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IMPLICATION OF DIFFERENT HEATING PERIODS ON SOME CHEMICAL COMPONENTS AND NUTRITIONAL VALUE OF *Nigella sativa* L.

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ABSTRACT

The objective of the present work was to follow up the effect of different heating periods i.e. 10, 20, 30 and 40 min. at 100°C on some chemical components and nutritional value of *Nigella sativa* L. *Nigella sativa* L. seeds are rich in crude fat content 35.22%, crude protein content (26.73%) and carbohydrate content (26.95%). The levels of antinutritional factors (ANFs) were found to be 1.70%, 1.12%, 4.3 mg/g and 51.40 (1 ml 0.1 N NaOH/100 g meal) for total phenolic compounds, phytic acid, trypsin inhibitor and lipase activity, respectively.

It was found that heating of *N. sativa* L. seeds generally and gradually reduced activity of trypsin inhibitor, phenolic compounds and phytic acid. Moreover lipase activity was totally destroyed after 30 min of heating. Concerning fatty acids present in *N. sativa* L. seed oil palmitic, oleic and linoleic acids seemed to be dominant ones.

Also, chemical properties and fatty acids composition of extracted oil were affected by the heat treatment of the seeds. The most dominant amino acids in *N. sativa* L. seeds were glutamic and aspartic acids, whereas the cysteine and methionine were of the least dominance. Heating seemed to reduce slightly contents of most the amino acids, whereas it increased protein digestibility.

Key word: *Nigella sativa* L. – Heating - Antinutritional factors – Fatty acids – Amino acids.

INTRODUCTION

Black cumin (*Nigella sativa* L.) is cultivated in Egypt, and known under different Arabic names: Habbah soeda, kamun Aswan and Habbet El-Baraka. The seeds possess aromatic odour and taste (Salama, 1973). The seeds are also used in the cooking and on bread products as a flavouring agent in Egypt, India and Turkey (El-Komey, 1996). Black cumin seeds have many medical uses such as digestive stimulants, carminative aromatic, diuretic, diphonetic stomachic and antheimitec agents (Agarwal. *et al.*, 1979 and Ibrahim, 1997). Compounds which have antimicrobial activities were found in the volatile oil of *N. sativa* L. seeds by Egyptian workers (El-Alfy *et al.*, 1975; Aqel and Shaheen, 1996).

Many reports and articles have been written (Datta *et al.*, 1987; Al-Jassir, 1992; Abdel-Aal and Attia, 1993a, b; Hailat *et al.*, 1995; and Ibrahim, 1997) indicating the importance of *N. sativa* L. seed oil in increasing immunity and maintaining good health.

Proteins and amino acids compositions of *N. sativa* L. seeds have been reported by Al-Jassir (1992); Abdel Aal and Attia (1993a) and Naroz (1997). On the other hand, antioxidative effects of black seeds were also discussed by Sosulski (1979), Nergiz (1991) and Nergiz and Otles (1993). Antioxidant substances are present in *N. sativa* L. seeds such as α, β and γ-tocopherols (about 340 μg/g) and polyphenols (about 1750 μg/g) in the seed oil. These compounds may be considered as native medicine and flavouring agents in several foods.

Oil of undamaged seeds is relatively stable due to physical separation between oil and seed lipases. When this physical separation is disrupted by grinding, inherently high lipase activities cause hydrolysis of natural fat to free fatty acids and glycerol. Because free fatty acids accumulate to unacceptable levels, the lipase must be inactivated. The only known practical method, which has commercial potential, is heat treatment (Desikachar, 1974).

The seeds and their oil may increase the human immunity (Toppazada *et al.*, 1965). They help in delaying menses, lactation, flatulence respiratory depression, asthma, cough, as a diuretic, antioxidants and reduce the microbial growth El-Mofty *et al.*, 1997; Atta and Imaizumi, 1998 and Ibrahim, 1999).

