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Evaluating the quality parameters of groundnuts seeds and cake (Arachis hypogaea L.) in relation to Sudanese Standard and Metrology Organization SSMO (1995)

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ABSTRACT: *This study was conducted in ten groundnut oil expellers in Kordofan state, the aim of study to Evaluation the quality parameters of groundnuts seeds and cake. 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, The study revealed that the quality parameters of groundnut seeds raveled that there were it higher percentage of impurity with low percentage of oil content. Also it had no dead insect and had good level of moisture and fiber content. The mean Ash content was found (1.60 %) while the samples E8, and E9 had signification lowest lower than specification range (1- 3).The mean protein was (23.9 %). The SSMO, established range (22-30%) these result is agreed with only E1 and E7. The Carbohydrate content was (27.46%).The sample E10 has significant highest carbohydrate content while the sample E5 had signification lowest content among all samples studied. Through thesis study all Expellers were highest than acceptable limit for the small seeds and crashed seed. Concerning weight of 1000 seeds only expellers E4 and E5 within acceptable limit, also all the oil expellers were free from death insects. The moisture content of the cake more than 50% of expellers were highest than the acceptable level. The mean ash content were higher than established limit in E3, E4and E5 while the other expellers within established limit. The study revealed the expellers E5, E7, E9 and E10 had significantly lower than the acceptable level about the mean Protein content. The fiber content expellers E1, E3, E4, E6 and E8 had significantly lower than the acceptable level.*

KEY WORD: chemical evaluation, groundnut, comparative, expellers, SSMO1995.

INTRODUCTION

Arachis hypogaea L., commonly known as groundnut, groundnut, or earth nut because the seeds develop underground, is produced on a significant basis in more than 30 countries, with worldwide production

figures estimated to be in excess of 20 million tons. The three largest producers of groundnuts (approximately 65% of the world production) are India, China, and the US. The world production of groundnut oil, expressed from the seeds, accounts for about 7–10% of the world vegetable oil total (Gunstone, 2002).

Groundnut is an important cash crop in the Sudan; it is grown mainly for its oil, protein, seed-cake and plant residue. Large areas of more than one million hectares both under rainfed and irrigation are devoted to this crop annually (Ahmed, 2002). In Sudan early maturing Spanish-types are grown in rainfed areas of Western and Southern Sudan, whereas Virginia-types are grown in irrigated areas of the Central and Eastern parts of the country. The most important areas of production under irrigated conditions were the Gezira and Managil schemes, Rahad scheme and New Halfa scheme in addition to White Nile, Blue Nile, Suki and Rubatab area. Areas of production under rainfed are South Darfur, North Kordofan and Southern region (Ahmed, 2002).

There are two varieties of irrigated groundnuts grown in Sudan, namely Ashford and Baberton. It has been observed that rainfed Sodari cultivar contained higher oil content (49.6%), but low in protein content (23.8%), while Elobyed cultivar contained higher protein content (29.7%). In irrigated cultivars, Ashford has a higher oil content (54.8%) and lowest protein content (23.4%). In conclusion the irrigated groundnut cultivars were good sources of oil and oleic acid, and have higher O/L ratio, while rainfed groundnut cultivar were good sources of protein (Elshafie, 1993).

Uses of Groundnut:
The nuts are economically important as a food crop. Due to their high content of digestible protein and unsaturated oil and an exceptional roasted nutty flavor, they have substantial value as a nutritious and flavorful food commodity. Overall more than 50% of all groundnuts produced are crushed for oil. In India, 75–80% of the groundnuts produced are crushed for oil. In contrast, only 10–12% of recent groundnut production in the US was used for oil production (Gunstone, 2002). Pressed cake from edible-grade groundnuts with low oil content may be ground into flour for human consumption. After minimal oil extraction, the pressed cake, which is low in oil and high in protein, may be used for animal food if aflatoxin is kept below the acceptable levels. Unacceptable pressed cake and much of the material remaining after physical and chemical extraction is relegated to fertilizer usage (Gunstone, 2002).

