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The Antioxidant Effect Of Black Cumin (*Nigella sativa* L.) Seed On The Stability Of Peanut (*Arachis hypogaea)* Oil During Frying And Storage

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Abstract

This study was conducted to evaluate the effect of black cumin (*Nigella sativa* L.) seeds (BCS) on crude and refined peanut oil stability after frying process and during storage. Crude and refined peanut oil was blended with 5gm of the flowing; (oil, powder and whole seeds) BCS. The blends were used to fry potato chips for 13±2 min with temperature control of 180(±1)°C, The crude oil(A0) ,refined oil (B0) and the blends (A_1, B_1, A_2, B_2,A_3 and B_3) were conducted to study the (free fatty acid (FFA), peroxide value(PV) , fatty acid composition and sensory evaluation of fried potato). On FFA at zero time adding different additions of BCS lowering the percentages of FFA comparing with control samples A_0(1.79%) and B_0(0.98%) which were ranged 1.69-0.5%).No increase in FFA values on the ^{1st}period, on the second period there was significant increase in the values the highest value was obtained by sample A_2(4.65%) .Higher decreased was noticed on the ^{3rd}period.B_1 sample had the best values of FFA in the all periods. On PV There was significant increase in PV at zero time; sample A_0 had less P.V. (1.5) than sample B_0 which was (2.4 mel.eq/kg oil) while other samples were ranged(0.8 to 14.00 ml.eq O_2/kg oil) ,on the ^{1st} period samples(A_0, B_0, $A_1$and B_1) were almost stable and there was significant decrease in (A_2,B_2,A_3 and B_3) samples These values were significant decreased on the ^{2nd} period; the lowest value was in sample B_0(1.70) flowed by A_0 (2.0), B_1 (2.50)and A_1(3.5).on the ^{3rd} period observed high decreased in PV of all samples. The mean values of saturated fatty acids percentages of peanut oil with BCS types were found higher in crude peanut oil samples, while the mean of unsaturated fatty acids were found higher in refined peanut oil samples. The results appeared that refined peanut oil samples with different additions of black cumin seed (BCS) have the highest ranks in different attributes.

Keywords: Black Cumin Seed, BCS

Introduction

Arachis oil (peanut oil; groundnut oil) is derived from groundnuts (Arachis hypogaea Linn). Groundnut oil is a vegetable oil which contains only a small proportion of non-glyceride constituents. Its fatty acid composition is complex including saturated fatty acids covering a wide range of molecular weights. Groundnut oil is excellent food oil, with good flavor and high quality with its low free fatty acid value. The nutritional and storage qualities of peanut are determined by its fatty acids composition. According to Andersen & Gorbet (2002). About 80% of the total fatty acid content of pea nut oil constitutes unsaturated fatty acids mainly oleic acid and linoleic acid (Ahmed & Young, 1982). Thus the chemistry and quality of pea nut oil mostly depend on the oleic to linoleic ratio. The studies by Millar *et al*., (1987) observed that the oil containing high UFAs/SFAs ratios are thermodynamically more stable and may be heated to high temperatures. Jakson *et al*., (1978) reported that the oil containing higher content of MUFAs fatty acids (oleic acid) are more stable to oxidative damage during refining and storage.

Peanut oil contains both saturated and unsaturated fatty acids. Among these, the amount of saturated and unsaturated fatty acids in peanut oil varies from 10.92 to 17.47% and from 81.13 to 94.81%, respectively. Oleic acid content in peanut genotypes can vary from 21 to 85% and linoleic acid from 2 to 43%.phenolic compounds of plant origin have attracted considerable attention due to their beneficial functional and nutritional effects including antioxidant and antimicrobial activity (Bubonja-Sonje et al. 2011). Oils with high amounts of oleic acids are slower to develop oxidative rancidity during shelf life or undergo oxidative decomposition during frying than those oils that contain high oleic acid, low – linoleic and low-linolenic acids produced by various methods including genetic modification (Anon, 1998), and have been shown to be more stable to deterioration during deep-frying than regular oils. The knowledge of thermal stability of antioxidants is very important in food preservation. In edible oils, the choice of antioxidant must be aimed at the preservation of unsaturated fatty acids to increase the stability to thermal degradation, which usually happens between 150 and 220 °C. However, the presence of high concentrations of unsaturated fatty acids in vegetable oils requires greater thermal stability of the antioxidant (Yilmaz and Karakaya, 2009).