Phenolic compounds are known to adversely affect the utilization of protein in animal and human diet due to their ability to bind and

precipitate proteins and inhibit some digestive enzymes such as trypsin and α-amylase (Davis and Hoseny, 1979). On the other hand, several epidemiological studies have shown that an increased dietary intake of natural phenolic antioxidants correlates with reduced coronary heart disease (Hertog *et al.*, 1993). The phenolic compounds have also, been found to exhibit many health-related properties include anticancer, antiviral anti-inflammatory and an ability to inhibit human platelet aggregation (Benavente-Gracisa *et al.*, 1997).

Phytic acid and phytate are natural plant inositol hexaphosphate usually present in seeds. In the meantime, phytic acid and phytate have an adverse effect on minerals bioavailability in nutrition. They reduce the solubility of starch and proteins and may decrease their digestibility. (Thampson, 1993). Trypsin inhibitors arc proteins with molecular weight ranging from 8,000 to 21,000 dalton (Liener, 1986). They hinder the digestibility of food proteins (El-Bagoury *et al.*, 1999).

Salem *et al.* (2001) found that *Nigella* flours defatted by pressing or by petroleum ether contained 643 and 620 mg/100 g phenolic compounds, 852.72 and 832.01 mg/100 g phytic acid and 7.45 and 10.21 trypsin inhibitor units. Heat treatments decreased the phenolic compounds by about 25-30%, phytic acid by 10-15% and trypsin inhibitors by 29-100%. In respect to amino acids composition, both defatted *Nigella* flours were rich in most of essential and non-essential amino acids compared to the FAO/WHO standards (1985).

Ghazi *et al.* (1992), El-Kady (2000) and Moussa (2001) used protein isolated from sugar-beet leaves flaxseed meal and *Nigella* meal for preparing a good sausage, pan bread and spaghetti macaroni.

Nigella seed oil is produced in Egypt by pressing or by organic solvents, but the pressed cake or defatted flour (by-product) has not efficiently been utilized. The objective of the present work was to determine the levels of antinutritive factors in *Nigella sativa* L., the effect of dry heating on antinutritive factors and evaluation of their nutritional value.

MATERIALS AND METHODS

Nigella sativa L. seeds were obtained from Agricultural Research Center, Giza, Egypt and were roasted by heating at 100°C for 10, 20, 30 and 40 min and than left to cool at room temperature, cleared and

finely ground. Hexane (B.P. 40-60°C) was used for the extraction of oil from the ground seeds.

Chemical analysis:

Moisture, crude fat, total protein and ash content were determined in *Nigella sativa* L. seeds according to the standard methods described in A.O.A.C. (1995).

Acid value, peroxide value and iodine value were determined according to the standard method described by A.O.A.C. (1995).

The total fatty acids after a saponification of the oil samples were methylated by diazomethane which was prepared from methyl amine and urea as reported by Vogel (1975). The fatty acids methyl esters were analyzed using a Pye Unicum Series 304 Gas-liquid Chromatography, with Flame Ionization Detector.

The trypsin inhibitor activity (TIA) was measured by the method described by Hamerstrand *et al.* (1981) and modified with respect to the initiation of the TIA assay, *i.e.* trypsin was added last to the inhibitor-substrate mixture (Stauffer, 1993), using N-benzoyl-DL-arginine-*p*-nitroanilide hydrochloride (BAPA) as synthetic substrate for trypsin. The assay was run in triplicate and average values were used in expressing the results.

Phytic acid content in raw and processed Nigella samples was estimated colorimeirically using Wade reagent (Latta and Eskin, 1980). The free bound or conjugated and total phenols were calorimetrically determined in the ethanolic extracts by using the Folin Denis reagent as described by Gutfinger (1981). Lipase activity in ground nigella seeds were determined according to the method of Ranakrishnan and Nevgi (1951). The activity was expressed as the difference between sample and blank titers (1 ml 0.1N NaOH/g seeds).

Molecular weights of subunits of protein extracted using (0.02 N NaOH) from different flours were determined using sodium dodecyi sulphate polyacrylamide gel electrophoresis (SDS-PAGE) according to the method described by Laemmeli (1970). The digestibility of protein in vitro was carried out as described by Singh and Jumbunathan (1981). The amino acids in *Niglla* seeds were determined using the amino acid analyzer (Model 121) as described by Moore *et al.* (1958).

