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RESEARCH ARTICLE

THE EVALUATION OF TUNDUB (CAPPARIS DECIDUAS PAX) SEED OIL AND ITS BLEND AS A PROMISING SOURCE OF EDIBLE OIL IN SUDAN

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ABSTRACT

This study was carried out to evaluate Tundub (*Capparis decidua* Pax) seed oil for different nutritional and industrial uses. The nutritional values were evaluated by measuring physicochemical properties, fatty acids profile and antioxidants of oil. The industrial value was evaluated by blending Tundub oil with sunflower oil for frying potato chips from oils in addition to sensory evaluation. The oil extracted from Tundub seeds has 1.485 refractive index, 21.34 cp viscosity, 0.91 relative density, 3.5% free fatty acids, 2.7meq/kg peroxide value (PV), 77.38 iodine value and 154.19 saponification value. The oil also contained the antioxidants and revealed the existence of unsaturated fatty acids in high quantities: oleic acid (50.69%), linoleic acid (13.5%) and arashidonic acid 1.89%, in addition to saturated fatty acids, palmitic acid (18.0%) and stearic acid (9.38%). Tundub oil was blended with refined sunflower oil in the ratio of 1:9. The blend and sunflower oil were used for frying potato chips at temperature of 160C° for a period of 1.5 hours, PV of each oil was determined every 15 minutes of frying time. In the end of period, sunflower oil had significantly ($p \leq 0.05$) higher PV (17.44meq/kg) than the blend oil (12.00meq/kg), also, oleic acid for blend oil had significantly higher (36.19meq/kg) than the refined sunflower oil. The panelists preferred the potatoes chips fried in blend oil.

INTRODUCTION

Capparis decidua or Tundub is a Sudanese plant widely distributed in North, South, East and West Sudan especially on sandy soils and low rainfall savanna on clays (El Amin 1990). It is also found in Blue Nile and Upper Nile (ELGazali*et al.*, 1987). In Latin, it is known as capparis derived from Kabar at capar (Bown. 2008). It is Belonging to the family cappuraceae. The plant usually grows in dry climate, shows strong climatic adaptation, often on foot hills and in waste lands. It is found in the deserts. The species are used for making pickle and number of other uses including medicinal, fuel wood and fodder. It is tolerant to high temperature, salt and drought stress and help in arresting wind erosion and improving the soil fertility (Mahla, *et al.,* 2013).*Capparis deciduas* is one of the important multipurpose woody species of desert and arid regions of the Indians sub continent, Africa and Saudi Arabia. It is an important constituent of desert ecosystems and plays a significant role in total economy of people of the arid regions.Besides many socioeconomic and ecological benefits, all parts of this plant has a number of medicinal properties (Mahla 2010).The natives of this region (arid) recognized the importance of this shrub long time ago (Singh and Ranjay. 2011).

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Fruit production increases as the plant get older, though there is a high variation in fruits yield and sometimes the older yield as high as 6- 8 kg fruit per tree during summer and winter seasons. It possesses diverse chemical constituents, which are of great nutritional and medicinal value and can be used as a potential food supplement (Chauhan*et al.,* 1986). Tundub has been used as a condiment for over 200 years and Verma et al (2011) mentioned Tundub fruits and flower buds are edible and are used in pickles since long time. The compositional studies indicated that *C decidua* seeds are rich sources of all three major food components carbohydrates (25.42 ± 0.26%), proteins (27.71 ± 1.39%), and lipids (29.11 ± 1.07%), therefore a proximate composition is index of total energy content in a food and its analysis usually is the first step when evaluating its nutritional potent (Muhammed et al . 2011) . The fatty acids composition are as follows: palmetic 21.1%, stearic 7.7%, myristic 0.6%, arachidic 2.0%, oleic 57.2% and linoleic 11.4%, the oil is rich in oleic acid and consists of 68.6% unsaturated fatty acids and 31.4% saturated fatty acids and suitable for both edible and non edible purposes (Anonymous. 2007). Moreover, γ-Tocopherol was found in highest amount in seed oil, while β-tocopheol was found in lowest amount. High amounts of tocopherols can be interesting for the stabilization of fats and oils against oxidative deterioration. Sterols are perhaps the most important class of the minor components and comprise a major portion of the unsaponifiable matter of most vegetable oils. The occurrence of Δ5-avenasterol in the seed oil is of interest because this

compound is known to act as an antioxidant and as an anti-polymerization agent in frying oils Muhammed *et al*, (2011). Fruit production increases as the plant get older ,though there is a high variation in fruit yield and sometimes the older tree yield as high as 6- 8 kg fruit per tree ,and tree is fruiting during summer and winter seasons.