METHODOLOGY

Assessment the quality parameters of groundnut seeds:

Sampling:
Two samples of peanut seeds were collected from each oil mills. The peanut samples were put in polyethylene page (PEP) and labeled. The samples were transferred to the experiment laboratory to meet the assessment of food safety requirement.

Analysis of quality parameters of groundnut seeds
The determination of moisture, crude protein, crude fat, crude fiber, ash, impurity, small Seed crashed

and weight 1000/ seed were carried out for raw materials seeds according to AOAC (1990) methods.

Moisture content:

Two grams of well –mixed sample were weighed accurately in clean preheated dish of known weight the uncovered sample and dish were kept in an oven provided with fan at 70 C under vacuum for 4 to 6 hours, the dish was covered and transferred to desiccators and weighed after reaching room temperature. The dish was again heated in the oven for another two hours and reweighted .this was repeated until constant weight was obtained.

The loss of weight calculated as percent of sample weight and expressed as moisture content.

$$\text{MC}\ (\%) = \frac{(\text{W2}-\text{W1})-(\text{W3}-\text{W1})}{(\ \text{W2}-\text{W1}\ )} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1.3$$

Where:

MC= Moisture content.

W1= weight of empty crucible

W2= weight of crucible +sample

W3 = weight of crucible + dry sample

Ash content:

A crucible was weight empty and then accurately 2 g of sample were put in it. The sample in crucible was placed in muffle furnace at 550 ^{o}C for 3h or more until white grey or reddish ash was obtained. The crucible was removed from furnace and placed in some desiccators to cool then was reweight. The process was repeated until constant weight was obtained.

Ash content was calculated using the following equation:

$$AC\% = \frac{W_2 - W_1}{W_S} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.3$$

Where:

AC = Ash content

W_1 =weight of empty crucible

W_2 = weight of crucible with ash

W_S = weight of sample

Crude protein:

Nitrogen content was determined by the semi –micro kjeldah distillation method.

Exactly 0.2 g of the sample was digested in small digestion flask using about 0.4 of the catalyst mixture (90%) anhydrous sodium sulphate and 10% mercuric oxide). 3.5 ml of concentrated nitrogen free sulphuric acid were added and the contents were digested for 2 h till a color less liquid was obtained. The digest was cooled then diluted and transferred to distillation unit using minimum volume of distilled water and treated with 20 ml of 40% aqueous NAOH solution and distilled ammonia was tapped into 1o ml of 2% boric acid solution plus 3-4 drops of methyl red indicator (Bromocersol green

0.5+0.1methyl red dissolved in 100ml of 95 ethanol and the pH was adjusted to 4.5 for 5-1o minutes .After lowering the receiving flask clear of condenser, the apparatus was seamed out for further 5minutes till the volume of receiving flask reached from 50-75m the distillate was the titrated with 0.02 NHCL.

$$N\ (\%) = \frac{T1F \times N \times 14}{1000 \times Ws} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.3$$

Crude protein % =N% ×6.25

Where:

T1F= mlHCL-mlblank

N = Normality

Determination of oil (ether extract):
A dry empty extraction flask was weighted, about 2g of sample was weighted and placed in a filter paper ,then placed in extraction thimble free from fat and covered with cotton wool .the thimble was placed in soxhlet extractor. Extraction was carried out for 7h with petroleum spirit (60-80) the heat was regulated to obtain at least 125 siphoning per hour .the residual spirit was dried by evaporation. The extraction flask was placed in an oven till drying was complete then cooled in desiccators and weight.
The fat content was calculated using the following equation

$$FC\% = \frac{W_2 - W_1}{W_S} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.3$$

Where:
FC = fat content
W_1 = weight of extraction flask
W_2 = weight of extraction flask with oil
W_S = weight of sample.

