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Some quality parameters of kordofan groundnuts (*Arachis hypogaea* L.) oil in relation to sudanese standards

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Abstract

The present work was conducted to evaluate the physicochemical properties of the native groundnut oil processed in Kordofan region in order to investigate the effect of environmental processing and handling on quality (Good Manufacturing Practices -GMP-) with respect to SSMO, 1995 and Codex Alimentarius, 2005. Ten samples of groundnut oil were collected from the four major oil producing localities of the Greater Kordofan region i.e. Sheikan (Five expellers), Elnuhud (Three expellers), Elrahad (One), and Um Rowaba (One expeller). The oil samples (two samples from each expeller) were collected and kept in dry bottles sealed tidily and labeled, then transferred to the laboratory to assess the quality parameters, which include color degree, viscosity, refractive Index, density, impurities, moisture content, acid value, FFA%, peroxide, anisidine and Totox values. The results indicated that the degree of colors ranges1.41 - 2.70, while viscosity ranges 39.0- 47.0 poise. The Refractive index ranges 1.4 - 1.5. Impurity ranges 3.0- 4.0%, the moisture ranges 0.01-0.34%, the acid value ranges 1.42 -4.0free fatty acids ranges 1.02% -3%;the peroxide value ranges 5-12.0 meqO2/kg, anisidine value ranges 5.70- 28.06 meq/kg, the totox value rangeds15.70 -52.04 meq/kg. The color degree and Refractive Index for ten oil samples were within the standards limit, while the viscosity, density and impurities were significantly higher than the acceptable standards limitation. The moisture contents for all samples were higher than the recommended limit, while the acid value, FFA% and peroxide value of the all oil samples were in agreement with the both standards.

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Introduction

The quality of vegetable oil is a measure of identity and edibility. This is also related to the method of obtaining the oils from the vegetable source (i.e. whether it is virgin oil or cold pressed oil) both obtained without altering the nature of the oil, by mechanical procedures (e.g. expelling or pressing), and the application of heat only. This may be purified by washing with water, settling, filtering, and centrifuging only (Codex, 2005).

Certain industrial manufacturing and refining processes may further blend (admixtures of two edible vegetable oils) according to industrial refining and production standard (Agimark, 2002). Vegetable oil sources include coconut, cotton seed, groundnut, maize germ, mustard seed, palm nut, sesame seed, soya beans, and sunflower seed. According to Codex (2005), edible vegetable oils are "foodstuffs which are composed primarily of glycerides of fatty acids being obtained only from vegetable sources. They may contain small amounts of other lipids such as phosphatides, of unsaponifiable constituents and of free fatty acids naturally present in the fat or oil". They have also been classified (Stanfield, 1986, Anita, 1996; Robert *et al*., 2003) as lipids, compounds that are insoluble in water but soluble in organic solvents such as trichloromethane, alcohol, etc. Since, these oils begin to decompose from the moment they are isolated from their natural living environment, with the production of an unpleasant taste and odor over a period of time to form oils often being referred to as rancid. The unpleasant organoleptic characteristics of the rancid vegetable oils are caused by the presence of free fatty acids and atmospheric oxidation. This is accelerated by the exposure of the vegetable oils to heat, light, moisture, residual natural dyes, pigments and by the presence of transition metals like copper, nickel and iron (Ronald and Ronald, 1989). Therefore, a number of parameters have been used to characterize the identity and edibility of vegetable oils i.e. color, odor, and taste are among the basic parameters. Insoluble impurity fatty acid content and antioxidants; acid value (AV), peroxide value (PI), iodine value (IV), refractive index (R I), relative density (RD) (Ronald and Ronald, 1989, Williams, 1990, BP, 1993; Prescott *et al*., 2002). Ali (2009) reported that the moisture content of peanut oil was found to be 0.15%, while Adam *et al* (2007) claimed that it was 2.979%. Ali (2009) evaluated the acid value of peanut oil and he found it was 0.973 mg NaOH/g , while Taha (2000) showed only 0.26 mg NaoH/g. Ali (2009) found that the P.V. of peanut oil was 6 meqO2/ Kg oil, while a value of 7.8 meqO2 / Kg oil was reported by Taha (2000). As well as 9.767 meqO2/ Kg oil documented by Adam *et al* (2007), The anisidine value was found to be 10 meq/Kg oil, which conduted by Ananda *et al* (2013), the totox value of peanut oil was found to be 50 meq/Kg oil conducted by Ananda *et al* (2013). Thus Totox value may provide a measure of the total oxidation of edible oil, so the present investigation was conducted to analyze groundnut oils, for evaluation of quality parameter such as physicochemical parameters of Groundnut oils collected from Kordofan region expellers in crude vegetable oils compare with quality parameters established by SSMO, 1995 or Codex, 2005.

