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Chemical Composition and Fatty Acid Profile of (Chrozophora oblongiflia) Seeds and Oils

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Abstract
The present research was conducted in laboratory of food sciences and technology, faculty of Natural Resources and Environmental Studies, University of Kordofan, Elobeid, Sudan to study the chemical characteristics of seeds and oil of Chrozophora oblongifolia, and oil fatty acid profile. The fresh seeds samples were procured from North and West Kordofan, regions, Sudan. The proximate composition of seeds, the oils extracted from plant seeds characterized and also fatty acids profile were investigated. The results showed that 41.7% fat and 20.7% protein contents, significant ($p \leq 0.05$) differences were found in moisture, fat and physiochemical properties of oil between locations, while protein, ash, fiber and carbohydrate of seeds statistically the same. The results showed low level of FFA, acid value and peroxide value in the seeds oil. Palmatic, arashidic, oleic and linolenic fatty acids were (17.89, 2.41, 22.33 and 1.06%), respectively in North Kordofan, slightly higher than (13.60, 2.27, 18.36 and 0.60%), respectively which were registered in West Kordofan, while stearic (12.69%) and linoleic acid (32.01%) were lower than (42.01%) stearic and (18.90%) linoleic in West Kordofan. The present finding indicated that C.oblongifolia seeds have a potentiality to be utilized as new vegetable oil due to its contents of protein, oil and carbohydrates; and have a great probability to serve as cheap source of edible protein. The oil produced showed a higher some fatty acids such as palmatic, arashidic, oleic and linolenic.The vitamins and minerals of the seeds need to be investigated and also oxidative oil stability and antimicrobial activity were needed in future studied as recommended point of view.

Keywords: Chrozophora oblongiflia plant, Fatty acid, Oil screening, Physicochemical characteristics, Proximate composition

Introduction
Plants have been used for thousands of years to flavor and conserve food, to treat health disorders and to prevent diseases including epidemics. Species of Chrozophora genus (Euphorbiaceae family) distributed in West African and Asia. These species are monoecious, shrubby herb and annual plants and their leaves, stems and fruits besides the whole plant have been used in food and traditional medicine for the treatment of infectious diseases. Many of these species showed high content of protein and oil with high percentages of fatty acids [1]. The extracts from different parts of the Chrozophora plants showed the presence of diterpenoids, triterpenoids, flavonoids and chromone glucosides, alkaloids, coumarins, chromones xanthones, diterpenoids and phenylpropanoid glycosides. However, there are many investigations showed this genus have antimicrobial, anticancer and antioxidant, antiplasmodial, antidiabetes, and anthelmintic property agents, and phytotoxic activity. Chrozophora oblongiflia one of Chrozophora genus plants. The plant is found in the sandy land of North Kordofan State, Sudan at gum Arabic belt. Seeds of the plants are grazed by sheep and camels. The biological activity of the Chrozophora plants received increased attention to discover new leading compounds for treatment of diverse ailments [2,3]. In 1995 study was conducted at Safiola company-Sudan to screening the seed oil characteristics. Results were 0.29 moisture, 2.7 free fatty acid, peroxide value, 102.9 iodine value (close to cottonseed and rapeseed oils), linoleic the dominant fatty acid (resembling corn and sunflower oils) and 4.5 red 47 yellow color. Also the trace metals contents were within the normal limit and its refining and bleaching behavior was very similar to other normal vegetable oils. Thus the industrial potentialities of argassy oil need to be explored. The seeds of the plant are of high protein content Therefore exploitation of argassy seed as Alternative source of proteins and oil should be of concern, so the aim of present work is to analyze chemical composition of seed and fatty acid profile of seeds oil of Chrozophora oblongifolia plant.

Materials and Methods
Plant Materials
The fresh seeds of Chrozophora oblongiflia were collected from two different locations i.e. West and North Kordofan States, Sudan. The plant materials were air-dried in the laboratory and then ground into powder form with mortar sieved and then stored in air tight bottles. The oil was extracted by soxhlet apparatus using hexane as a solvent.

Chemical Composition of Seeds
Chrozophora oblongiflia plant seeds and cake were analyzed for moisture and crude protein, ash, crude fiber and fat contents according to the AOAC methods [4,5]. The carbohydrates content were calculated by subtraction.

Physicochemical Analyses of Seed Oil
The viscosity was recorded using an ostwald-U-tube viscometer according to Cocks and Van Rede (1966) [6]. The free fatty acids, acid value,

iodine value, peroxide value, saponification value, unsaponifiable matter was determined according to AOAC methods [4]. Ester value was calculated as a different between saponification value and acid value.

