32}O_2$, Oleic Acid/ $C_8H_{34}O_2$ acid, 1,2-Binaphthalene/$C_{20}H_{14,}$ Undec-10-ynoic Acid/ $C_{11}H_{18}O_{2,}$ 5-Hexenoic Acid/$C_6H_{18}O_{2,}$ Cyclopentaneundecanoic Acid/$C_{16}H_{30}O_2$, 9,12-Octadecadienoyl Chloride /$C_{18}H_{31}ClO$, Acetamide/C_2H_5NO. In this study, the result obtained vis a vis; saponification value, iodine value, acid value coupled with the presence of oleic acid, makes C. panados seed oil suitable for use as a paint binder, and soap production. It is also a good candidate for foam making this is due to the polyols of this oil will give a high number of OH, which is suitable for foam production. The preliminary investigation reveals that C. panados seed oil could be used as paint binder, soap making and foam production pending further research.

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1. INTRODUCTION

Over the years seed has been regarded as waste except for minute fraction that is used in agriculture for planting. The natural existence of oil in seed and in varying proportion together with the application of knowledge of seed oil extraction techniques suggest that vegetable oil could possibly be extracted and be used for industrial purposes [1,2]. Oils of industrial, dietary, pharmaceutical and other importance have a wide range of sources. Oils extracted from seeds, their yields, their physicochemical properties determine their applications in various fields apart from dietary [3]. In a continuous effort to determine the potentials of wild fruits and seeds [4,5,6], an attempt was made to determine the utilization potentials of the fruits and seeds of *C. panados*. In the study area (Nkafamiya Wulla Michika Local Government Area of Adamawa State), common or cultivated fruits and seeds like guava, orange, mango and cottonseeds are scarce. Wild fruits and seeds like *C. congoensis, N. latifolia* and the *C. panados* provide the necessary vitamin, oil, mineral, fat, protein and carbohydrate to the people living within the study area. Also, wild fruits and seeds are cheaper and this makes the affordability easier for low-income earners with large family size [7,4,8].

According to [9], natural vegetable oils and fats are increasingly becoming important in nutrition as well as the manufacturing industry worldwide. Nutritionally, vegetable oils are important sources of dietary energy and antioxidants. In the production industry, they are used as raw materials for the manufacture of various foods, cosmetic, pharmaceutical and chemical products. Vegetable oils account for 80% of the world's natural oils and fat supply [10].

Physicochemical properties of oils are determined to know the quality, purity and identification. Characteristic properties are properties that depend on the nature of the oil. These are used to characterize oil, irrespective of location or sources of origin. Example of these properties is iodine value and saponification value. While the variable properties change with location, examples are peroxide value, free fatty acid value, acid value and density [11].

[12] reported that acid value is often used as an indicator for edibility of oil or suitability for industrial use. Oils with high acid value are not edible but can be utilised in the soap making and paint industries [9]. Vegetable oils are sourced from different varieties of leguminous plants. With an ever-increasing demand for vegetable oils for food and industrial applications, there is a need for considerable expansion of oil seed crop production [13]. This expansion can be achieved by exploring other sources of vegetable oils, especially underutilized oil seeds [14]. Oil is able to dry and polymerize to a semi-fluid state if it contains enough unsaturated fatty acids preferably di-or tri-unsaturated [15]. The participation of mono-unsaturated (oleic) acid is not well known but rather limited [16].

Since several years, varieties of vegetable and non-edible oils are used in paint industry as they are able to dry quickly, sometimes more quickly than linseed oil or soya bean oils [17]. The drying process itself results in a polymerization upon uptake of oxygen. The complex mechanism includes mainly the oxidation degradation of unsaturated fatty acids leading to the formation of aldehyde groups later transformed into carboxylic groups. Thus dicarboxylic acid is progressively formed with the aging of the mixture. Pimelic, suberic, uzelaic and subacic acids being mainly found in an old paint [18].

[19] reported that the main components of paints are binders, diluents, pigment and additive. The binder, commonly called the vehicle, is the film-forming component of paint. It is the only component that must be present. It is the part of the paint in which the pigment is suspended. It is often referred to as carrier. The binder imparts adhesion and strongly influences properties such as gloss durability, flexibility and toughness. Binders include synthetic or natural resins such as alkyds, acrylics, vinyl-acrylics, vinyl acetate/ethylene (VAE), polyurethanes, polyesters, melamine resins, epoxy, or oils [15].

Scientific reasons were given to the effect that pigments make opaque and lasting coatings consist of several components including resins, vegetable oils and solvents. Vegetable oil impart valuable properties to coating but in order to furnish these properties, the oil must be incorporated into the formulation either by cooking, simple blending or by melting resins into the oil [16]. The aim of this work, therefore, is to preliminary determine the suitability of *C.*

panados seed oil for industrial applications via soxhlet extraction, determination of the physical and chemical parameters and GC-MS and IR spectroscopy.

2. MATERIALS AND METHODS

2.1 Samples Collection

Plant samples were collected from Nkafamiya, Michika Local Government Area of Adamawa State, of Nigeria. Samples were dried at room temperature and pulverized for subsequent analysis.