Objectives

- Although, Tundub fruits are consumed in Sudan since long times ago, till now there is no specific research carried out to study the nutritional and industrial uses of the oil.
- To draw the attention of farmers living in areas rich in Tundob plant to the value of this plant and the appropriate methods obtaining valuable food products out of this plant.

Materials used in the study

After Collecting Tundub (*Capaarisdicedica*) fruits from Elsururab area, these were kept in plastic containers and stored at refrigerant temperature. Oil was extracted from Tundub seeds. Potatoes were brought from local market. Sunflower oil was brought from Arab Sudanese Vegetable Oils Company.

Tundub seed oil and frying operation

The Tundub oil was extracted from the Tundub seeds, the frying was carried out in stainless steel fryer; 4 Kg of potatoes were used for frying. Potatoes were cut into slices and were divided into two parts, one part was fried in sunflower oil and the second part in a blend of sun flower oil- Tundub seeds oil

Table 1. Physico-chemical properties and antioxidants activity of the Tundub seed oil

Item	Amount	Item	Amount
Refractive Index	1.466	Fry fatty acids	3.05 %
Viscosity	21.4231 cp	Peroxide value	2.46mg/Kg
Relative density	0.9067 g/ml	Iodine value	77.38
DPPH Tundub oil	16.00 %	Saponification value	154.19
DPPH Control PG	93.00 %	Unsaponifaible matter	1.33 %

Table 2. Free fatty acids profile of Tundub and sunflower oils

Oil	Oleic	Linoleic	Palmatic	Stearic
A	34.33^{d} ±0.01	53.70^{b} ±0.01	7.07^{d} ±0.01	4.90^{d} ±0.01
A_1	34.19^{e} ±0.01	54.16^{a} ±0.01	7.00^{e} ±0.01	4.65^{e} ±0.01
B	36.19^{b} ±0.01	50.44^{d} ±0.01	8.33^{b} ±0.01	5.05^{b} ±0.01
B_1	35.85^{c} ±0.01	50.99^{c} ±0.01	8.19^{c} ±0.01	4.99^{c} ±0.01
C	50.69^{a} ±0.01	13.51^{e} ±0.01	18.01^{a} ±0.01	9.38^{a} ±0.01
$Lsd_{0.05}$	0.0005753^{*}	0.0005753^{*}	0.0005753^{*}	0.0005753^{*}
SE±	0.0001826	0.0001826	0.0001826	0.0001826

Any two mean value(s) sharing different superscript(s) in a column are significantly different (P≤0.05) according to DMRT.
A ≡Sunflower oil at zero time
A_1 ≡Sunflower oil at 90 minutes.
B ≡ Mix oils (sunflower and Tundub) at zero time.
B_1 ≡ Mix oils (sunflower and Tundub) at 90 minutes.
C ≡ Tundub oil at zero time