Fatty Acid Analysis

Fatty acids composition of the oil samples were analyzed by gas Chromatographs-Thermo quest -Trace GC equipped with split/split less injection – with flame ionization detector with advanced software (Chromcard-32 bit Ver. 1.06 October). Fatty acid methyl esters was analyzed on a Chemito G.C. 8610 gas chromatograph equipped with flame ionization detector and capillary column B P × 70 (50 m × 0.32 mm × 0.25 µm films Identification of the peaks was performed by comparing retention times with those of genuine standards analyzed under the same conditions.

Results and Discussion

Proximate Analysis of Chrozophora oblongifolia Seeds

The results showed that moisture, oil, protein, fiber, ash and carbohydrates of North Kordofan seeds were obtained 5.19, 41.7, 20.69, 22.12, 1.73 and 11.13%, respectively, while the West Kordofan seeds were 3.89, 40.03, 20.5, 21.23, 1.18 and 10.61%, respectively (table 1). These statistical analysis explained that no significant ($p \leq 0.05$) different found among different samples in protein, fiber, ash and carbohydrates, while there were significant ($p \leq 0.05$) variations were found between North and West Kordofan in moisture and oil contents. The values of protein and oil were not in agreement with Hussein et al., (2006) who recorded values of 38.5% for oil and 26.2% for protein, also that of Ahmed (2014) who reported a value of 42.9% for oil and 18% protein [1,7].

Table 1: Proximate analysis of two varieties samples for Chrozophoraoblongifolia seeds

Parameters	North Kordofan	West Kordofan
Moisture content %	(5.19)a ±0.38	(3.89)b ±0.26
Oil content %	(41.70)a ±0.65	(40.03)b ±0.60
Crude protein %	(20.70)a ±1.22	(20.50)a ±1.30
Fiber %	(22.12)a ±1.22	(21.23)a±0.88
Ash %	(1.73)a ±0.38	(1.18)a ±0.22
Carbohydrates%	(11.13)a ±0.58	(10.61)a ±1.16

*Each value is mean of three replicates ± standard deviation.
*Means not sharing same superscript letter are significantly different at $P < 0.05$ as evaluated by Duncan's Multiple Range Test.

Proximate Analysis of Chrozophora oblongifolia Seeds Cake

The results showed that moisture, oil, protein, fiber, ash and carbohydrates of North Kordofan seeds were obtained 3.36, 2.19, 26.1, 37.7, 4.33 and 26.3%, respectively, while that of West Kordofan seeds were 1.42, 5.97, 25.77, 37.44, 4.66 and 24.74%, respectively (table 2). The statistical analysis showed that there were significant ($p \leq 0.05$) variations between samples of the two different locations in moisture, oil content and carbohydrates, while protein, fiber and ash contents were statistically the same. The results also showed that there were significant ($p \leq 0.05$) differences found between crude seeds and seeds cake for the different two locations of Chrozophoraoblongifolia seeds. The cake demonstrated high content of protein 26.1%, carbohydrates 26.3% and fiber 37.7% in North Kordofan; therefore, the cake can be considered as a good nutritional source for feeding animals.

Table 2: Proximate analysis of Chrozophora oblongifolia seeds cake

Parameters	North Kordofan	West Kordofan
Moisture content%	(3.36)b ± 0.55	(1.42) a ±0.47
Oil content %	(2.19)b ±1.18	(5.97) a ±0.89
Crude Protein %	(26.1)a ±0.75	(25.77) a ±1.64
Fiber %	(37.7) a ±0.43	(37.44) a ±0.61
Ash %	(4.33) a ±0.48	(4.66) a ±0.49
Carbohydrates %	(26.3) a ±0.97	(24.74)b ±1.94

*Each value is mean of three replicates ± standard deviation.
*Means not sharing same superscript letter are significantly different at $P < 0.05$ as evaluated by Duncan's Multiple Range Test.

Physical Properties of Seeds Oil

The results of physical properties of Chrozophora oblongifolia seeds oil extracted were refractive index, density and viscosity of North Kordofan oil seeds were 2.21, 0.91 and 26.2, respectively and that of West Kordofan oil were 1.47, 1.41 and 28, 17, respectively (table 3). These values of North and West Kordofan seeds oil statistically not the same, while moisture contents of the two different locations statistically the same. The reading of its color was red 2.3 and yellow 2.6 of North Kordofan oil seeds, these values were differently than 3.2 red and 2.8 yellow from West Kordofan oil seeds, these results were indicated a clear intensive in yellow color, while red color was decreased. The refractive index of the oil was in the range of edible oils and also was in agreement with 1.467(25oc) reported by Hussein et al., (2006) [7].

The differences may be attributed to the differences in varieties, genetic factors, environment, ecology and harvesting conditions of the plant.