2.2 Methods

The oil from the seeds of *C. panados* was soxhlet extracted with n-Hexane (40-80°C) and was then characterized by a standard method for oil and fat analysis [20,8]. The chemical parameters (peroxide value, iodine value, the percentage of free fatty acids and saponification value) were tested based on America Oil Chemist Society methods [20,8]. The color of the oil sample was determined by observation using several independent competent individuals. Oil colour was correlated using colour charts [21]. All reagents used for the analyses were of analytical grades and were not subjected to further purification. The refractive index (RI) and infrared (IR) spectrum were determined using the method described by [20]. GC-MS Analysis of the fatty acids in the *Conorandus Panados* seed oil sample was done at the American University of Nigeria Yola, Adamawa State, Nigeria (a Shimadzu QP2010 plus series gas chromatography coupled with Shimadzu QP2010 plus mass spectroscopy detector (GC-MS) system was used). The temperature programmed was set up from 70°C to 280°C. Helium gas was used as carrier gas. The injection volume was 2 μl with injection temperature of 250°C and a column flow of 1.80 mL/min for the GC. For the mass spectroscopy ACQ mode scanner with scan range of 30-700 amu at the speed of 1478 was used. The mass spectra were compared with the NIST05 mass spectral library [22]. The physicochemical analysis of the saponification value, color, specific gravity, refractive index, acid value, iodine value as can be seen in Table 1 and 2 were determined according to the method described in the manual of method of analysis of food, FATS AND OIL, which was issued by Food Safety and Standards Authority of India Ministry of Health and Family Welfare, Government of India, New Delhi in 2012.

To acquire absorption spectrum the oil sample was applied as a film between two NaCl plates. The spectra were obtained using buck scientific IR spectrometer using the following experimental condition: Spectra width 4000-600cm^{-1}, spectrum resolution, 0.4 cm^{-1}: number of scans, 16. Each spectrum was normalized from 0-1, dividing all point of a spectrum by the highest value to mitigate the influence of the film thickness on signal intensities. Statistical packages for social sciences (SPSS) were used to arrive at the mean, standard deviation and correlation.

3. RESULTS AND DISCUSSION

The physical properties of C. panados seed oil is presented in Table 1. The oil obtained from C.*panados* seed had a yellowish colour and remained liquid at room temperature. The refractive index values obtained for C.*panados* (1.470) was in close agreement with the value reported for neem seed oil (1.465), [23]. The oil had a specific gravity of 0.871, this is closer to 0.870 specific gravity reported for African pear (*Dacryodes edulis*) seed oil and less dense than 0.880 reported for Bambara groundnut seed oil [24]. The viscosity of C.*panados* (9.53) was higher than that of melon seed oil (5.89) [23].

Table 1. Physical properties of the oil extract

S/N	Parameters	Value
1	Colour	Yellow
2	Specific gravity	0.871 ± 0.01
3	Refractive index	1.47 ± 0.21
4	Viscosity at 40^{o}C (s)	9.53 ± 0,11

The results of the physicochemical analysis (Table 2) shows that *C. panados* seed oil has Saponification value of 788 mgKOH/g which is higher than that of *Dennettia tripatala* fruit oil (Pepper fruit) 159.33 ± 1.20 suitable for soap making [25] also higher than that of African pear oil 143.76 mgKOH/g which could be good for soap making too [26]. This indicates that the oil could be used in soap making since its saponification value is high. Higher saponification value, justify the usage of fat or oil for soap production [27]. A low Acid value of 0.052g was obtained. Lower acid value makes oil suitable for soap production [27]. Iodine value of 107g was obtained, which shows that the oil belongs to the class of non-drying oils consisting predominately

Table 2. Results from physicochemical analysis of oil

S/N	Properties	Values
1	Oil yield (%)	27.5 ± 0.76
2	Acid value (mgKOH/g)	0.052 ± 0.66
3	Peroxide value (meq/kg)	2.600 ± 0.77
4	Iodine value (gI_2/100g)	107 ± 0.81
5	Saponification value (mgKOH/g)	788 ± 0.12
6	Ester value (mgKOH/g)	140.223 ± 0.51

Table 3. Physicochemical analysis of fatty acid from G Chromatography Mass Spectrometer

S/No.	Retention time	Area%	Compound/Molecular formular
1	4.714	0.36	2-Methyl-4-heptenal/$C_8H_{18}O$
2	4.923	0.60	4-Heptanal/$C_7H_{12}O$
3	5.341	0.60	1,5-Hexadiene/C_6H_{10}
4	5.723	0.51	2-isononenal Zinc/$C_9H_{15}ZnO$
5	14.300	42.82	9,12-OctadecadienoicAcid/$C_{18}H_{32}O_2$
6	28.822	45.45	Oleic Acid/ $C_8H_{34}O_2$
7	28.953	3.06	1,2-Binaphthalene/$C_{20}H_{14}$
8	41.506	0.29	Undec-10-ynoic Acid/ $C_{11}H_{18}O_2$
9	41.547	0.08	5-Hexenoic Acid/$C_6H_{18}O_2$
10	41.750	1.08	Cyclopentaneundecanoic Acid/$C_{16}H_{30}O_2$
11	41.774	0.68	9,12-Octadecadienoyl Chloride/$C_{18}H_{31}ClO$
12	41.858	4.40	Acetamide/C_2H_5NO