RESULTS AND DISCSSION

Results of chemical analysis of *N. sativa* L. seeds are presented in Table (1). These results reveal that *N. sativa* L. seeds are rich in crude fat (35.22%), crude protein (26.73%) and carbohydrate (26.95%). The crude protein of *N. sativa* L. was relatively higher than that reported by El-Malt *et al.* (1998) but, on the other hand, it was in a good agreement with that reported by Salem *et al.* (2001) and Atta (2003). Such variation in crude protein content might be attributed to the variations in both physical and chemical properties on which the plants were grown. Also, the different fertilization treatments may account for these variations.

Table (1): Chemical composition of *Nigella sativa* L. seeds.

Components	
Moisture (%)	6.30
Ash (%)	4.80
Fat (%)	35.22
Crude protein (%)	26.73
Carbohydrate (%)	26.95
Polyphenols (%)	1.70
Phytic acid (%)	1.12
Trypsin inhibitor (mg/g)	4.30
Lipase activity (1 ml 0.1 N NaOH/100 g)	51.40

The levels of antinutritional factors (ANFs) in *N. sativa* meal were found to be 1.70%, 1.12%, 4.3 mg/g and 51.40 (1 ml 0.1 N NaOH/100 g meals) for total phenolic compounds, phytic acid, trypsin inhibitor activity and lipase activity, respectively.

The polyphenolic compounds content of *N. sativa* seeds (1.7%) is different from that reported by El-Malt *et al.* (1998), but is in agreement with that reported by Nergiz and Otles (1993) which was (1.744%). The contents of the other ANFs in *N. sativa* seeds are in agreement with those reported by Shaker *et al.* (1997), Moussa (2001) and Ramdan *et al.* (2003).

Chemical properties of oils extracted from *N. sativa* seeds heated on different periods are presented in Table (2). There were slightly and gradually increases in acid value and peroxide value whereas a decrease occurred in iodine value with increasing time of heating. The

increase in acid value may be attributed to a slight random hydrolysis of triacylglycerols by heating that produces free fatty acids and diacylglycerols (Yoshida *et al.*, 1992). The increase in peroxide value is probably due to the oxidation of unsaturated fatty acid occurred as a result of heating of the *N. sativa* seeds (Yoshida *et al.*, 1990). On the other hand, the decrease occurred in iodine value in oil extracted from *N. sativa* seeds might be attributed to the effect of heating on oxidation of the unsaturated fatty acids which results in a decrease in the relative percentage of total unsaturated fatty acids and a corresponding increase in the relative percentage of total saturated fatty acids (Yoshida *et al.*, 1990).

Table (2): Effect of dry heating on chemical properties of *N. sativa* L. seeds oil.

Parameters	Time of heating (min)				
	0	10	20	30	40
Acide value	11.50	11.30	12.70	13.90	14.98
Peroxide value	6.18	6.90	7.12	7.90	8.97
Iodine value	125.60	124.13	123.13	122.10	121.21

The fatty acids composition of oils extracted from *N. sativa* seeds heated for different periods are presented in Table (3). The obtained results show that the major constituents of these fatty acids were palmitic, oleic and linoleic acids whereas low the other fatty acids i.e. myristic, stearic, arachidic and linolenic acids were detected in lower percentages. These results are in good agreement with those reported by Ramadan and Morsel (2002), Bahman *et al.* (2003) and Talaat and El-Din (2005). The percentage of total saturated fatty acids increased whereas the percentage of total unsaturated fatty acids decreased due to heating at 100°C for different periods, yet the effect seemed more prounced by increasing period of heating. These results are in good agreement with those reported by Moussa (2001).

Table (3): Effect of dry heating on fatty acid composition of *N. sativa* L. seeds oil.