Nigella sativa L. is a vegetal spice belongs to the Ranunculaceae family, commonly known as black cumin seed. The seeds of *Nigella sativa* L have several therapeutic effects such as prevention of cancer, antihypertensive effect anti-inflammatory, analgesic and antihistaminic action. *N. sativa* seeds are used for edible and medicinal purposes. They are used in the preparation of traditional sweet dish, composed of black cumin paste, which is sweetened with honey or syrup, and in flavoring of foods, especially bakery products and cheese (Salma *et al*. 2007). Nigella seed oil or extract has protective and curative actions and is considered as one among newer sources of edible oils (Hamadi, 2007). Black cumin seeds contain appreciable quantities of unsaturated especially polyunsaturated fatty acids (48 to 70%), while mono unsaturated (18to 29%), and saturated fatty acids (12to 25%), are in lesser proportions. Besides a better fatty acid profile, it contains considerable quantities of tocopherols and allied bioactive compounds. Moreover, the presence of phytosterols in amounts of 0.33 to 0.36% (Sultan *et al*., 2009). The oxidative reaction is responsible for rancid odors and flavors within fats and oils which reduces nutritional quality of foods. Oxidation reactions consist of auto-oxidation, photooxidation, enzymatic oxidation and ketonic oxidation, whereas auto-oxidation is the most common deterioration during storage of edible oils. More of the interest on naturally occurring antioxidants is developed because of the trend to minimize or avoid the use of synthetic food additives (Shahidi 2005). The oxidative stability of peanut oil, was improved by blending with olein according to Prakash *et al*. (2001). Mariod. (2005) studied the improvement of the oxidation stability of sunflower kernel oil (SKO) blending with highly stable unconventional melon bug oil (MBO). They found that the stability of SKO and MBO were 43 and 48respectively. The blending of (SOK) with the usual Sudanese oils resulted in remarkable increase in their oxidative stability. Black cumin oil is very rich in natural antioxidant 45.066 mg/100g oil, Sultan *et al*., (2009) added cumin oil to peanut oil to improve its stability characteristics. The aim of this study was to evaluate the effect of Black cumin seeds (black seed) on the frying stability and the storage of crude and refined peanut oil by adding them in different types.

Materials and Methods

Refined Peanut oil was obtained from the supermarket and crude peanut oil from traditional mill. Black cumin seed and cumin oil were obtained from supermarket. Potato used in the frying experiments was brought from Bahri supermarket.

Preparation of samples:

Each 400ml of peanut oil (refined and crude) were put in containers and added 5gm of the flowing; cumin seed oil, cumin seed powder and cumin seeds. The samples of peanut oil having the following codes: control samples of peanut oil: crude (A_0) and refined (B_0)., crude peanut oil with cumin oil (A_1), refined peanut oil with cumin oil (B_1) ,crude peanut oil with cumin seed powder (A_2), Refined peanut oil with cumin seed powder (B_2), crude peanut oil with cumin seed (A_3) and refined peanut oil with cumin seed (B_3). All the samples were left for a weak and filtered to carry out the frying experiment.

Analytical Methods:

The study was conducted for six months and divided into zero time which was after a weak from adding cumin , ^{1st} period directly after frying, other periods(^{2nd}period and ^{3rd}period) were take two months between them**.** The samples were conducted to

determining; Free Fatty Acid (F.F.A), Peroxide Value (P.V) according to AOAC (2000), the fatty acid composition according to Anonymous, (1987) and sensory evaluation of potato chips according to Ihekoronye and Ngoddy (1985). All measurements were carried out in triplicate.

