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Fatty Acid Profiles and Vitamins and Chemical properties of *Acacia tumida, Acacia torulosa* and *Acacia elacantha Seeds*

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Abstract

The study investigated the chemical properties, fatty acid profile and vitamin content of Acacia seeds using the method of analysis of official analytical chemists (AOAC methods), gas chromatography and high performance liquid chromatography, respectively. The acid value and iodine value ranged from 23.3 to 53.2 g KOH / kg) and 1522.8 to 1878 g iodine / kg, respectively. Stearic and olic acid were the dominant fatty acids in the samples, whereas eicosenoic acid (C20:1) was highest in both A. elacantha and A. tumida.. Tocopherol ranged from 724 – 897 mg / kg, whereas α- and β- carotene and cryptoxanthin ranged from 965 to 1724, 974 to 1919, 650 to 2286 µg / 100g, respectively. Pyridoxine, thiamine, folate, niacin and ascorbic acid (µg / 100g)ranged from 109 - 301, 88 – 223, 41 – 91, 53 – 109 and 77 – 250, respectively. The Acacia oils compared well with conventional oil and the seeds are nutritious.

Keywords: Acacia seeds, Carotenoids, Iodine value, Polyunsaturated fatty acids, Vitamins

1. Introduction

The severe drought of 1973 drew the attention of the world to the plight of the population living in the Sahel region of Africa spanning from Senegal to Ethiopia. A. colei was identified by Thomson in his study travel through West Africa and called attention to the food potential of the plant. Since then, the faith based Serving-in-Mission (SIM) has introduced some Australian Acacia species to ameliorate the situation. A. colei is an ideal crop for the Sahel because it germinates easily, has a high survival rate after transplanting, has rapid early growth even under difficult conditions and on a wide variety of soils from pure sand to heavy clay [1].

It thrives on wasteland and hardpans, where regular crops cannot be grown, because of its extensive shallow root system. A. colei is an early and heavy seed bearer with two and three year old trees producing up to 6 kg of seed with under 400 mm of rain while two year old trees produced up to 3.5 kg of seed with only 296 mm of rainfall [2]. In addition, seed ripening occurs within a 4-week period [3].

Despite these attributes, A. colei gave poor results when sown directly into the soil but raising A. colei through a nursery would increase the cost of production for the poor farmers. In addition, the shrub produces pods that shatter when dry broadcasting its small seeds. A. torulosa, on the other hand, is much more suitable for direct sowing making it more cost effective to establish.

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High survival rates were recorded for A. torulosa and its mature plants in Niger Republic showed no signs of stress and carried a heavy seed crop after a low rainfall year. A. torulosa can produce medium sized poles, eagerly sought after for local building tasks and responds well to pruning either at ground level or at one meter to provide the much needed firewood for personal use or for sale. Furthermore, this specie has large seeds, which give it several advantages over those of A. colei for processing, namely, ease of harvest, ease of removing seeds from the pods and ease of separating the flour (germ) from the seed coat.

A. elacantha has a good growth rate and higher seed yields than A. colei, but it has a long ripening period and also a tendency to shatter. A. elacantha is a vigorous tree producing a lot of biomass and strong poles 3 - 4 m in length.

A. tumida has grown well in Niger Republic but needs slightly higher rainfall conditions to thrive; the tree may grow rapidly but fail to set seed during the low or inconsistent rainfall year. It has large seeds which are easy to harvest and better balanced nutritionally than A. colei seed [4]. Early research and development effort has focused on A. colei but the attributes of these other Acacia species and the constraints encountered in A. colei have shifted research, development and domestication efforts from A. colei towards the former. Seeds of A. torulosa, A. elacantha and A. tumida grown around Maradi, Niger Republic have been harvested for several years and stored in a seed bank prior to its distribution to farmers.