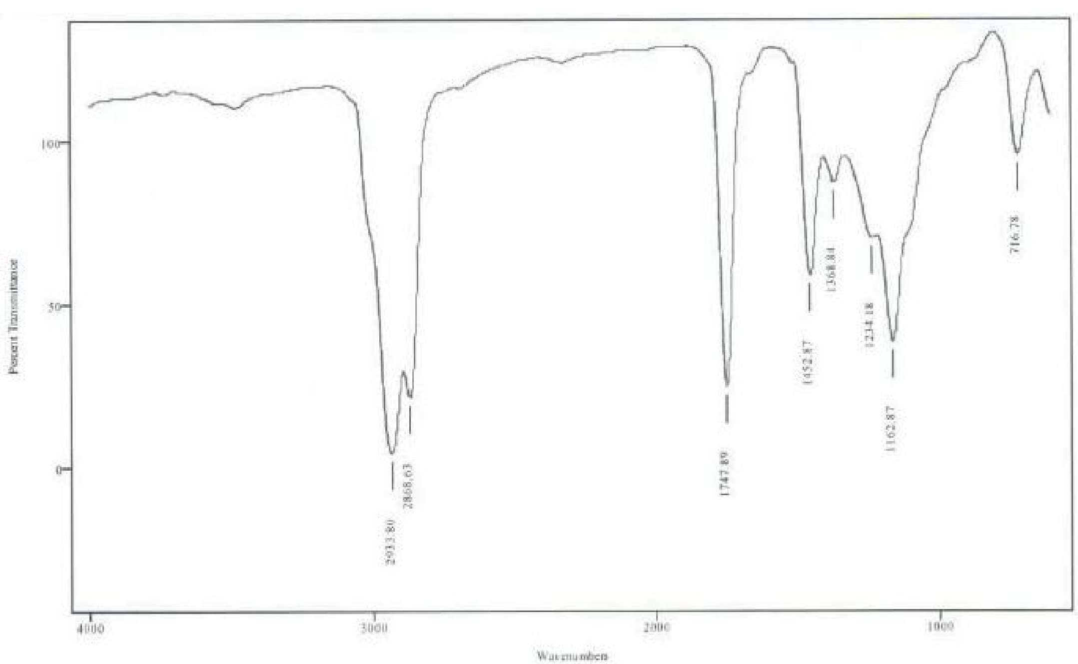

Fig. 1. IR spectroscopy of oil extract of C. panandos

polyunsaturated fatty acids mainly oleic acid. This class of oils whose iodine value is between 100-150 possesses the property of absorbing oxygen on exposure to the atmosphere; though do not do so sufficiently to qualify them as drying oils. They become thicken and remain sticky but do not form a hard dry film. They are used in the production of margarine and soap [28]. Refractive index was 1.47 higher than 1.44 ± 0.00 reported for onion seed oil [29] both indicating high purity [30].The result in Table 3 shows that *C. panados* seed oil contains fatty acid like Oleic acid safer for use at required concentration in the preparation of oleates and lotions, and as a pharmaceutical solvent [30].

IR spectroscopy of the oil presented in Fig. 1. The IR spectroscopy of the oil showed bands at 3470-3494cm^{-1}, strongly suggesting the presence of hydro-peroxide; at 1740-1745 cm^{-1}, suggesting ester C=O stretching which indicates possible formation/presence of aldehyde, ketones and acids; at 1650-1654cm^{-1}, suggesting conjugation of double bonds; and at 159-1162 cm^{-1}, 1234cm^{-1} and 1368cm^{-1}, suggesting the presence of methyl ester and secondary alcohol [31]. Others at 970, 853-890 and 716cm^{-1} are due to rocking vibrations [32]. This is very consistent with a similar work done by [33]. Bio-based polyols, used in the production of foams, has been synthesized from highly polyunsaturated seed oil [34]. From the literature reviews, there are several methods to synthesize bio-based polyols from vegetable oils [35,36,37,38]. The conventional chemical methodology for the functionality of unsaturated moieties to produce OH groups is the most operational such as *in situ* epoxidation-hydroxylation at the double bonds with percarboxylic acids. That is to say, the number of the OH in the hydroxylated seed oil is proportional of the level of unsaturation in the oil. The more the double bond the more the number of OH and the more suitable it is in foam production. The iodine value is the measure of the amount of unsaturation (number of double bond) in fat/oil. The iodine value for C. Panandos shows that C. Panandos is highly polyunsaturaturated, hence, the polyols of this oil will give a high number of OH, which is suitable for foam production.

4. CONCLUSION

The results of the preliminary investigation suggested that the C. Panados seed oil could be used in soap making, and foam production

COMPETING INTERESTS

Author has declared that no competing interests exist.

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