Table 3.The physico-chemical characteristics of frying oil

Frying time (min.)	Peroxide value (mEq/kg)		Free fatty acids (%)		Viscosity (c.p)		Density		Refractive index	
	M	P	M	P	M	P	M	P	M	P
0	0.99^{e} (±0.01)	3.01^{de} (±0.01)	3.79^{a} (±0.22)	3.04^{b} (±0.93)	19.90^{c} (±0.13)	20.36^{ab} (±0.16)	0.9181^{a} (±0.00)	0.9159^{e} (±0.00)	1.472^{b} (±0.00)	1.471^{c} (±0.00)
15	5.01^{cd} (±0.04)	5.53^{cd} (±2.15)	3.8^{a} (±0.21)	3.66^{ab} (±0.05)	20.49^{ab} (±0.09)	20.50^{ab} (±0.06)	0.9181^{a} (±0.00)	0.9141^{f} (±0.00)	1.472^{b} (±0.00)	1.472^{b} (±0.00)
30	5.48^{cd} (±0.74)	10.56^{b} (±0.78)	3.53^{ab} (±0.20)	3.52^{ab} (±0.21)	19.90^{c} (±0.11)	20.49^{ab} (±0.46)	0.9168^{d} (±0.00)	0.9158^{e} (±0.00)	1.472^{b} (±0.00)	1.472^{b} (±0.00)
45	5.97^{c} (±1.38)	6.25^{c} (±1.11)	3.68^{ab} (±0.01)	3.94^{a} (±0.02)	20.44^{ab} (±0.07)	19.85^{c} (±0.24)	0.9179^{ab} (±0.00)	0.9160^{e} (±0.00)	1.472^{b} (±0.00)	1.473^{a} (±0.00)
60	7.01^{c} (±0.07)	12.51^{b} (±2.09)	3.93^{a} (±0.03)	3.93^{a} (±0.38)	20.20^{bc} (±0.05)	20.53^{ab} (±0.05)	0.9171^{cd} (±0.00)	0.9158^{e} (±0.00)	1.472^{b} (±0.00)	1.473^{a} (±0.00)
75	5.97^{c} (±0.04)	16.92^{a} (±1.46)	3.66^{ab} (±0.05)	4.08^{a} (±0.20)	20.41^{ab} (±0.10)	20.47^{ab} (±0.00)	0.9173^{bcd} (±0.00)	0.9157^{e} (±0.00)	1.472^{b} (±0.00)	1.473^{a} (±0.00)
90	12.00^{b} (±1.51)	17.43^{a} (±0.76)	3.80^{a} (±0.18)	3.78^{a} (±0.20)	20.73^{a} (±0.15)	20.53^{ab} (±0.14)	0.9176^{abc} (±0.00)	0.9157^{e} (±0.00)	1.472^{b} (±0.00)	1.473^{a} (±0.00)
$Lsd_{0.05}$	2.45^{**}		0.6205^{*}		0.3589^{*}		0.0006782^{*}		0.0006782^{*}	
SE±	0.8078		0.2145		0.1183		0.0002236		0.0002236	

Mean±SD values having same superscript within columns and rows (for each parameter) are not differ significantly (P≤0.05) according to DMRT.
P = Pure sunflower oil
M = Sunflower oil mixed with Tundub oil (9 – 1).

as 9-1 ratio respectively, frying was carried out for different periods (15, 30, 45, 60, 75 and 90 minutes). Thermostat control was used for measuring temperature at 160 °C; Samples were cooled and stored until required for analysis.

METHODS

The Refractive Index (RI) was determined by abbe 60 refracto meter as described by AOAC methods (2008). The viscosity of the oil samples was recorded using an Ostwald-U-tube viscometer according to Cocks and Van Rede (1966). The oil density was determined according to AOAC (2008) methods, using psycho-meter. The 2-2Di(4-tert-octylphenyl)-1pectyl-hydrazyl (DPPH) radical scavenging was determined according to the methods of Shimada et al (1992) using Propyl Gallate (PG) as standard. The Peroxide value (PV) of the oil samples was determined according to the AOAC methods (2008). The method used for determination of free fatty acids (FFA) was that of Cocks and Van Rede (1966). The iodine value of the oils, which quantifies their unsaturation level, was determined according to the AOAC methods (2008).The determination of saponification value (SV) was carried out according to the AOAC methods (2008). Fatty acids composition of oil were determined by gas chromatography apparatus (Py E-UNICAM model GCD) according to acid catalyzed method lipid technology 2.42-49 AOAC methods (2008).

Sensory evaluation analysis

Potatoes chips fried with two oils were organoleptically evaluated by the method described by Ihekoroney and Ngoddy (1985). Semi trained staff from National Food Research Center (NFRC), Sudan, Shambat, were asked to examine and evaluate samples by giving mark to attribute stated to them on evaluation forms in which highest mark was taken to represent the best sample in the respective attribute, while the lower mark was taken as the least in quality. Sum of marks were then statistically interpreted.

Statistical analysis

Data generated was subjected to Statistical Analysis System (SAS) Software. Means –SD were tested using One Factor Analysis of Variance (ANOVA) according to Steel and Torrie (1980), and the means separated using Duncans Multiple Test (DMRT) according to Duncan (1955).