Frying Process:

The samples of peanut oil A_0, B_0, A_1, B_1, A_2, B_2, A_3 and B_3 were used to fry about hundred grams of potato chips for 13±2 min with temperature control of 180(±1) °C. The frying process was done in four successive days. After each frying experiment about 250 gm oil withdrawn and kept in analysis plastic containers till required for analysis. Samples of oils used in the frying stored at room temperature (37±2 C) for 6months (180 days divided to 3periodes).

Sensory Evaluation:

The fried potato chips were sensory evaluated by the ranking procedure described by Ihekoronnnye and Ngoddy (1985). Trained staffs (10 panelists) were asked to examine and evaluate the chips subjected to the ranking test, according to color, taste, flavuor, crispness and overall acceptability. Ranking was done for the eight samples :(1= excellent, 2= very good, 3 = good and 4 = unacceptable) for the different attributes. Sum of ranks were then statistically interpreted according to a table given by Ihekoronye and Ngoddy (1985).

Statistical Analysis:

Data generated were subjected to SAS version 9.2. One-factor complete randomized design (CRD) was assessed and then means were separated refer to Duncans' Multiple Range test.

Results and Discussion

Free Fatty Acid:

Table (1) shows the FFA of crude and refined peanut oil with different BCS additions. At zero time the control samples A_0 (1.97%) and B_0 (0.987%) have higher values than other samples which were have A_1(1.41%),B_1(0.56%), A_2 (1.69%), B_2(0.84%), A_3(1.6%)and B_3(0.84%), we noticed that the adding different blends of cumin seed was lowering the percentages of FFA comparing with control samples. On the ^{1st} period was no significant changes in FFA in all samples which have the same results on zero time; these results agree with results of Adam,. (2017) which were no significant difference in FFA at zero and 15 min of frying potato chips with the blend of crude peanut oil mixed with 5% BCSO (0.226) and (0.226). The percentage on ^{2nd}period significantly increased in all samples, highest increased was in samples A_2 (4.65), A0(3.9%) ,A_3(3.8%) and A1(3.3%) respectively. On ^{3rd}period there was significant decrease on FFA at all samples, which may resulted to long period of storage. Among all the blended samples the B(B0,B1,B2and B3) samples having the lowest values. All the samples in were stable values after frying that means the addition of black cumin seed at different forms(oil, powder and seeds) have significant effect. This results was agree with Adam,. (2017) which have significant difference in FFA of blended peanut oil with different percentages(5%,10% and15%) of black cumin seed oil (BCSO)at different frying times and disagreed with Khattab and Shakak (2012) who found that there was no significant difference in FFA of the blend of moringa oil with groundnut (1:1) oil compared with groundnut oil after frying potato chips., Shakak *et al*. (2015) showed that there was significant increase in FFA of blend of palm olein with groundnut oil (1:1) compared with palm olein oil after 5 hours frying potato chips.

Table 1: Changes in free fatty acids (%) in crude and refined peanut oils with different additions of black cumin seed during frying and storage

Storage period (month)	Samples							
	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3
Zero time	1.97^{f} ±0.03	0.987^{j} ±0.01	1.41^{h} ±0.01	0.564^{l} ±0.01	1.69^{g} ±0.04	0.846^{k} ±0.01	1.69^{g} ±0.02	0.846^{k} ±0.01
1st period	1.97^{f} ±0.03	1.128^{i} ±0.04	1.41^{h} ±0.01	0.564^{l} ±0.01	1.69^{g} ±0.02	0.846^{k} ±0.01	1.69^{g} ±0.02	0.846^{k} ±0.01
2nd period	3.90^{b} ±0.04	1.150^{i} ±0.02	3.30^{d} ±0.02	1.20^{i} ±0.03	4.65^{a} ±0.01	2.20^{e} ±0.02	3.80^{c} ±0.03	1.70^{g} ±0.02
3rd period	0.846^{k} ±0.01	0.282^{m} ±0.01	0.846^{k} ±0.01	0.282^{m} ±0.01	1.128^{i} ±0.01	0.846^{k} ±0.01	0.846^{k} ±0.01	0.282^{m} ±0.01
$Lsd_{0.05}$	0.07295^{*}							
SE±	0.02582							