Crude fiber:
Crude fiber was determined according to AOAC (1990).About two gram of sample. Sample was weighted.150 ml of H_2SO_4 (conc.7.3ml/L) were added and then heated to boiling. The mixture was boiled for 30 minutes and then filtered. The residue was washed three times with hot water. And then 150ml of pre-heated KOH (12.89ml/l) were added and then heated to boiling. The system was boiled for 30minutes and then filtered. The residue was washed was washed three times with hot water. It was dried under suction and then in an oven at 150C° overnight and then weighted. The residue was ashed in muffle furnace at550C° for three hours till alight grey ash was formed then weighted to constant weight. The crude fiber was calculated using the following equation:

$$CF\% = \frac{W_2 - W_1}{M_S} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5.3$$

Where:

CF = crude fiber

W_1 = weight of the sample before ignition

W_2 = weight of sample after ignition

M = moisture content of sample

S = original weight of sample

Determination of carbohydrates:

Carbohydrates were determined by difference.

CHO_S = 100- (Ash%+moisture%+CP%+oil%+crude fiber %) ……..…..6.3

Weight of 1000 kernel seeds:

To determine weight of 1000 seed, count 1000 seed and note the weight in g.

Determination of shrunken seeds:

Weight 500g seed peanut, detect shrunken seeds from total weight, then weight it to calculate percentage as flows:

$$PshS = \frac{Wshs}{W_{TS}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7.3$$

PshS = Percentage of shrunken seeds %.

Wshs = Weight of broken seeds per gram.

W_{TS} = Weight of total seeds per gram.

Determination of broken seeds:

Weight 500g seed peanut, detected broken seed from total weight, then weight it to calculate percentage as flows:

$$PBS = \frac{W_{BS}}{W_{TS}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8.3$$

PBS = Percentage of broken seed %.

W_{BS} = Weight broken seeds per gram.

W_{TS} = Weight of total seeds per gram.

Determination of impurities:

Weighted amount of seeds about 500gram and after that isolated the foreign material like (little – sand – stones - other seeds – etc ...) and then weighted the foreign materials, to calculate percentage as flows:

$$PI = \frac{W_{FM}}{W_{TS}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9.3$$

PI = Percentage of impurity %.

W_{FM} = Weight of foreign materials per gram.

W_{TS} = total weight of seeds per gram.

Statistical analysis:

Data generated was analyzed using Statistical Package for Social Sciences (SPSS). Means (±D) were tested using one factor analysis of variance (ANOVA), and then separated using Duncan's Multiple Range Test (DMRT) according to Mead and Gurney (1983)

RESULTS AND DISCUSSION:

Quality parameters of groundnut seeds collected from North Kordofan expellers.

Moisture content of groundnut seeds (%):

The mean Moisture content obtained from oil samples in all Expellers of Kordofan was found (3.31 %) the samples E8, E9 and E10 resulted in significantly highest moisture content while samples E4, E5 and E6 had signification lowest moisture content among all samples studied. The mean of moisture was lower than that of (7.40 %) reported by Savage and Keeman (1994).Also The mean of moisture was lower than that (7.48) and (7.30) was found by Ayoola et al (2012) and Jambunathan et al (1985).The Sudanese Standard and Metrology Organization (1995) that the moisture content of peanut seeds must be in the range (3-6%) these result is disagreed with E2, E4, E5 and E6.

Ash content of groundnut seeds (%):

The mean Ash content obtained from oil samples in all Expellers of Kordofan was found (1.60 %) the sample E1 resulted in significantly highest moisture content while samples E3, and E7 had signification lowest moisture content among all samples studied. Analysis of variance revealed there are no significant differences were between E2 and E6 and between E8 and E9 among all samples studied. The mean Ash content obtained from oil samples in all Expellers of Kordofan was found higher than (1.48%) and (1.37 %) obtained by Ayoola et al (2012) and Jambunathan et al (1985).The The Sudanese Standard and Metrology Organization (1995)that the moisture content of peanut seeds must be in the range

Protein content of groundnut seeds (%):
The protein content among the ten expellers differs significantly (P≤0.05). The mean protein obtained from oils in all Expellers of Kordofan was found (23.9 %). The protein content varied between 17.33 % in E6 and 36.33 in E5. The protein percent was corresponding to the result (24.7%) which was obtained by Savage and Keeman (1994). The mean of protein content in these study closely with (24.70) and (24.9) reported by Ayoola et al (2012) and Jambunathan et al (1985). The Sudanese Standard and Metrology Organization (1995)that the protein content of peanut seeds range (22-30%) these result is agreed with E1 and E7.