Fatty acids	Time of heating (min)				
	0	10	20	30	40
$C_{12:0}$	0.45	0.60	0.67	0.74	1.15
$C_{14:0}$	0.97	1.60	1.11	1.80	1.99
$C_{16:0}$	17.70	17.85	18.11	18.55	19.80
$C_{18:0}$	2.69	2.70	2.95	3.11	3.27
$C_{20:0}$	0.20	0.25	0.27	0.30	0.41
$C_{18:1}$	21.37	20.17	20.40	20.86	19.90
$C_{18:2}$	56.88	56.13	55.88	54.20	54.18
$C_{18:3}$	0.74	0.70	0.61	0.44	0.30
Total saturated fatty acids	22.01	23.00	23.11	24.50	25.62
Total unsaturated fatty acids	78.99	77.00	76.89	75.50	74.38

Effects of dry heating on antinutrional factors contents of lipase activity, trypsin inhibitor activity, polyphenolic compound and phytic acid in *N. sativa* L. seeds were examined and the results are presented in Table (4) and illustrated graphically in Fig. (1). Dry heating of *N. sativa* L. seeds for 40 min reduced activity of trypsin inhibitor by 78%. Polyphenolic and phytic acid were more resistant to heat treatments compared to trypsin inhibitor activity where heating for 40 min reduced their contents by 55 and 59%, respectively.

Lipase activity was totally destroyed after 30 min of heating of *N. sativa* seeds. These results are, to some extent, in agreement with those reported by El-Kady (2000) and Salem *et al.* (2001).

Table (4): Effect of heating on antritional factos (ANFs) of *N. sativa* L. seeds:

Time of dry heating (min)	Lipase activity (%)	Trypsin inhibitor activity (%)	Phytic acid (%)	Polyphenols (%)
0	100	100	100	100
10	42	75	71	70
20	21	45	68	65
30	0.0	29	45	55
40	0.0	22	41	45

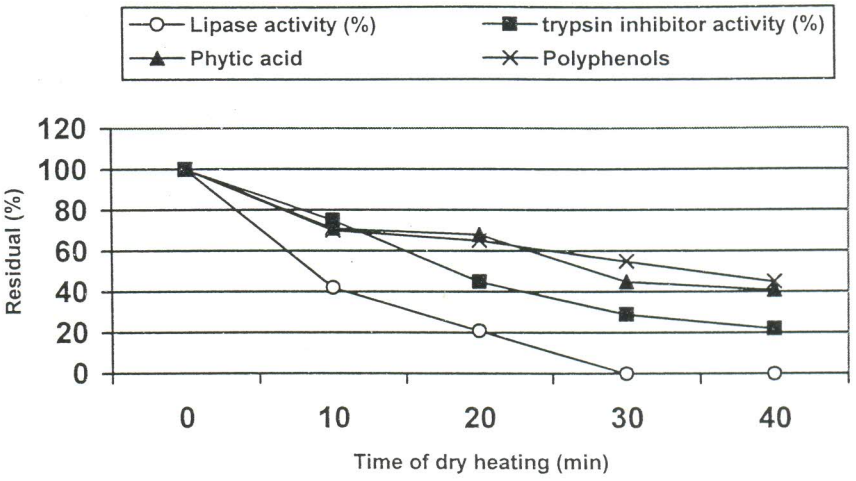

Fig. (1): Effect of dry heating on antinutrional factors (ANFs) of *N. sativa* L. seeds.

The amino acids profile of *N. sativa* seeds as affected by dry heating for 30 and 40 min is shown in Table (5). The most dominant amino acids in *N. sativa* seeds were glutamic acid (17.3 g/100 g protein) followed by aspartic acid (8.3 g/100 g protein) whereas the cysteine and methionine were the least dominant amino acids. The defatted *N. sativa* seeds (meal) were rich in both essential and non-essential amino acids. Threonine, isoleucine and aromatic amino acids were present in *Nigella* flours in amounts higher than those reported by FAO/WHO (1985). Heating seemed to reduce slightly contents of most of the amino acids. Such results are in agreement with those found by Salem *et al.* (2001) who found that heat treatment had a little effect on amino acid of *Nigella* protein isolate.