Values are mean±SD.
Means having different superscripts are significantly different (P≤0.05)

Peroxide Value:

Table (2) show changes in peroxide value (ml. eq. O_2/kg oil) of crude and refined peanut oil mixed with different types of BCS. There was significant increase in PV at zero time, sample A_0 had less P.V. (1.5) than sample B_0 which was (2.4 ml.eqo_2/kg oil).; sample A_1 (0.80) and B_1 (1.7) were decreased comparing with control, these results agreed with Adam,(2017) that there was significant increase in PV at zero, 15 and 30 min of frying potato chips with the blend of crude peanut oil mixed with 5% BCSO (4.67, 5.00, 6.00) . On the 1st period samples (A_0, B_0, $A_1$and B_1) were almost stable and there was significant decrease in (A_2, B_2, A_3 and B_3) samples which have (6.00, 9.00, 7.00 and 8.00 ml.eq O_2/kg oil) respectively. These values were significant decreased on the 2nd period; the lowest value was in sample B_0(1.70) flowed by A_0 (2.0), B_1 (2.50)and A_1(3.5).on the 3rd period observed high decreased in PV of all samples ,the highest value was in sample A_2(24), while the lowest value was in sample A_1 (8.0).The blend of black cumin seeds($A_1$and B_1) oil with crude and refined peanut oil showed the significant effect on stability of peanut oil in all periodes when was compared with others. But there was significant different in (PV) in other treats of BCS at different periodes comparing with control samples. This results agree with Adam (2017) which was found the significant decrease in PV of the blend of crude peanut oil with 5% concentration of BCSO (6.00) when compared with same the blends of same peanut oil mixed with (CA, 10% BCSO, 15% BCSO) and control (6.67, 6.33, 15.00 and 12.00), respectively, and disagreed with Shakak *et al*. (2015) who showed that there was significant increase in PV of blend of palm olein with groundnut oil (1:1) compared with palm olein oil after 5 hours frying potato chips.

Fatty Acid Composition:

Table (3) show fatty acid composition of crude and refined peanut oil before and after adding BCS types. The values are significantly different (P≤0.05). The essential fatty acid linoleic (omega 6) was highest in (B) samples which was :59.41% ,58.47%, 58.14 and 55.26% in sample; B_3,B_2,B_0 and B_1 respectively being the major fatty acid. These results were higher than those found by Ali *et al*., (2012) and Padmaa, (2010) which was 52.6 and 55.6 %, respectively. The highest values of oleic acid was in samples (A) which was:47.81%, 39.14% ,38.79% and 37.63% in sample:A_3 ,A_2 ,A_0 and A_1 respectively .these results was higher than that reported by Padmaa, (2010) which was 23.4% and Adam (2017) which was(19.65%). The highest value of palmitic acid was in sample A_3(12.13%) which was agree with Adam (2017) 12.07%, and Ali *et al*., (2012) 12.5%. While the lowest value was in sample B_2 (6.862%). The percentages of stearic acid was the highest in sample A_3 (4.262%) and the lowest in sample B_3 (3.007%) which was higher than that obtained by Gharby *et al*. (2015) which was (0.2%) and Adam (2017) which was (2.49%). The mean values of saturated fatty acids percentages of peanut oil with BCS types were found higher in crude peanut oil samples: A3, A_2, A_0 and A_1 which were (8.196%, 6.377%, 6.237% and 6.126%) respectively than refined peanut oil samples (B samples). While the mean of unsaturated fatty acids