Oil content of groundnut seeds (%):
Significant differences were obtained among the expellers for this trait. Mean of oil was 41.38%. E1 has the highest oil content (47.7%) and E10 has the lowest oil content (34.33%).The mean of oil in Kordofan Expellers was lower than that reported by savage and keeman (1994) who found that the oil content is (46.10 %). Ayoola et al (2012) and Jambunathan et al (1985) there found that the oil content is (46.10) and (48.00) the Sudanese Standard and Metrology Organization (1995)reported that the oil content of peanut seeds must be more than (47%); this result is agreed with E1 and E5.

Fiber content of groundnut seeds (%):
Analysis of variance revealed significant differences were between all ten expellers accept expeller E5 and E9 (2.9%).The mean fiber content for all samples collected from Kordofan Expellers was (2.31%).The fiber content varied between 3.33 %, in E10 and 1.2% in E7. The mean of fiber content agreed with Ayoola et al (2012) and Jambunathan et al (1985).The mean fiber was lower than the value (2.83 and 24.7 %) obtained by Savage and keeman (1994). All expellers were found agreed with range of The Sudanese Standard and Metrology Organization (1995) (1- 3 %).

Carbohydrate content of groundnut seeds (%):
The mean Carbohydrate content for all samples collected from Kordofan Expellers was (27.46%).The sample E10 has significant highest carbohydrate content while the sample E5 had signification lowest carbohydrate content among all samples studied. The mean of carbohydrate content online with Ayoola et al (2012) was found (27.19%) and higher than (25. 7%) reported by Jambunathan et al (1985).

percent of groundnut seeds (%):
Analysis of variance revealed significant differences were between all ten expellers. The mean impurity content for all samples collected from Kordofan Expellers was (15.5%) samples E10 has the highest impurity content (31.6%) while that of samples E1 showed the lowest (5.4 %) all Expellers disagreed of The Sudanese Standard and Metrology Organization (1995) (1.5%).
Small percent of groundnut seeds (%):
Analysis of variance revealed there no significant differences were between all ten expellers. The mean small seeds content for all samples collected from Kordofan Expellers was (3.34 %) samples E1 has the highest small seeds content (1.4 %). while that of samples E5 showed the lowest (1.0 %)
The result showed all the Expellers were found disagreed with the Sudanese Standard and Metrology Organization (1995)less than (1.0 %) except E5.

Crushed percent of groundnut seeds (%):
The mean value of crashed seed content of the ten oil samples in vest gated was (31.1 %) sample E2 has the highest crashed seed content (66.3 %) and was significantly ($p \leq 0.05$) higher than all other samples obtained from all other Expellers in Kordofan oil. Lower crashed seed content were found in samples (6.20%). The mean crashed seed content was higher than the range (0-3 %) limited by The Sudanese Standard and Metrology Organization (1995) for each Expellers.

Weight of 1000 number of groundnut seeds (gram)
The mean weight of 1000 seeds was found (324.1gm) signification different between the samples in all Expellers were observed, while samples E2 has the highest weight of 1000 seed (480.5 gm) among samples obtained from different Expellers in Kordofan oil, sample E4 has lowest weight 1000 seed (221.7 gm).these result lower than (560.2) reported by Jambunathan et al (1985). The Sudanese Standard and Metrology Organization (1995)that the weight of 1000 seed of peanut seed must be in range (300-700 gm) these result is disagreed with E4 and E5.