The solubility curve Fig. (2) showed that about 91% of the protein content was soluble between pH 8 and 10. Minimum solubility about (18.5%) occurred at pH 4.2 which is represents the isoelectric point. These results are in agreement with the results of Abd El-Galil and Latif (2003) who reported that maximum value of protein solubility was found at pH range 9-12 and minimum solubility was at pH range 3-5. The results obtained herein referrers that all heat treatments increased the extractability of protein from defatted *Nigella* flour.

The effect of heating treatments on protein subunits of *N. sativa* seeds are shown in SDS-PAGE patterns (Table, 6 and Fig., 3). The unheated seed showed 14 subunits with molecular weights ranging from 90,000 to 16,000 KD. On the other hand, seeds heated for 20 min showed only 9 subunits with molecular weight ranging from 55,000 to 16,000 KD. Increasing heating time for 30 and 40 min showed a reduction in the number of subunits to 7 and 6 subunits, ranging from 39,000 to 16,000 and 33,000 to 16,000, respectively. In general, it could be concluded that heat treatment caused subunits of the high molecular weights to disappear probably due to their dissociation to lower molecular weight subunits.

Table (5): Effect of dry heating on the amino acids percentage (g/100 g protein) of *N. sativa* L. seeds.

Amino acids	Heating time at 100°C (min)			FAO/WHO (1985) pattern (g/100 g protein)
	0	30	40	
Essential amino acids (E.A.A.):				
Lys.	3.81	3.55	3.35	5.50
Leu.	6.97	6.75	6.63	7.00
Isoleu.	3.70	3.70	3.64	3.50
Cys.	2.15	2.11	1.89	3.50
Met.				
Phe.	3.85	3.84	3.69	6.00
Tyr.	4.31	4.29	4.25	
Thr.	4.56	4.56	4.53	4.00
Val.	4.91	4.90	4.82	5.00
Try.	1.98	1.85	1.64	1.00
Total E.A.A.	36.24	35.55	34.44	
Non essential amino acids (N.E.A.A.)				
His.	3.95	3.89	3.89	
Arg.	6.54	6.51	6.11	
Asp.	8.30	8.12	8.00	
Glu.	17.30	17.32	17.35	
Ser.	4.40	4.38	4.34	
Pro.	4.52	4.42	4.28	
Gly.	6.41	6.41	6.22	
Ala.	4.52	4.49	4.33	
Total N.E.A.A.	55.94	55.54	54.52	
Total A.A.	92.18	91.09	88.96	

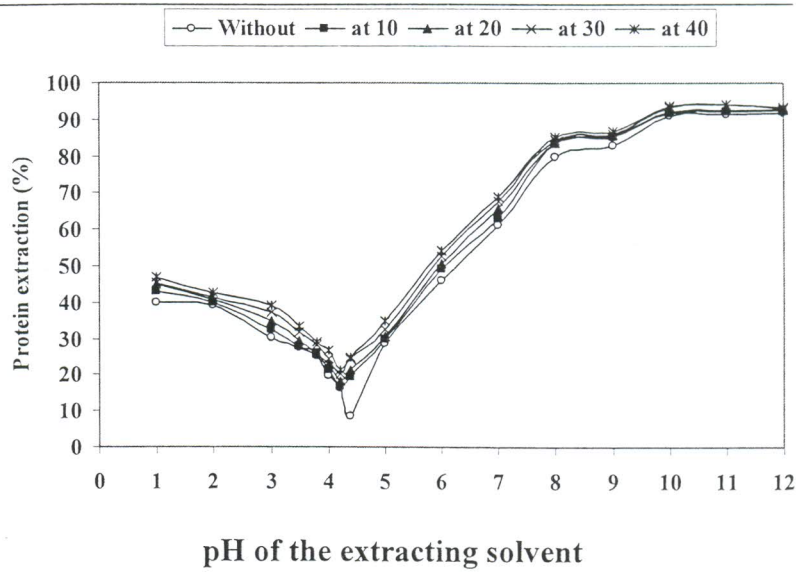

Fig. (2): Effect of dry heating on the stability of *N. sativa* L. seed protein.

Table (6): Molecular weights of *N. sativa* L. protein subunits extracted at different times of heating (as determined by SDS-PAGE, KD).