Table 2: Changes in peroxide value (m.Eq/kg oil) in crude and refined peanut oils treated with different addition of cumin during storage

Storage period (month)	Samples							
	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3
Zero time	1.50^{jk} ±0.03	2.40^{ij} ±0.01	0.80^{k} ±0.01	1.70^{jk} ±0.02	9.00^{ef} ±0.06	11.00^{cd} ±0.02	12.00^{c} ±0.07	14.00^{b} ±0.14
1st period	1.50^{jk} ±0.03	2.40^{ij} ±0.01	0.80^{k} ±0.01	1.60^{jk} ±0.03	6.00^{h} ±0.02	9.00^{ef} ±0.01	7.00^{gh} ±0.05	8.00^{fg} ±0.03
2nd period	2.00^{jk} ±0.04	1.70^{jk} ±0.12	3.50^{i} ±0.05	2.50^{ij} ±0.02	8.00^{fg} ±0.03	9.00^{ef} ±0.01	10.00^{de} ±0.11	10.00^{de} ±0.11
3rd period	14.00^{b} ±0.10	23.00^{a} ±0.13	8.00^{fg} ±0.04	15.00^{b} ±0.08	24.00^{a} ±0.07	14.00^{b} ±0.06	15.00^{b} ±0.10	23.00^{a} ±0.06
$Lsd_{0.05}$	1.294^{*}							
SE±	0.4579							

Values are mean±SD.
Means having different superscripts are significantly different (P≤0.05).

Table 3: Fatty acid composition (%) of crude and refined peanut oils treated with different addition of cumin seed

Component (%)	Samples								$Lsd_{0.05}$	SE±
	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3		
Palmetic acid (%)	8.536^{c} ±0.05	7.339^{e} ±0.05	8.499^{d} ±0.04	7.109^{g} ±0.02	8.623^{b} ±0.01	6.862^{h} ±0.04	12.13^{a} ±0.02	7.153^{f} ±0.04	0.0005474^{*}	0.0001826
Linoelic acid	44.39^{f} ±0.56	58.74^{b} ±0.78	45.58^{e} ±0.56	55.26^{d} ±0.71	43.67^{g} ±0.29	58.14^{c} ±0.14	28.66^{h} ±0.22	59.41^{a} ±0.36	0.0005474^{*}	0.0001826
Oleic acid	38.79^{c} ±0.25	29.60^{f} ±0.41	37.63^{d} ±0.11	31.39^{e} ±0.43	39.14^{b} ±0.41	29.51^{g} ±0.47	47.81^{a} ±0.45	27.95^{h} ±0.40	0.05474^{*}	0.01826
Stearic acid	3.939^{c} ±0.06	3.646^{g} ±0.03	3.753^{e} ±0.04	3.813^{d} ±0.04	4.131^{b} ±0.05	3.685^{f} ±0.01	4.262^{a} ±0.02	3.007^{h} ±0.05	0.0005474^{*}	0.0001826

Values are mean±SD.
Means having different superscripts in a row are significantly different (P≤0.05).

of peanut oil BCS types were found higher in refined peanut oil samples:B_0,B_2,B_3 and B_1which was (44.17%, 43.825%, 43.68% and 43.595%) respectively than crude peanut samples(A samples), these results was lower than that reported by Ali *et al*., (2012) which was 78.4% .That means the addition of BCS types(oil, powder and seeds) have significant effect on crude and refined peanut oil stability during frying and storage.