The chemical composition and nutritional value of A. colei have been studied and reported [5,6,7,8] but not much work has been done on A. torulosa, A. elacantha, and A. tumida grown in Maradi, Niger Republic. The aim of the present study is to investigate some of the chemical and nutritional parameters of these species of Acacia being trialled in the Sahel region with a view to picking the best species suited for each ecological zone within the region as well as serve the needed food security during drought and famine.

2. Materials and Method

Source of Samples and Preparation: Seeds of *A. tumida, A. elacantha, and A. torulosa* (harvested in year 2002 and 2006) planted around Maradi, Niger Republic were supplied from the main store at Danja, by Maradi Integrated Development Project (MIDP) Project Director, Maradi in 2010. The seeds were cleaned by removing stones, fragments of wood and resinous matter by hand and milled in a locally fabricated mill (Lawood Metals, Osogbo, Nigeria). The milled samples were sieved using a local sieve (aperture size of 0.6 mm) to remove the coarser fragments of the seed coat. The success of this process depends on how finely the seed have been milled. All the samples were milled as one batch, mixed thoroughly and sub- samples randomly taken from different parts of each milled sample, mixed together and stored in the freezer until analyzed.

2.1 *Methods*

The oils content of the samples were extracted with hexane using soxhlet extraction method [9]. The chemical parameters of the extracted oils were analysed using Association of Official Analytical Chemists' methods [AOAC 936.16; AOAC 920.158 and AOAC 936.15 for acid value, iodine value and saponification value, respectively].

2.2 *Determination of Fatty Acid profile*

The fatty acid profile of the oil samples was determined by the AOAC method 965.33 [9] using Agilent 6890 gas chromatograph (Hewlett-Packard, Sunnyvale, CA, USA) equipped with an on-column automatic injector, flame ionization detector, HP-88 capillary column (100 m x 0.25 µm film thickness) and a Chemstation software. The samples were re-dissolved in dry Chloroform / methanol (19:1, v/v) and clarified by centrifugation then 0.1mL aliquot was withdrawn for transmethylation using 0.3 mL of 14% BF_3 in methanol in a 2-mL Teflon lined screw-cap vial which was heated in a boiling water bath for 15 min. After cooling and addition of 0.3 mL of water, the transmethylated fatty acids were extracted into hexane. Aliquots of the hexane phase were taken for gas chromatographic analysis.

The operating conditions. The carrier gas is helium and the injector temperature was set at 250^{o} C, detector temperature at 280^{o} C and the temperature was programmed by setting the initial temperature at 175^{o} C, allowed it to raise to 220^{o} C at a rate 2^{o} C / min and was then held at 220^{o} C for 20 min.

The fatty acid methyl esters were identified by comparing their retention times to those of known standards (nonedecanoic acid) and quantified using the principle of internal standardization. The coefficient of variation for the method was less than 4 %.

2.3. *Determination of Pro-Vitamin A (Carotenoids)*

Carotenoid content of the samples was determined by AOAC method 970.64 [9]. The sample extraction and treatment of the extracts were carried out as previously described [9]. The absorbance of each the fraction was scanned between 350 and 530 nm using a spectrophotometer (Pye Unicam Ltd, UK). The concentrations of the carotenoids (α- carotene; β-carotene and cryptoxanthin) were calculated using the following extinction coefficients: α- carotene (2640); β-carotene (2480); and cryptoxanthin (2460) as described by Klein and Perry [10]. The retinol equivalent was calculated by converting each of the carotenoids to international unit (I.U) by assuming that 1.2 µg α- carotene, 0.6 µg β-carotene, and 1.2 µg cryptoxanthin were equivalent to 1.0 I.U. [11] and then the values were added together.

2.4 *Determination of Total Tocopherol*

The total tocopherol content of the oil sample was determined by the spectrophotometric method of Contreas-Guzman and Strong [12] using bathocuproine (Sigma) as the complexing agent for colour formation with α-tocopherol (Sigma) as a standard. All solvents used for the extraction and subsequently assay were purified and re-distilled as previously described [12]

2.5 *Determination of Water Soluble Vitamins*

The water soluble vitamins were determined by HPLC equipped with UV detector [Agilent Technologies Model 1200, Germany] [13] with slight modifications as described below.