Death of insect's percent of groundnut seeds (%):
The result revealed that all the oil expellers under study were free from death insects. The Sudanese Standard and Metrology Organization determine that the percentage of death of insects of groundnut seeds must be range between (0 -0.1).Through these result all expellers were online with the Sudanese Standard and Metrology (1995).

Quality parameters of groundnut cake collected from North Kordofan oil expellers.
Moisture content of groundnut cake (%):
The mean Moisture content obtained from cake samples in all Expellers of Kordofan was found (3.517 %) the sample E8 resulted in significantly highest moisture content while samples E2, E4, E5 and E6 had signification lowest moisture content among all samples studied. The mean Moisture content obtained from cake samples was higher than (3.30%) reported by babiker (2009) as well as lower than (4.48 %) obtained by Fekria, et al (2012). The Sudanese Standard and Metrology Organization (1995) determine that the moisture content of groundnut cake should not be more than 4%. The study revealed the expellers E1, E3, E8, E9 and E10 had significantly highest than the acceptable level while the rest expellers were agreed with specification level.

Ash content of groundnut cake (%):
The mean ash content obtained from cake samples in all Expellers of Kordofan was found (9.103 %) the sample E5 requested highest ash content (12.0 %) when compare with all Expellers. Analysis of variance revealed there are no significant differences were between the samples E1, E2, E3 and E7. By the other hand there are significant differences were between all the rest samples at ($P \leq 0.05$). The mean ash content obtained from cake samples was higher than (5.27%) reported by babiker (2009) as well as lower than (14.49 %) obtained by Fekria, et al (2012). The Sudanese Standard and Metrology Organization determine that the ash content of groundnut cake must be not more than 9%. Through the study the expellers E3, E4and E5 were higher than established limit while the other expellers within established limit.

Protein content of groundnut cake (%):
The mean Protein content obtained from cake samples in all Expellers of Kordofan was found (43.81 %) the samples E2 and E4 resulted in significantly highest Protein content flowed by samples E1, E3 and E6 while sample E10 had signification lowest Protein content among all samples studied. Analysis of variance revealed there are no significant differences were between the samples E2 and E4 and between the samples E1, E3 and E6 at the same probability ($P \leq 0.05$). The mean protein content obtained from cake samples was lowest than (53.44%) reported by babiker (2009). The protein percent was corresponding to the result (44.51%) which was obtained by Fekria, et al (2012). The Sudanese Standard and Metrology Organization recommended that the protein content of groundnut cake must be more than 44%. The study revealed the expellers E5, E7, E9 and E10 had significantly lower than the acceptable level while the rest expellers were agreed with specification level.

Oil content of groundnut cake (%):
Analysis of variance revealed there are significant differences were between E1and all other expellers. The mean oil content for all samples collected from Kordofan Expellers was (8.903%) sample E10 has the highest signification oil content while sample E2 had signification lowest oil content among all samples studied. The mean oil content obtained from cake samples was higher than (6.73%) and (7.47%) reported by Fekria, et al (2012) and babiker (2009). The Sudanese Standard and Metrology Organization established that the oil content of groundnut cake more than 8%. Through the study the expellers E1, and E2 were lower than established limit while the other expellers within established limit.

Fiber content of groundnut cake (%):
The mean fiber content for all samples collected from Kordofan Expellers was (9.757%) sample E1 has the highest signification fiber content while sample E6 had signification lowest fiber among all samples studied. Analysis of variance revealed there are no significant differences were between E3, E4and E8 among all samples studied. The mean fiber content for all samples collected from Kordofan Expellers was higher than (8.55%) reported by babiker (2009) and lowest than (16.99) obtained by Fekria, et al (2012). The Sudanese Standard and Metrology Organization concluded that the fiber content of groundnut cake must be higher than 10%. The study revealed the expellers E1, E3, E4, E6 and E8 had significantly lower than the acceptable level while the rest expellers were agreed with specification level.