Band	Heating time (min)				
	0	10	20	30	40
1	90000	---	---	---	---
2	82000	82000	---	---	---
3	77000	77000	---	---	---
4	72000	72000	---	---	---
5	68000	68000	---	---	---
6	55000	55000	55000	---	---
7	42000	42000	42000	---	---
8	39000	39000	39000	39000	---
9	33000	33000	33000	33000	33000
10	29000	29000	29000	29000	29000
11	25000	25000	25000	25000	25000
12	23000	23000	23000	23000	23000
13	21000	21000	21000	21000	21000
14	16000	16000	16000	16000	16000

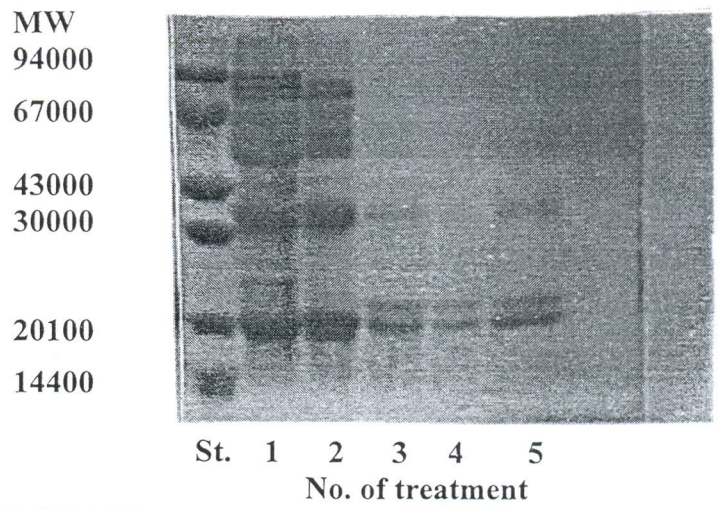

Fig. (3): SDS-PAGE pattern of *N. sativa* L. protein extraction after heating treatments.
1- Without heating.
2- Heating at 100°C for 10 min. 3-Heating at 100°C for 20 min.
4- Heating at 100°C for 30 min. 5- Heating at 100°C for 40 min.

The results in Fig. (4) show that the *in vitro* protein digestibility of unprocessed N-sativa seed was 81.30%. Heat treatment increased protein digestibility to 87.6% at 40 min. The increase in protein digestibility after heating could be partially attributed to the protein denaturation which improves protein susceptibility to attach with enzyme. Furthermore, elimination or reduction of antinutritional factors would certainly improve protein digestibility (Salem *et al.*, 2001).

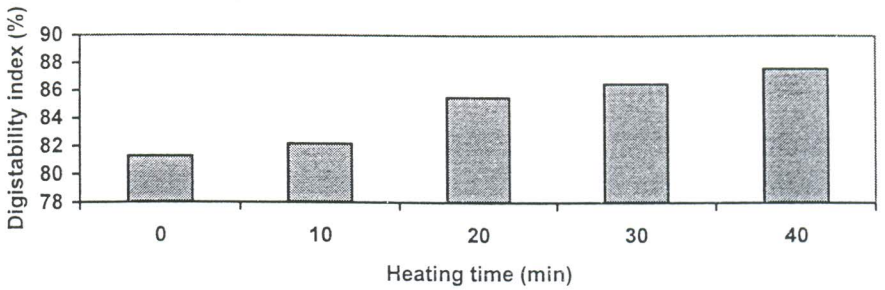

Fig. (4): Effect of heating *N. sativa* L. seeds on *in-vitro* protein digestibility.

The aforementioned results revealed that dry heating at 100°C for periods extending to 40 min reduced or even eliminated the antinutritional factor (ANFs) and hence improved the protein digestibility.

REFERENCES

Abdel-Aal, E.S.M. and Attia, R.S. (1993a): Characterization of black cumin (*N. sativa*) seeds. 1- Chemical composition and lipids. Alex. Sci. Exch., 14(4): 467-482.