Chromatographic conditions. The reverse phase HPLC was used for this analysis while the chromatographic separation column consisted of a stainless steel (4.6 × 150 mm) Eclipse XDD, 5 µm mbondapack C_{18} column. The HPLC had an integrated UV detector which was set at 254 nm wavelength to monitor the column effluent. The mobile phase comprised of 0.01M sodium monohydrogen phosphate and HPLC grade methanol in ratio 9:1. The elution was conducted isocratically at a flow rate of 0.60 mL / min. The other procedures were as reported earlier [13].

3. *Statistical analysis*

Results were expressed as mean and standard deviation of triplicate analysis. Data were subjected to one-way analysis of variance to determine the levels of significant difference by performing a multiple comparison post test (Turkey) using GraphPad Instat version 3.06 for windows. The data were considered significant at $p < 0.05$.

4.*Results and Discussion*

4.1. Chemical properties of the oil samples

The chemical properties of the oil samples are presented in Table 1. The ether extract that provides information on the level of lipid was between 12.3 ± 0.8 and 18.2 ± 0.2 % for *A. torulosa* 2002 and *A. elacantha*, respectively. The value reported here for *A. tumida* compared favourably with 12.6 % reported for *A. colei* [14].

The acid value and percentage free fatty acid (FFA) provide information on the storage quality of vegetable oil. For example, FFA is more susceptible to lipid oxidation compared to intact fatty acids in triacylglycerol. Therefore, the higher the values of these two parameters in vegetable oil, the lower the shelf-life. These parameters are presented in table 1. Acid value varied between 23.3 ± 1.6 and 53.2 ± 0.04 g KOH/ Kg oil. These values were higher than 10.2 and 15.1 g KOH/ Kg oil reported earlier for *A. tumida* and *A. colei* seed oil, respectively [14]. These values were also higher that 0.8 g KOH / kg and 1.4 g KOH / kg reported for groundnut oil and sunflower oil, respectively [14,15]. The implication of this is that these *Acacia* seed oils will easily deteriorate compared with the conventional oils given above, hence most be adequately processed to reduce FFA and acid values if the oils are to be stored for long. For vegetable oil to be suitable for cooking, its acid value must not be higher than the recommended value of 3.00 g KOH / kg oil [16]. Hence, these *Acacia* oils must be processed to bring the acid value below this recommended value for them to be suitable for cooking. In addition to the above short

comings of these oils, the *Acacia* oils will also not be suitable for the production of biodiesel. This is because the large amount of the FFA in the oils will undergo a saponification reaction with the alkaline solution used in the transesterification leading to the production of soap which will make the separation of biodiesel from the soap formed difficult.

Iodine value (IV) is a measure of the degree of unsaturation of a given vegetable oil. This parameter is presented on Table 1. The iodine value varied between 1522.8 ± 0.8 and 1878.1 ± 1.2 g iodine / kg for *A. torulosa* 2006 and *A. tumida*, respectively. The IV of all the samples analyzed were higher than 1093 ± 85 g iodine / kg recorded for groundnut a conventional oil [14]. This shows that these *Acacia* oils will be richer in polyunsaturated fatty acids (PUFA) than groundnut. Oils rich in unsaturated fatty acids have been reported to reduce heart diseases linked to cholesterol [17]. These results showed that *Acacia* oils could be better that groundnut oil from nutritional view point. Among the *Acacia* oils, *A. tumida* was superior to others as a source of PUFA. Because of the high iodine value, these *Acacia* oils will not be suitable for the production of biodiesel. The high iodine value will make the oil viscous due to polymerization which can lead to a low degree of atomization [18]. The high iodine value also implies that these oil samples will have drying property which will make them suitable for use as vehicle for paint in coating industries [19].