Sensory Evaluation Of Fried Potato Chips With Peanut Oil Samples Treated With BCS Types:

Table (4) shows the organoleptic properties of the potato fried with two types of peanut oil with different additions of BCS including colour, taste, flavour, crispness, and general acceptability. The results of colour appeared that there was no significant difference, sample B_0 (1.80) gained excellent ranking and samples A0 (2.80) A_1 (2.60), B_1 (2.60), A_2(2.60) , B_2 (2.40)and B_3 (2.10) were gained very good ranking respectively and sample A_3 (3.60) had good ranking. Also there was no significant difference were obtained in taste of fried potato with peanut oil types with different BCS types, very good rank were obtained by samples B_0(2.40) B_1(2.30), B_2(2.70) and B_3(2.00) while good ranking were obtained by A_0(3.60), A_1(3.20), A_2(3.00), A_3(3.40),) . There was no significant difference in flavour of fried potato in all samples, crude peanut oil samples have gained good rank: A_0(3.60), A_1(3.30), A_2(3.40) and A_3(3.50) while refined peanut oil samples were gained very good ranking: B_1(2.30), B_2(2.50) and B_3(2.20) and excellent ranking was obtained by sample B_0(1.90). Also the same table shows there was no significant difference in crispness of fried potato with crude peanut oil with different types of BCS :A_0(3.90), A_1(3.50), A_3(3.40) and A_2(3.30) which were good ; while refined peanut samples were gained very good ranking :B_0(2.50), B_1(2.80), B_2(3.00) and B_3(2.50). Table(4) shows that there was no significant difference in overall acceptability of fried potato with refined peanut oil blended with different BCS types which had very good ranking B_0(2.00), B_3(2.20), B_1(2.50) and B_2(2.60) ; while crude peanut oil samples with different types of BCS have good ranking which were A_0(3.70), A_1(3.60), A_3(3.50) and A_2(3.00). These results appeared that refined peanut oil samples with different additions of black cumin seed (BCS) have the highest ranks in different attributes .

Table 4: Acceptability test of potato chips fried by peanut oils treated with black cumin seeds

Quality attributes (scores)	Samples								$Lsd_{0.05}$	SE±
	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3		
Colour	2.80^{b} ±0.63	1.80^{c} ±0.79	2.60^{b} ±0.84	2.60^{b} ±0.84	2.60^{b} ±0.52	2.40^{bc} ±0.84	3.60^{a} ±0.97	2.10^{bc} ±0.74	0.6974^{*}	0.2474
Taste	3.60^{a} ±0.97	2.40^{cde} ±0.70	3.20^{abc} ±1.03	2.30^{de} ±0.82	3.00^{abcd} ±0.67	2.70^{bcde} ±0.95	3.40^{ab} ±0.84	2.00^{e} ±0.67	0.7501^{*}	0.2661
Flavour	3.60^{a} ±0.97	1.90^{b} ±0.74	3.30^{a} ±1.06	2.30^{b} ±0.82	3.40^{a} ±0.70	2.50^{b} ±1.18	3.50^{a} ±0.71	2.20^{b} ±0.63	0.7757^{*}	0.2751
Crispiness	3.90^{a} ±0.88	2.50^{b} ±0.85	3.50^{ab} ±1.18	2.80^{b} ±0.92	3.30^{ab} ±0.67	3.00^{ab} ±1.15	3.40^{ab} ±1.07	2.50^{b} ±1.27	0.907^{*}	0.3217
Overall acceptability	3.70^{a} ±0.67	2.00^{d} ±0.47	3.60^{ab} ±0.97	2.50^{cd} ±0.53	3.00^{bc} ±0.67	2.60^{cd} ±0.84	3.50^{ab} ±0.71	2.20^{d} ±0.79	0.6435^{*}	0.2283

Values are mean±SD.

Means having different superscripts in a row are significantly different (P≤0.05)

Conclusion

The antioxidant activity of *Nigella sativa* L. seed's has been demonstrated in two types of peanut oil (crude and refined) when was used in frying process and during storage of frying oil, black cumin seeds oil was found the best form when tested for increased stability of crude and refined peanut oil followed by black cumin seeds form which was also have effect on stability of frying oil.

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