RESULTS AND DISCUSSION

Table (1) shows the physical properties of Tundub seed oil, the results showed that refractive index, viscosity and relative density were found to be 1.466, 21.4231 and 0.9067, respectively.

Table 4. Sensory evaluation of potato chips

Frying time(min)	Color	Taste	Flavor	Appearance	Texture	Overall acceptability
	Scores					
15 M	6.69±1.03^{a}	6.23±1.24^{a}	5.69±1.38^{ab}	6.23±1.17^{abcd}	6.77±1.54^{a}	6.15±1.57^{a}
30 M	6.54±1.27^{a}	6.23±1.54^{a}	6.39±1.56^{ab}	6.31±1.32^{abcd}	6.15±1.68^{abc}	6.23±1.79^{a}
45 M	6.46±1.39^{a}	4.92±1.50^{a}	5.31±1.25^{ab}	6.39±1.19^{abc}	6.00±1.87^{abc}	5.62±1.71^{a}
60 M	7.23±0.83^{a}	5.92±1.32^{a}	6.62±0.65^{a}	7.00±1.00^{a}	6.69±1.32^{ab}	6.54±0.97^{a}
75 M	7.00±1.29^{a}	5.92±1.50^{a}	6.08±1.19^{ab}	6.69±1.25^{ab}	6.08±1.50^{abc}	6.23±1.36^{a}
90 M	6.92±1.38^{a}	5.77±1.30^{a}	6.00±1.15^{ab}	6.00±1.41^{abcd}	6.08±1.80^{abc}	6.08±1.50^{a}
15 P	6.39±1.98^{a}	5.08±2.22^{a}	5.15±2.03^{b}	5.23±1.83^{cd}	5.15±1.99^{bc}	5.23±1.74^{a}
30 P	6.85±0.99^{a}	5.77±1.59^{a}	6.08±1.26^{ab}	6.46±1.13^{abc}	5.77±1.54^{abc}	5.85±1.41^{a}
45 P	6.77±1.17^{a}	6.23±1.42^{a}	5.69±1.60^{ab}	5.92±1.44^{abcd}	5.62±1.76^{abc}	5.92±1.38^{a}
60 P	6.46±1.05^{a}	5.77±1.42^{a}	5.54±1.33^{ab}	5.00±1.91^{d}	5.46±1.61^{abc}	5.54±1.45^{a}
75 P	6.54±1.05^{a}	5.62±1.33^{a}	5.62±1.45^{ab}	5.46±1.66^{bcd}	5.08±1.61^{c}	5.54±1.81^{a}
90 P	6.15±1.63^{a}	5.54±1.85^{a}	5.46±1.98^{ab}	5.39±2.02^{bcd}	5.15±2.15^{bc}	5.62±2.10^{a}
$Lsd_{0.05}$	1.000	1.195	1.114	1.148	1.326	1.233
SE+	0.3579	0.4273	0.3987	0.4106	0.4745	0.441

Any two means score(s) bearing different superscript(s) are significantly different (P≤0.05).
M = Sunflower oil mixed with Tundub oil (9 : 1). P = Pure sunflower oil.

Table 5. Changes in peroxide values (mEq./kg) of groundnut butter affected by natural and artificial antioxidants.

Antioxidant	Time (days)				
	0	15	30	45	165
BLK	3.00^{m} ±0.11	8.00^{h} ±0.23	13.00^{g} ±0.56	24.00^{d} ±0.93	65.00^{a} ±4.91
MRN		7.00^{i} ±0.19	13.00^{g} ±0.56	20.00^{e} ±0.89	32.00^{b} ±1.18
TND		4.00^{l} ±0.13	8.00^{h} ±0.23	16.00^{f} ±0.78	26.00^{c} ±0.97
BHT		4.00^{l} ±0.13	5.00^{k} ±0.16	5.00^{k} ±0.16	6.00^{j} ±0.17
$Lsd_{0.05}$	0.8169**				
SE±	0.2573				

Values are mean±SD.
Mean(s) having different superscript(s) are significantly different (P≤0.05) according to DMRT.
BLK= Blank
MRN= Moringa Oil
TND= Tundub Oil