Saponification value is a parameter that indicates the suitability or otherwise of vegetable oil for the production of soap. This parameter is presented in Table 1. The value ranged from 201.1 to 218.9 g KOH/kg for *A. torulosa* 2002 and *A. tumida*, respectively. The saponification value reported here for *A. elacantha* and *A. torulosa* agreed favourably with 201.7 and 198.0 g KOH / kg oil reported earlier for *A. colei* oil and groundnut oil (a conventional oil), respectively [14]. On the other hand, the value reported here for *A. tumida* was higher than 202.2 g KOH / kg oil reported earlier for the same oil [14]. The saponification values of these *Acacia* oils compared well with palm oil (196 – 205 g KOH / kg oil), olive oil (185 – 196 g KOH / kg oil), soya bean oil (193 g KOH / kg oil), cottonseed (193– 195 g KOH / kg oil), butter (220 – 233 g KOH / kg oil) and linseed oil (193 – 195 g KOH / kg oil) [20]. This indicated that the oil of *Acacia* seed could be used as a substitute for these conventional oils in soap making. The high saponification value suggested a preponderance of high molecular weight fatty acids [21].

A sample of chromatogram of the fatty acid profile of the *Acacia* seed oil is provided in Figure 1 while the results of the fatty acid profiles are presented in Table 2. The result showed that total saturated fatty acid (SFA) ranged between 26.16 and 29.86 % of the total fatty acid in the samples. It was also observed that the total SFA in all these samples were similar. Stearic acid was the dominant saturated fatty acid (13.74 to 17.03 %), followed by myristic acid (9.45 to 12.8 %) while palmitic acid was detected only in *A. elacantha*. The total monounsaturated fatty acids (MUFA) differed marginally in all the samples analyzed. The results of monounsaturated fatty acid indicated that palmitoleic acid was not present in *A. torulosa* but was obtained in trace amount in *A. elancantha and A. tumida* which agreed favourably with 0.30 % reported for *A. colei* [5]. Oleic acid was the predominant MUFA in *A. torulosa* (15.32 and 17.7 %) whereas eicosenoic acid (C20:1) was the highest in *A. elacantha* and *A. tumida* (15.49 and 14.02 %). The total polyunsaturated fatty acid (PUFA) in all the samples was similar with the exception of *A. torulosa* 2002 that was marginally lower (Table 2). The PUFA varied between 52.27 and 58.38 %. The preponderance PUFA in all the samples was linoleic acid, an acid believed to be responsible for the *de novo* synthesis of icosanoids, whose function is to militate against dysfunction of cardiovascular, renal, reproductive, gastro-intestinal and immune systems [21]. The next in order of abundance was eicosatrienoic acid (C20:3) while docosahexaenoic acid (DHA) was 2.02 and 1.80 % in *A. elancantha and A. tumida*, respectively. The benefits of this fatty acid and eicosapentaenoic acid (EPA) (C20:5) have been well documented to include anti-atherogenic, anti-thrombotic, anti-inflammatory effects and reduction in the risk of coronary health diseases [22]. Other PUFAs were present in trace amounts in all the samples.

It has been suggested that the appropriate proportions of the total saturated, total monounsaturated and total polyunsaturated fatty acids (S: M: P) are 1:1:1 [23].

The S: M: P ratios obtained in this study were 1.7:1:2.9, 1.7:1: 3.4 and 1.9:1:3.8, for *A. torulosa, A. elacantha* and *A. tumida* oils, respectively which were higher than Food and Agricultural Organization (FAO) recommendation. The beneficial effects of PUFAs depend on the ratio of the omega-6 (n-6) fatty acids to omega-3 (n-3) fatty acids. It is generally accepted that the ideal proportion of n-6 to n-3 fatty acids is about 4:1, while the World Health Organization recommended a range of ratio 5:1 to 10:1 [24]. The ratio observed for *A. torulosa* was 27:1 while that of *A. elacantha* and *A. tumida* was 20:1 apiece. Although none of the *Acacia* oils analyzed contain ideal ratio of n-6 to n-3, but the combination of *Acacia* seed oil with oils rich in omega 3 such as cod liver oil will bring these oils to the required ratio.