Table 3: Physical properties of Chrozophora oblongifolia seeds oil

Parameters	North Kordofan	West Kordofan
Moisture content %	(0.27) a ±0.04	(0.28) a ±0.03
Refractive Index	(2.21) a ±0.25	(1.47) b ±0.02
Density of oil g/ml	(0.91) b±0.00	(1.41) a ±0.45
Viscosity(poise)	(26.20) b±0.19	(28.17) a ±0.24
Color	2.3R, 2.6y	3.2R, 2.8Y

*Each value is mean of three replicates ± standard deviation.
*Means not sharing same superscript letter are significantly different at $P < 0.05$ as evaluated by Duncan's Multiple Range Test.

Chemical Properties of Seeds Oil

Acid value

Results obtained indicated that acid value of the oils ranged from 3.86 mg KOH/g oil for North Kordofan seeds oil to 1.8 mg KOH/g oil from West Kordofan seeds oil (Table 4). Analysis of variance revealed there were significant differences found between North and West Kordofan seeds oil. And these results were in agreement with the Sudanese standards who reported not more than (4.00 mg/g) for acid value of edible oil in Sudan.

Table 4: Chemical properties of Chrozophora oblongifolia seeds oil

Parameter	North Kordofan	West Kordofan
Free fatty acid%	(3.55)a ±0.58	(1.73)b ±0.47
Acid value mg/g	(3.86)a ±0.61	(1.8)b ±0.26
Peroxide value meq/Kg	(1.89) a ±0.20	(1.98) a ±0.28
Saponification mg/g	(186.60) a±3.37	(184.70) b ±3.57

Unsaponifiable matter%	(0.15) a ±0.09	(0.12) a±0.04
Iodine value g/100g	(106.60)b ±3.34	(114.47)a ±3.03
Ester value mg/g	(184.40)a ±3.43	(184.00)a ±2.90

*Each value is mean of three replicates ± standard deviation.
*Means not sharing same superscript letter are significantly different at P < 0.05 as evaluated by Duncan's Multiple Range Test.

Free Fatty Acids (FFA)

Results showed that the oil extracted from North Kordofan seeds oil had 3.5% free fatty acids and 1.73% for that of West Kordofan seeds oil (table 4). Significant (p ≤0.05) differences were found between the samples of the two different locations. The free fatty acids of the present findings were higher when compared with Hussein et al., (2006) who reported that between 0.76 - 0.82%ofC [7]. Brocchiana freshly extracted oil had low free fatty acid that increased due to differences species of this plant. On the other hands these results agreement for the study by Ahmed (2014) reported 2.66%. The low level of percent FFA in the seed oil suggests that the oil could be a good source of edible oil that can be stored for a long time without spoilage via oxidative rancidity [1].

Iodine Value

The results obtained showed that iodine values were 106.60g/100g for North Kordofan and 114.47g/100g for West Kordofan samples studied. The statistical analysis showed that there were significant (p≤ 0.005) differences were found between North and West Kordofan samples in iodine value. Iodine value was found to be lower than that reported by Hussein et al. (2006)120.28g/100g in Chrozophorabroc chiana seed oil and in agreement with groundnut oils mentioned by (Al-Kahtani, 1989) [7,8]. The results differ probably because of the different varieties, genetic, environment, ecology and harvesting conditions of the seed plant. The iodine value shown in table is the measure of the degree of unsaturation of the oil, and it is identity characteristic of native oil [9].

Peroxide Value

The results obtained indicated that the peroxide value of the sample procured from North Kordofan was 1.8 meq/Kg and that of West Kordofan was 1.98meq/Kg (table 4). Statistical analysis revealed that there were no significant (p ≤0.05) differences found between samples of the two different locations. The peroxide values (PV) in both samples were found to be higher than1.4meq/Kg oil recorded by and 0.97meq/Kg oil, these findings of the present results indicated low levels of oxidative rancidity of the oils and may suggest strong presence or high levels of antioxidant lead to the facts that the oils may not be easily susceptible to deterioration by those factors of oxidative rancidity [1,7,10].

Saponification Values

The Saponification values of the Chrozophora oblongifolia seeds oil from North Kordofan was 186.6 and from West Kordofan seeds oil was 184.7 mg KOH/kg oil (table 4). The statistical analysis showed that there were no significant (p ≤0.05) differences found between samples of the two different locations. Saponification value was found to be similar than that reported by Hussein et al, (2006)185.5mg KOH/g oil of Chrozophorabrocchiana seeds oil and for most vegetable oils [7,11,12]. Saponification values had been reported to be inversely related to the average molecular weight of the fatty acids in the oil fractions. Oil fractions with saponification values of 200 mg KOH/g and above, had been reported to possess low molecular weight fatty acids [9].