CHO's content of groundnut cake (%):
The mean CHO' s content obtained from cake samples in all Expellers of Kordofan was found (24.91 %) the sample E1 has the highest signification CHO's content while samples E4 and E5 had signification lowest CHO's among all samples studied. Analysis of variance revealed there are no significant differences were between E6, E8, E9 and E10 among all samples studied. The mean CHO' s content obtained from cake samples was highest than (20.54%) and (12.70%) reported by Fekria, et al (2012) and babiker (2009).

Table 1: Quality parameters of groundnut seeds collected from of oil expellers in North Kordofan State.

Expellers	Moisture (%)	Ash (%)	Protein (%)	Oils (%)	Fibers (%)	Impurities (%)	Small Seeds (%)	Crushed (%)	Weight of 1000/Seeds
E1	(3.16)^{b} ±0.03	(1.45)^{e} ± 0.37	(29.33)^{c} ±0.58	(47.70)^{a} ±0.64	(2.72)^{bc} ±0.80	(5.45)^{j} ± 0.37	(1.94)^{b} ± 3.62	(15.37)^{h} ± 0.21	(331.32) ^{b}±6.06
E2	(2.50)^{c} ±0.31	(2.23) ^{c} ± 0.23	(33.33)^{b} ±2.89	(46.33)^{a} ±1.16	(1.96)^{de}± 0.68	(6.23) ^{h} ± 0.23	(1.43)^{e}±0. 02	(66.39)^{a} ±0.38	(480.57) ^{a}±5.24
E3	(3.17)^{b} ±0.30	(1.16)^{f} ±0.29	(21.33)^{de}± 0.15	(42.70)^{b} ±0.58	(1.81)^{e} ±0.66	(11.16)^{f} ±0.29	(1.41)^{e} ±0.04	(28.23)^{e} ±0.62	(304.44) ^{f}±2.14
E4	(2.90)^{bc} ±1.00	(2.51)^{a}±0 .44	(20.00)^{d} ±1.73	(39.67)^{c} ±0.58	(2.30)^{cd} ±0.40	(13.51)^{e}± 0.44	(1.54)^{d} ±0.02	(63.58)^{b} ±0.43	(221.74)^{h} ±2.91
E5	(2.80)^{bc} ±0.04	(2.37)^{b} ±0.17	(36.33)^{a} ±0.58	(47.33)^{a} ±1.16	(2.91)^{ab} ±0.12	(8.37)^{g} ±0.17	(0.58)^{f} ±0.02	(38.44)^{c} ±0.35	(291.70) ^{g}±0.37
E6	(2.84)^{bc} ±0.12	(2.13)^{c} ±0.15	(17.33)^{f} ±0.58	(37.68)^{cd} ±0.51	(2.55)^{c} ± 0.65	(19.13)^{d} ±0.15	(2.34)^{a} ±0.40	(23.36)^{f} ±2.23	(310.60) ^{e}±1.01
E7	(3.34) ^{b} ±0.34	(1.01)^{f} ±0.12	(22.33)^{d}± 2.31	(46.07)^{a} ±1.73	(1.24)^{f} ±0.32	(7.01)^{i} ±0.12	(1.60)^{d} ±0.06	(18.73)^{g} ±0.13	(330.53) ^{b}±4.56
E8	(4.32)^{a} ±0.31	(0.80)^{g} ±0.27	(20.67)^{de}± 2.31	(37.03)^{de} ±1.73	(1.62)^{ef} ±0.22	(21.80)^{c} ±0.27	(1.80)^{c} ±0.06	(6.20)^{di} ± 0.55	(327.12) ^{c}±3.52
E9	(4.21) ^{a} ±0.53	(0.76)^{g} ±0.33	(19.33)^{de} ±1.50	(35.41)^{ef} ±1.37	(2.91)^{ab} ±0.12	(27.50)^{b} ±0.33	(1.80)^{c} ±0.02	(32.42)^{d} ±0.33	(327.12) ^{c}±4.34
E10	(3.90) ^{a} ±0.13	(1.60)^{d} ±0.51	(18.67)^{ef} ± 0.58	(34.33)^{f}± 1.16	(3.33)^{a} ± 0.30	(31.60)^{a} ±0.51	(2.33)^{a} ±0.02	(18.62)^{g} ±0.52	(313.72)^{d} ±5.96