The studies by Millar *et al*., [25] (1987) observed that the oil containing high UFAs / SFAs ratios are thermodynamically more stable and may be heated to high temperatures. Hence these *Acacia* oils are also expected to be thermodynamically stable when heated at high temperature.

4.2 *Vitamins*

The vitamins content of these samples are presented in Table 3. The total tocopherol also expressed in vitamin E equivalent is believed to protect heart against oxidative stress related diseases [26]. This vitamin ranged between 724 and 897 mg/kg (160 and 199 I.U.). This range agrees with total tocopherol range reported earlier for some *Acacia* species (563 to 808.76 mg/kg) [27] The total tocopherol reported in this work was higher than what was reported for some other vegetable oils like grape seed (142.6 mg/.kg) olive (216.8 mg/ kg), flaxseed (588.5 mg / kg), peanut (398.6 mg / kg), pumpkin (508.1 mg/.kg), rapeseed (624.6 mg / kg), and sunflower (634.4 mg/kg) but lower than soybean (1797.6 mg / kg) and maize (1618.4 mg/kg) [28] The recommended daily intake (RDI) for this vitamin is between 8 and 10 mg / day. About 14 g of *A. tumida* which recorded the least level of this vitamin will provide the RDI of the vitamin. This shows that these *Acacia* samples are good sources of this vitamin.

4.2.1 Vitamin A. The vitamin A precursor (α-carotene and β - carotene) and a non-vitamin A precursor (Cryptoxanthin) are carotenoids known to be involved in immune-enhancement, treatment and prevention of cancer and reduction of morbidity and mortality in children of the third world [29]. The ranges of these carotenoids are 965 to1724, 974 to 1919 and 650 to 2286 µg / 100g for α-, β- carotene and cryptoxanthin, respectively while the retinol equivalent ranged from 3293 to 5443 I.U. The carotenoids obtained in this study were lower than 2200 to 4900 and 4600 to 10300 µg / 100g for α-carotene and β-carotene, respectively obtained for 19 cultivars of carrots [29]. The values were on the other hand, higher than those reported for β-carotene in red chillies (0.47 mg/100 g); tomatoes (0.37 mg/100 g) and lettuce (0.10 mg/100 g) [30].

4.2.2 Pyridoxine. The pyridoxine content of these samples varied between 109 ± 0.8 and 301 ± 4.2 µg /100 g for *A. torulosa* 2002 and *A. tumida*, respectively. Year of harvest seemed to affect the level of this vitamin in *A. torulosa*. The seed harvested in 2006 was about 50 % higher in pyridoxine compared to the seed harvested in 2002. The difference could be due to climatical conditions that played out between the planting time and the time of harvest.

*4.2.3 Thiamine (vitamin B_1).*This vitamin ranged between 88 ± 1.0 and 223 ± 5.0 µg /100 g for *A. elachantha* and *A. tumida* respectively. The *A. torulosa* harvested in 2006 was 3 % higher in thiamine compared to the seed harvested in 2002. When effect of harvesting period on this vitamin was compared with that of pyridoxine, thiamine seemed to be able to withstand the weather conditions than pyridoxine. The range of this vitamin was within the range of 17 to 296 µg /100 g reported for starchy carbohydrate roots and tubers [31]. The RDI for thiamine are 1.1 mg / day for men of 19 – 64 years old and 0.8 mg / day for women of the 19 – 54 years old [32]. Using the requirement for men, 1375g of *A. elachantha* which gave the least value for this vitamin will be needed to supply the RDI while 493 g of *A. tumida* will be required to provide the RDI of this vitamin. The shows that *A. tumida* is a good source of this vitamin. On the other hand, about 598 to 618 g *A. torulosa* will be required to provide the DRI of this vitamin.