Materials and methods

Sampling procedure and preparation

Ten samples (approximately 500 ml each) were collected from the four major vegetable oil producing localities of the State; Sheikan (Five expellers), Elnuhud (Three expellers), Elrahad (One expeller), and Um Rowaba (One expeller).

Two samples of oil were collected from each oil Expellers. The oil sample was kept in dry bottles sealed tidily and labeled. The samples were transferred to the laboratory to assess the quality parameters.

Quality parameters determination

Determination of color

The color was determined according to ASTM Color 1500 (2010) using a standard light source .A liquid sample was placed in the test container and compared with colored glass disk ranging value from 0.5 to 8. The viscosity was determined using an Ostwald-U-tube viscometer according to Cocks and Van Rede (1966).

The refractive index (RI) was determined by Abbe 60 Refractometer as described by the AOAC (1984). The refractive indices of all samples were determined at 20°C.

Relative Density was determined by pycnometer method according to AOAC (1990).

Impurity

The impurity was determined according to the methods described by Mohammed and Khattab (2011). The impurity was expressed as impurity percentage.

Moisture content (MC) was determined according to the AOAC (1990).

Acid value (AV) was carried out according to the British Standard Institution (1958) methods.

Free fatty Acids (FFA) was determined according to Cock and Van Rede (1966). The FFA was expressed as percent oleic acid, while the AV as milligram of KOH per gram oil sample.

Peroxide value (PV) of oils, which indicates the extent of overall oxidation, was determined according to the AOAC (2000) methods. It was expressed as meqO_2/ Kg oil.

The anisidine value (A.V) or the carbonyl value was measured in the oil according Holm *et al* (1972). It was expressed as meqO_2/Kg oil.

The Totox Value (TOV) is calculated value based on peroxide and anisidine value, was determined according to the Holm (1972) according to the following Equation: Totox value = 2×proxide + Anisidine value.

Statistical analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS). The means were tested using one factor analysis of variance (ANOVA), and then separated using Duncan's Multiple Range Test (DMRT) according to Duncan (1995).

Results and discussion

Physical parameters of groundnut oils collected from greater Kordofan expellers

Color degree

The statistical analysis for color degree in the investigated samples showed that there were no significant differences (P≤0.05) between the samples E1, E4 and E7 and between E2, E3 and E9. The mean value of the color degree of all the samples was 1.944; it was ranged between 1.41 and 2.70 in E3 and E10. The sample E7 resulted in significantly the highest color degree, while the lowest value were found in the expellers E3, E6 and E9.The Sudanese standards specified that the color degree in the sample must be less than 3 degree. Through this study all Expellers within the limit of those standards.

Viscosity

Total mean of viscosity was found to be 41.83 poise, the samples E_1, E_7, E_4 and E_{10} resulted significantly the highest viscosity, while samples E_8 and E_9 were the lowest. The statistical analysis for viscosity value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples E1 and E8. Also there were no significant differences between samples in expellers E2, E3, E4, E5, 46, E7, E9 and E10 at the same probability.

Refractive index

The statistical analysis for Refractive index value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples in expellers E2, E3, E4, E5, E7, E8, E9 and E10, but there were significant differences between samplers E1 and E6 at the same probability.

The mean Refractive index for all samples Expellers was 1.238 nm. The Sudanese standards specified that the refractive index must be in the range of 1.460-1.465. The present findings revealed that E_1, E_4 and E_8 were not in agreement with the Sudanese standards.

Table 1. Physical properties of groundnuts oils selected from greater kordofan expellers peanut oils.