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

*Each treatments connected by same letter they are not differ significantly

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

Table 2: Quality parameters of groundnut cake selected from north Kordofan Expellers groundnut oil:

Expellers	Moisture (%)	Ash (%)	Protein (%)	Oils (%)	Fiber (%)	CHO (%)
E1	$(4.12)^{bc} \pm 0.12$	$(8.99)^{bc} \pm 0.27$	$(44.00)^{b} \pm 1.0$	$(3.50)^{f} \pm 0.50$	$(9.50)^{bc} \pm 0.50$	$(29.89)^{a} \pm 0.1$
E2	$(3.50)^{c} \pm 0.4$	$(9.00)^{bc} \pm 0.27$	$(49.00)^{a} \pm 1.0$	$(5.83)^{e} \pm 1.04$	$(10.43)^{abc} \pm 0.53$	$(22.24)^{c} \pm 1.0$
E3	$(4.40)^{b} \pm 0.4$	$(9.13)^{bc} \pm 0.91$	$(44.00)^{b} \pm 0$	$(10.50)^{b} \pm 0.50$	$(9.20)^{cd} \pm 0.3$	$(22.77)^{c} \pm 0.2$
E4	$(3.53)^{c} \pm 0.5$	$(10.00)^{b} \pm 1.00$	$(48.00)^{a} \pm 2.7$	$(9.20)^{cd} \pm 0.30$	$(9.00)^{cd} \pm 0.1$	$(20.27)^{d} \pm 2.9$
E5	$(3.20)^{c} \pm 0.21$	$(12.00)^{a} \pm 1.70$	$(43.30)^{bc} \pm 1.05$	$(8.60)^{b} \pm 0.51$	$(11.00)^{ab} \pm 1.73$	$(21.90)^{d} \pm 1.5$
E6	$(3.40)^{c} \pm 0.22$	$(8.60)^{bcd} \pm 0.53$	$(44.40)^{b} \pm 1.3$	$(8.80)^{d} \pm 0.71$	$(7.70)^{d} \pm 0.30$	$(27.10)^{b} \pm 1.4$
E7	$(3.72)^{cd} \pm 0.2$	$(9.06)^{bc} \pm 0.06$	$(43.10)^{bc} \pm 1.05$	$(10.30)^{bc} \pm 0.61$	$(10.20)^{abc} \pm 0.72$	$(23.62)^{c} \pm 2.0$
E8	$(5.04)^{a} \pm 016$	$(7.50)^{d} \pm 0.50$	$(40.80)^{cd} \pm 1.3$	$(10.30)^{bc} \pm 1.11$	$(8.92)^{cd} \pm 0.70$	$(27.44)^{b} \pm 2.0$
E9	$(4.60)^{ab} \pm 0.2$	$(8.81)^{c} \pm 0.30$	$(38.90)^{de} \pm 2.06$	$(9.70)^{cd} \pm 0.60$	$(10.10)^{bc} \pm 0.82$	$(27.89)^{b} \pm 0.7$
E10	$(4.70)^{ab} \pm 0.6$	$(7.94)^{cd} \pm 0.40$	$(37.30)^{e} \pm 1.20$	$(12.30)^{a} \pm 0.60$	$(11.70)^{a} \pm 0.60$	$(26.06)^{b} \pm 0.4$

* E_1 To E_{10} represents oil expellers audited.
*Each treatments connected by same letter they are not differ significantly
* Values in column share the same superscript letter show no significant difference at 0.05 level

CONCLUSION:
Groundnut oil expellers need to establish proper quality assurance laboratories to help them monitor quality of raw materials and end productions.

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