4.2.4 Folate. The folate content of these samples varied between 41 ± 1.4 and 91 ± 2.8 µg /100 g. The

folate content of *A. torulosa* 2006 was 33 % higher than *A. torulosa* harvested in 2002. As observed with pyridoxine, folate could also be affect by climatical conditions between the periods of planting to harvesting.

4.2.5 Niacin. Niacin is a vitamin known to be incorporated into the nicotinamide adenine dinucleotides to form enzymes that are involved in the electron transfer reactions of the respiratory chain as well as those involving oxidative phosphorylation. Niacin content of these samples ranged between 53 ± 0.9 and 109 ± 6.0 µg /100 g for *A. elachantha* and *A. torulosa* 2006, respectively. The year of harvest also seemed to affect the niacin content. The niacin content of *A. torulosa* 2006 was 37 % higher than that of *A. torulosa* 2002.

The RDI of 18 mg niacin equivalent / day and 15 mg / day for male and women, respectively for 35 -50 years old have been recommended [3].

To meet the RDI for niacin using *A. torulosa* 2006 with the highest niacin, 16,514 g of this *Acacia* oil will have to be injected which is not visible. This shows these *Acacia* seeds can't be *good* sources of this vitamin.

*4.2.6 Ascorbic acid.*Ascorbic acid well is known to help in the formation of collagen and in the prevention of scurvy. It acts as an antioxidant by preventing oxidative stress diseases [3] and also enhance mineral availability [7]. This vitamin ranged between Ascorbic acid 77 ± 0.67 and 250 ± 3.4 µg /100 g for *A. tumida* and *A. torulosa* 2006, respectively. *A. torulosa* harvested in the year 2006 was 18 % higher in ascorbic acid compared to the seed harvested in 2002. The recommended dietary allowance (RDA) for ascorbic acid is 60 mg per adult [3]. For this RDA to be attained, 24,000 g of *A. torulosa* 2006 that gave the highest level of this vitamin will have to be consumed. This shows that *Acacia* is not a good source for this vitamin.

Table 1. Chemical properties of A .tumida and A. elacantha and A. torulosa seed oils

Samples	*A. elacantha*	*A. tumida*	*A. torulosa* 2002	*A. torulosa* 2006
Ether extract (%)	18.2 ± 0.2^{a}	12.6 ± 0.4^{b}	12.3 ± 0.8^{b}	13.8 ± 1.2^{b}
Acid value (g KOH / kg)	45 ± 0.2^{c}	53.2 ± 0.04^{a}	49.5 ± 1.6^{b}	23.3 ± 1.6^{d}
% FFA (as Oleic acid)	22 ± 0.09^{c}	26.8 ± 0.07^{a}	24.8 ± 0.8^{b}	11.7 ± 0.8^{d}
Iodine value (g iodine / kg)	1648 ± 2.4^{b}	1878 ± 1.2^{a}	1624 ± 0.8^{c}	1523 ± 0.8^{d}
Saponification value (g KOH / kg)	203 ± 2.0^{b}	218.9 ± 1.6^{a}	201.1 ± 1.6^{b}	202.2 ± 1.4^{b}

Values are means of triplicate determination ± standard deviation of mean.;
Values in the same row with the same superscripts are not significantly different at the 5 % probability level.