Expellers	Color Degree	Viscosity poise	Refractive Nm	Density g/cm³	Impurity %
E1	(2.03) ^{ab} ± 0.01	(47.0)^{a} ± 11.2	(1.5)^{a} ± 0.02	(0.94) ^{d} ±0.01	(3.7) ^{ab} ±0.05
E2	(2.08) ^{a} ±0.13	(41.7)^{ab} ±1.07	(1.4)^{ab} ±0.04	(1.4)^{a}±0.02	(3.8) ^{a} ±0.12
E3	(1.41) ^{c} ±0.08	(40.2) ^{ab} ±1.20	(1.4)^{ab}±0.04	(1.1) ^{bc} ±0.05	(4.0) ^{a} ±0.01
E4	(2.00)^{ab}±0.01	(42.1)^{ab} ±0.40	(1.5) ^{ab} ±0.04	(1.1) ^{bc} ±0.06	(3.1^{d} ±0.14
E5	(2.07)^{a} ±0.60	(41.4)^{ab} ±1.20	(1.4) ^{ab} ±0.02	(1.2) ^{b} ±0.01	(3.2 ^{d} ±0.01
E6	(1.70) ^{bc} ±0.60	(40.1)^{ab} ±0.20	(1.4) ^{b} ±0.02	(1.0) ^{c} ±0.04	(3.4)^{bcd}±0.40
E7	(2.24) ^{a} ±0.13	(43.7)^{ab} ±1.50	(1.4) ^{ab} ±0.02	(1.0) ^{c} ±0.01	(3.6) ^{abc} ±0.50
E8	(2.31)^{a} ±0.17	(39.0)^{b} ±0.06	(1.5)^{ab} ±0.02	(1.0) ^{c} ±0.01	(4.0) ^{a} ±0.07
E9	(1.60) ^{c} ±0.09	(40.8) ^{ab}±0.70	(1.4) ^{ab} ±0.04	(1.1)^{bc} ±0.05	(3.3) ^{cd} ±0.07
E10	(2.00)^{ab} ±0.02	(42.3)^{ab} ±1.13	(1.4)^{ab} ±0.05	(1.1)^{bc} ±0.05	(3.0) ^{d} ±0.05

* E_1 To E_{10} represents oil expellers audited.

Each value is an average of three replicates. Each value is average ± standard deviation.

* Values in column share the same superscript letter show no significant difference at 0.05 levels.

Density

The statistical analysis for density value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples E3, E4. E9 and E10.Also there were no significant differences between the samples E6, E7 and E8. The mean value of the density for all samples collected from kordofan expellers was found to be 1.08 g/cm³. Sample E_5 has the highest density 1.2 g/cm³, while the sample E_1 showed the lowest density 0.8 g/cm³. Also there is no significant different (P≤0.05) between E_4 and E5.

All Expellers were not in agreement with the Sudanese standards which ranged 0.912-0.920 g/cm³.

Impurity

The statistical analysis for Impurity value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples collected from expellers E2, E3 and E8. Also there were no significant differences between the samples E4, E5 and E10. Total mean of Impurity was found to be 3.51%.

The samples E_3 and E_8 resulted insignificantly the highest impurity, while samples E_4 and E_{10} were the lowest. The Sudanese standard specified that the Impurity must be less than 0.05%. These results showed that all samples were higher from the standards limit.

Table 2. Chemical parameters of Groundnuts oils collected from oil expellers in greater Kordofan State.

Expeller code	Moisture (%)	Acid value (mg/g)	F. F. A (%oleic)	Anisidine value (*mEq*/Kg)	Peroxide value ($mEqO_2$/Kg)	Totox value (*mEg*/Kg)
E1	(0.11)^{e} ±0.03	±0.67 ^{h}(1.72)	±0.13 ^{b}(2.85)	±0.50^{g}(7.60)	(5.00)^{d} ±0.31	(17.60)^{f} ±0.25
E2	(0.22)^{b} ±0.01	±1.02 ^{f}(2.00)	±0.54 ^{f}(1.68)	±0.08^{e}(14.00)	(7.03)^{c} ±0.40	(28.06)^{d} ±0.02
E3	(0.03)^{e} ±0.00	±0.07 ^{i}(1.42)	±0.02 ^{e}(2.00)	±0.50 ^{h}(5.70)	(5.00)^{d} ±0.72	(15.70)^{g} ±0.31
E4	(0.03)^{e}±0.09	±0.03 ^{d} (2.69)	±0.05 ^{g}(1.03)	±0.14 ^{f}(11.20)	(6.04)^{cd} ±0.26	(23.28)^{e} ±0.33
E5	(0.23)^{b} ±0.08	±0.02 ^{c}(3.36)	±0.34 ^{e}(2.07)	±0.70^{a}(28.06)	(11.93)^{a} ±0.23	(51.92)^{a} ±0.07
E6	(0.24)^{b} ±0.06	±0.04 ^{g}(2.17)	±0.10 ^{e}(2.07)	±0.12 ^{d}(15.03)	(8.05)^{c} ±0.07	(31.43)^{c} ±0.62
E7	(0.20)^{c} ±0.00	±0.06 ^{b}(3.82)	±0.06 ^{c}(2.78)	±0.54 ^{b}(20.45)	(10.33)^{b}±0.12	(41.11)^{b} ±0.70
E8	(0.21)^{c} ±0.02	±0.07 ^{h}(1.74)	±0.04 ^{g}(1.02)	±0.11 ^{d}(15.08)	(8.20)^{c} ±0.15	(31.48)^{c} ±0.22
E9	(0.18)^{d} ±0.04	±0.21 ^{g}(2.16)	±0.04^{d}(2.10)	±0.30^{e}(14.31)	(7.30)^{c} ±0.25	(28.60)^{d} ±0.73
E10	(0.34) ^{a} ± .0.5	±0.02 ^{a}(4.00)	±0.10 ^{a}(3.00)	(28.61)^{a} ±0.70	(12.02) ^{a} ±0.18	(52.04)^{a} ±0.35

*E_1 To E_{10} represents oil expellers audited.