This result is in the range of the edible oils. Moreover, the refractive index in this study was similar to the result obtained by (Attila and Musa. 1999) for oil seeds of different cappers (Tundubs) species, but the result of relative density for previous oil seeds was ranged between 1.0840 – 1.1045. In Table (1) the chemical composition of Tundub seed oil showed, 3.05 %, 2.46 meq/kg, 77.38, 154.19 and 1.33 % as free fatty acids, peroxide value, iodine value, saponification value and unsaponifiable matter, respectively. The values for free fatty acids, iodine value and unsaponifiable matter were identical to the values recorded by (Anonymous. 2007), while the value for saponification was higher than the result obtained in this study, this may be due to the different in places and climates. The antioxidant activity of the oil of *C. deciduas* was evaluated using DPPH assays. Result is shown in Table 1.

Although the oil showed weak DPPH scavenging activity, but, previous study on *C. decidua* revealed that γ-Tocopherol was found in highest amount in seed oil, in addition to leaves, flowers and fruits have potent antioxidant activity, which are reducing different types of radicals as well as ferric reducing antioxidant power as mentioned by (Muhammed, 2011). . The most fatty acids found in Tundub seed oils were palmitic acid, palmitoliec acid, stearic acid, oleic acid, linoleic acid and arashidonic acid as, 18.01 %, 5.01 %, 9.3 %, 50.69 %, 13.5 % and 1.89 %, respectively (Table 7). These results agree with Anonymous, (2007). Fatty acid composition of Tundub seeds oils can be considered as an interesting point with regard to the further uses of the seeds for oil purpose, the oil was rich in unsaturated fatty acids and the important oleic acid. Saturated fatty acids were found with suitable amounts, in particular, palmitic acid. Unsaturated fatty acids were approximately 68 % of total fatty acids. Attila and Musa, (1999) mentioned that the fatty acid that was most determined in different species of cappers was oleic acid. Also, they said that the fatty acids composition of vegetable oils were affected by species, variety, breed, growth conditions, harvest and postharvest conditions so, by cultivating and breeding of Tundub trees regularly, a more productive and good quality raw materials would be obtained. Also, oleic acid is higher in Tundub oil while linoleic acid is higher in sunflower oil so, the mixed oil becomes rich with two fatty acids.

Table (3) shows the physico-chemical characteristics of two kinds of potatoes frying oils, sunflower oil and mixed oil (sunflower oil and Tundub oil), the results obtained showed significant difference for different times and different oil types. The mixed oil has the best values for, peroxide value, free fatty acids, viscosity and refractive index. This oil was mixed with highly refined sunflower oil in a ratio of (1g - 9g) respectively. The mixed oil was compared with pure sunflower oil by running continual frying to potatoes chips with every oil for 1.5 hour, and after every 15 minutes the samples were tested. Concerning the chemical properties of oils, the peroxide values were changed in the first half an hour from 3.02 meq/kg to 10.56 meq/kg for sunflower oil and from 1 mg/kg to 5.49 mg/kg for the mixed oil, and after one hour sunflower oil was become 12.52 meq/kg and the mixed oil was reached 7.01 meq/kg, at the end of the specified period sunflower oil was raised to 17.44 meq/kg, while the mixed oil was rested in 12.00 meq/kg. For the physical properties it was found that the refractive index was stable in 1.472 for the mixed oil, but on the other hand sunflower oil was changed from1.461 to 1.472 and to 1.473 at the end of period .Table (4) contained the values of sensory evaluation of potatoes chips using two different oils. Sensory quality characteristics evaluation for color, taste, flavor, appearance, texture and overall acceptability of fried potatoes chips. Chips fried by mixed oil have scored high value by the panelists, i.e. these chips have higher acceptance, so the chips fried by mixed oil was prefered than that fried by pure sunflower oil. Table (5) shows the assessment of antioxidants potent of Tundub oil by adding different antioxidants Tundub oil (4%), Moringa oil (4%) and Butylated hydroxy tuleune BHT (200mg/kg) into groundnut better. Peroxide value of groundnut better treated with Tundub oil was changed from 3 meq/kg at zero time to 26 meq/kg at the end of period (165 days), and for Moringa oil PV increased to 32 meq/kg for the same period, while the blank sample PV elevated to 65 meq/kg.

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