***Table* 2.** Fatty acid profiles of *A. torulosa, A. elancantha, A. tumida* (as % of the total fatty acids)

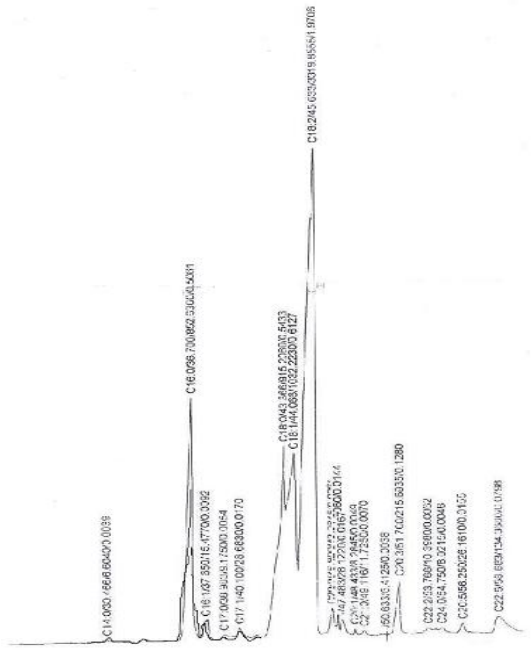
Fatty acids	*A. torulosa* 2002	*A.torulosa* 2006	*A. elancantha*	*A. tumida*
		saturated fatty acids		
C12:0	0.09	0.08	0.10	0.10
C14:0	9.93	9.45	12.80	11.09
C16:0	ND	ND	0.14	ND
C18:0	17.03	14.40	13.74	16.14
C20:0	1.23	1.10	0.66	1.36
C21:0	0.26	0.22	0.18	0.21
C24:0	1.30	0.93	0.12	0.28
Total SFAs	29.86	26.16	27.72	29.17

Mono unsaturated fatty acids				
C16:1	ND	ND	0.23	0.55
C18:1	17.70	15.32	0.430	ND
C20:1	0.16	0.14	15.49	14.02
Total MUFAs	17.87	15.46	16.28	14.68
Poly unsaturated fatty acids				
C18:2	46.61	52.82	49.83	49.79
C18;3	0.64	0.79	0.37	0.34
C20:3	3.21	3.02	3.24	3.34
C20:5	0.91	1.10	0.39	0.68
C22:2	0.61	0.48	0.16	0.20
C22:6	0.30	0.16	2.02	1.80
Total PUFAs	52.27	58.38	55.99	56.15
SMP ratio	1.7:1:2.9	1.7:1:3.7	1.7:1:3.4	1.9:1:3.8
n6:n3 ratio	27.4:1	27.5:1	19.5:1	20.6:1

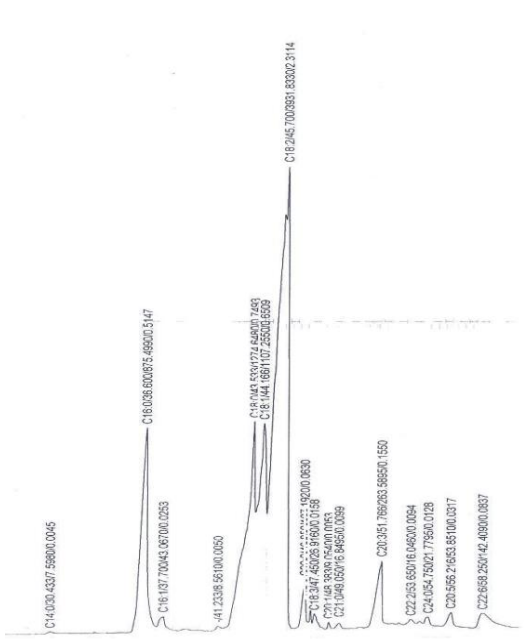
***Table* 3.** Vitamin content of *A. tumida* and *A. elacantha* and *A. torulosa*