Each value is an average of three replicates. Each value is average ± standard deviation.

*Values in column share the same superscript letter show no significant difference at 0.05 levels.

Chemical parameters of Groundnut oils collected from greater Kordofan expellers

Moisture contents

The statistical analysis for moisture content in the investigated samples showed that there were no significant differences (P≤0.05) between the samples E1 and E3, and between E2, E5 and E6, also the E7 and E8 statistically showed the same results. The moisture mean of all the samples collected for study was 0.177, the highest value (0.34) recorded in E4 and the lowest value (0.01) was shown in E7. The present findings were lower than (2.33) reported by Omer *et al* (2007) for groundnuts oil. The Sudanese standard recommended that the moisture content of groundnut oil must be less than 0.02 %, so according to this we can conclude that all Expellers in present work not in agreement with the Sudanese standards limitations.

Acid value

The statistical analysis for acid value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples (E1, E3 and E8), and between (E2, E6 and E9). The overall mean for the acid value in all expellers of Kordofan was 2.91mg KOH/g oil. It ranged between 4.0 and 1.42 which revealed in E3 and E10, respectively. The present results were higher than (0.68) reported by Omer *et al* (2007). The results obtained from the all expellers were approved by the Sudanese standards (4.00 mg KOH/g oil).

Free fatty acids

The statistical analysis for free fatty acids in the investigated samples showed that there were no significant differences (P≤0.05) between the samples E1, E7 and E10, and between E3, E5, E6 and E9, also there were no significant differences between E3 and E8.

The mean of free fatty acids obtained from oil samples in all Expellers of greater Kordofan was found to be 2.06 % the highest value(3.00%) of free fatty acids was found in E10, and the lowest value in E8(1.02%). These present results higher than (0.343) reported by Omer *et al* (2007) for Sudanese groundnuts oil.

The Sudanese standard decided that the limit of free fatty acids must be not more than 3% as oleic acid, which confirmed that all Expellers in present work within the limit of those standards.

Peroxide value

The statistical analysis for peroxide value in the investigated samples showed that there were no significant differences (P≤0.05) between E1and E3, and between E2, E6, E8 and E9, while the E5 and E10 were statistically showed the same results. The mean of peroxide value for all sample collected from the greater Kordofan expellers was 8.6 the highest value was (12.0 meqO2/kg oil) in E10 and the lowest value (5.0 meqO2/kg oil) in E1 and E3.These rang of peroxide value in agreement with (6.33 meqO2/kg oil) reported by Omer et al (2007), As well as lower than that value of (20.0 meqO2/kg oil.) reported by Ananda et al (2013) for groundnut oil. The Sudanese standards specified that the peroxide value must be less than the 15meqO2/kg oil. The study results showed that all samples within the Sudanese standards limit (table 2).

Anisidine value

The statistical analysis for anisidine value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples E5and E10, and between E2, E6, E8 and E9.The mean of anisidine value for all samples collected from greater Kordofan Expellers was 15.98.The highest value was (28.06 meq/kg oil) in E10, and the lowest value (5.70) in E3. Ananda et al (2013) reported that anisidine value of peanut oil is (10.0).The Iranian standards showed that anisidine number must be less than the 26 meq/kg oil. According to our findings in present work the expellers E5 and E10 were out of the standards limit, while the others Expellers within the standards limit.

Totox value

The statistical analysis for Totox value in the investigated samples showed that there were no significant differences (P≤0.05) between the samples of E5 and E10, and between E6 and E8, in addition to E2 and E9.

The mean value of Totox for all samples collected from greater Kordofan expellers was 32.12 meq/kg oil. The highest value was (52.04meq/kg) in E10 and the lowest value (15.70 meq/kg) in E3. Iranian standards specified that Totox value must be less 30meq/kg. The highest value (50.0 meq/kg oil.) of expeller E10 in agreement with Ananda *et al.* (2013) who reported the same value (50.0 meq/kg oil). The study results showed that E5, E6, E7, E8, and E10 were out of the standards limit, while the others Expellers within the standards limit (Table 2).

Conclusion

The processing has varied effect on some parameters like Refractive index, density, moisture content, anisidine value and totox value.

The environmental processing of groundnuts oil in this expellers studied have characteristics almost differ from those specified by SSMO or/and Codex Alimentarius.

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