Unsaponifiable Matter

The results showed that the unsaponifiable matter for the samples collected from North Kordofan was 0.15% and that from West Kordofan was 0.12% (table 4). These results were higher than 0.06% for Chrozophorabrocchiana oil reported by Hussein et al, (2006) [7].

Ester Value

The results in table (4) showed that the ester values of samples procured North and West Kordofan oil were the same and found to be 184.40 mg KOH/g oil. These results were in agreement with 183 mg KOH/G OIL from groundnut oil reported by Belsare and Bande (2017) [13]. The high ester value of oils from the two different location of Chrozophora oblongifolia seeds oil indicated the presence of high amounts of esters and low molecular weight fatty acids count.

Fatty Acids Profile

Fatty acids profile of Chrozophora oblongifolia seed oil is formed by a mixture of saturated (SFAs) and unsaturated (UNFAs) fatty acids classified according to the number of unsaturated bonds as monounsaturated (MUFAs) or polyunsaturated fatty acids (PUFAs).

Saturated Fatty Acids

The results showed that the total methyl ester of fatty acids (FAMEs) were palmitic and stearic acid and by followed arachidic acid was found to be a predominant of saturated fatty acids (SFA) in the majority of Chrozophoraoblongifolia samples (table 5). The values of North Kordofan seeds oil for palmitic, nonadecylic, arachidic, and behenic acid that were 17.89, 2.96, 2.41 and 0.92%, respectively, these results slightly higher than 13.60, 0.27, 2.27 and 0.34%, respectively found for West Kordofan seed oil, while stearic 12.69% and margaric acid 1.11% for North Kordofan were lower than 42.01% and 1.62%, respectively for West Kordofan seeds oil. In fact some studies have reported various impacts of SFAs on the human health and it has been concluded that lauric acid (C12:0) as well as myristic acid (C14:0) raise plasma total cholesterol concentrations, on the other hands, myristic (C14:0) and palmitic acids (C16:0) affected this ratio only little and stearic acid (C18:0) slightly reduced this ratio [14].

Table 5: Fatty acids composition of North and West Kordofan Chrozophoraoblongifolia seeds oil (%)

Fatty acids	North. k seeds oil	West. K seeds oil
Caproic C6:0	0.05	0.01
Caprylic C8:0	0.21	0.09
Pelargonic C9:0	0.17	0.03
Capric C10:0	0.01	0.01
Undecylic C11:0	0.02	0.01
Lauric C12:0	0.06	0.06
Myristic C14:0	0.04	0.02
Pentadecylic C15:0	0.07	0.05
Palmatic C16:0	17.89	13.60
Margaric C17:0	1.11	1.62
Stearic C18:0	12.69	18.90
Nonadecylic C19:0	2.96	0.27
Arachidic C20:0	2.41	2.27
Behenic C22:0	0.92	0.34
TricosylicC23:0	0.14	0.06
Lignoceri acid C24:0	0.52	0.16

Pentacosylic C25:0	0.07	0.01
Cerotic C26:0	0.08	0.02
Palmitoleic acid C16	0.67	0.76
Oleic acid C18	22.33	18.36
Linoleic acid C18	32.01	42.01
Linolenic acid C18	1.06	0.60
Other acids	4.51	0.74
Saturated fatty acid	43.93	38.27
Unsaturated fatty acids	56.07	61.73
Mono unsaturated	23	19.12
Poly unsaturated	33.07	42.91

Unsaturated Fatty Acids

The investigated of oil extracted showed the highest proportion of MUFAs or PUFAs in their FAMEs composition. In general, the results obtained showed that unsaturated fatty acids were 56.07% in North Kordofan and 61.73% for West Kordofan. In both samples the Poly unsaturated fatty acids (PUFAs) were found to be high amount percentage 33.07% North Kordofan and 42.91% in West Kordofan. Linoleic acid (LA, C18:2, n-6) was most abundant PUFAs in all both samples. Oleic acid (C18:1, n-9) was found as the greater percentage MUFAs in North and West Kordofan samples. These results are in good agreement with that reported by Hussein et al., (2006) who reported linoleic acid as the most dominant fatty acid followed by oleic, stearic and palmitic acids [7,15,16].

Conclusions

This study investigated the nutritional value and potential of Chrozophoraoblongifolia seeds as a source for edible oil. The results concluded that seeds contain high amounts of protein, oils and carbohydrates; therefore it's have a potentiality to be utilized as new vegetables oil. The proteins concentration of seeds have a great probability to serve as cheap source of edible protein. The oil of seed investigated in present work have a high some fatty acids profile such as palmitic, arachidic, oleic and linoleic acids.

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