Sample	***A. elachantha***	***A. tumida***	***A. torulosa* 2002**	***A. torulosa* 2006**
Total Tocopherol (mg/kg)	858 ± 0.7^{b} (190± 03) ^{b*}	724 ± 5.0^{b} (160±0.2) ^{d*}	835 ± 7.0^{c} (185±0.2) ^{c*}	897 ± 12^{a} (199 ±0.8) ^{a*}
Pro vitamin A Caroteniods (µg / 100 g)				
α- carotene	1332 ± 32^{b}	1364 ± 8.0^{b}	965 ± 18^{c}	1724 ± 1.4^{a}
β- carotene	1514 ± 10^{b}	1919 ± 5.0^{a}	974 ± 4.0^{d}	1051 ± 2.0^{c}
Cryptoxanthin	1022 ± 9.0^{b}	538 ± 15^{d}	650 ± 7.0^{c}	2286 ± 12^{a}
Retinol Equivalent (I.U)**	4989 ± 12^{a}	5422 ± 15^{a}	3293 ± 22^{c}	5443 ± 8.0^{a}
Water Soluble Vitamins (µg/100 g)				
Pyridoxine	176 ± 5.0^{c}	301 ± 4.2^{a}	109 ± 0.8^{d}	226 ± 4.0^{b}
Thiamin	88 ± 1.0^{c}	223 ± 5.0^{a}	178 ± 4.0^{b}	184 ± 2.2^{b}
Folate	41 ± 1.4^{d}	46 ± 1.8^{c}	61 ± 0.5^{b}	91 ± 2.8^{a}
Niacin	53 ± 0.9^{c}	62 ± 0.8^{b}	69 ± 1.0^{b}	109 ± 6.0^{a}
Ascorbic acid	196 ± 7.0^{b}	77 ± 0.67^{c}	204 ± 0.7^{b}	250 ± 3.4^{a}

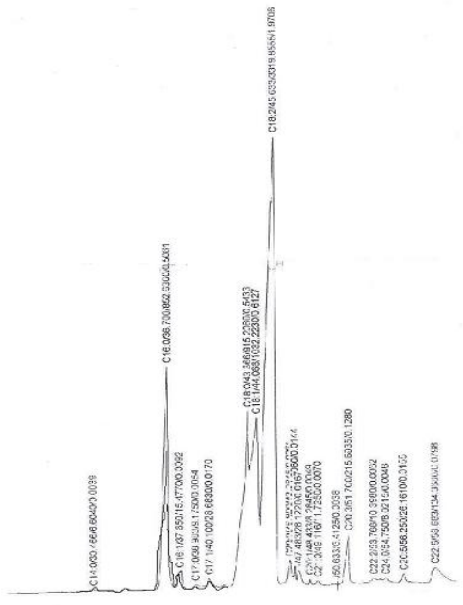
Values are means of triplicate determination ± standard deviation of mean.
Values in the same row with the same superscripts are not significantly different at the 5 % probability level.
* Vitamine E equivalent (IU)
** The retinol equivalent was calculated from the values obtained from the three carotenoids.



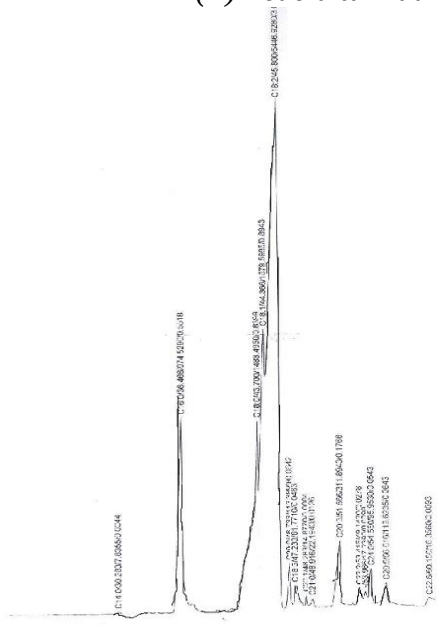
(A) Acacia elacantha



(B) Acacia tumida



(C) *Acacia torulosa* 2002



(D) *Acacia torulosa* 2006

Figure 1. Chromatogram of the fatty acid profile of (A) *A. elacantha* (B) *A. tumida* (C) *Acacia torulosa* 2002 and (D) *Acacia torulosa* 2006**.**

5. Conclusion

The high iodine value of these oils showed that the oils will not be suitable for the production of biodiesel but could be substitute for conventional oils in paint industry. The results also indicated that the *Acacia* seed oil could be used as a substitute for conventional oils in soap making. The chemical composition of *Acacia* seeds revealed the seeds to be nutritious and could be candidates for solving the problem of hunger in drought-stricken parts of Africa.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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