Abdel-Aal, E.S.M. and Attia, R.S. (1993b): Characterization of black cumin (*N. sativa*) seeds. 2- Proteins. Alex. Sci. Exch., 14(4): 483-496.

Abd El-Galil, M.L. and Latif, S.S. (2003): Black cumin (*Nigella sativa* L.) seeds as potential food additive source. J. Agric. Sci. Mansoura Univ., 28(7): 5803-5814.

Agarwal, P., Kharya, M.D. and Shrivastava, S.A. (1979): Antimicrobial and anthelmintic activities of the essential oil of *N. sativa* Linn. Indian J. Exp. Biol., 17: 1264-1277.

Al-Jassir, S.M. (1992): Chemical composition and microflora of black cumin (*N. sativa* L.) seeds growing in Saudi Arabia. Food Chem., 45(4): 239-242.

A.O.A.C. (1995): Official Methods of Analysis of the Association of Offiial Analytical Chemists. Published by the A.O.A.C. 16th Ed. Washington. D.C.

Aqel, M. and Shaheen, R. (1996): Effects of *Nigella sativa* seeds on the uterine smooth muscle of rats and guinea pigs. J. Ethnophamacol., 52(1): 23-26.

Atta, M.B. (2003): Some characteristics of *Niglla* (*Nigella sativa* L.) seed cultivated in Egypt and its lipid profile. Food Chemistry, 83(1): 63-68.

Atta, M.B. and Imaizumi, K. (1998): Antioxidant activity of nigella (*Nigella sativa* L.) seeds extracts. J. Jpn. Oil Chem. Soc., 47: 475-480.

Bahman, N.; Faraz, M.; Katayoun, J. and Amoli, M.A.R. (2003): Chemical composition of the fixed and volatile oils of *Nigella sativa* L. from Iran-Zeitschrift-fur-Naturforschung-C,-Biosciences. 58: 629-631.

Benavente-Gracisa, O.; Castillo, J.; Marin, F.R.; Ortumo, A. and Rio, J.A. (1997): Use and properties of cirrus flavonoids. J. Agric. Food Chem., 45: 4505.

Datta, A.K.; Das, J.L. and Biswas, A.K. (1987): Electrophoretic characterization and evaluation of proteins in control and mutant lines of *Nigella sativa* L. Cytologia, 52(2): 317-322.

Davis, A.B. and Hoseny, R.C. (1979): grain sorghum condensed tannins. 1. Isolation estimation and clective adsorption by starch. Cereal Chem., 56: 310.

Desikachar, H.S.R. (1974): Status report. Preservation of by-products of rice milling. Page 1 in Proc Rice By-products Utilization. Int. Conf. II Valencia, 1974.

El-Alfy, T.; El-Fatary, H. and Toama, M. (1975): Isolation and Structure assignment of an antimicrobial principle from the volatile oil of *Nigella sativa* L. seeds. Pharmazie, 30: 109.

El-Bagoury, A.A.; Salem, M.A. and Kassab, H.E. (1999): Effect of soaking and germination of some legumes on their chemical and nutritional values. J. Agric. Sci., Mansoura Univ., 24: 573.

El-Kady, E.A. (2000): Chemical, physical and technological evaluation of flaxseed meal. Ph.D. Thesis, Food Technol. Dept., Fac. of Agric., Kafr El-Sheikh, Tanta Univ., Egypt.

El-Komey, A.G. (1996): Effect of black seeds (*N. sativa* L.) during pregnancy and location on mammary gland development in rats. Alex. J. Agric. Res., 41(1): 63-74.

El-Malt, E.A.; Ghazy, M.A.; Metry, S.W. and Noroz, A.Y. (1998): Chemical analysis of *Nigella sativa* L. seeds grown in Minia governorate Egypt. J. Agric. Sci. Mansoura Univ., 23(3): 1303-1318.

El-Mofty, M.M.; Abdel-Galil, A.M.; Shuaireb, M.H.; El-Dakhakhny, M.M.; Rizk, A.M. and Hofny, E.H. (1997): Prevention of skin tumers induced by 7, 12 dimethylbenz (a) anthracene in mice by black eed oil. Oncology Reports, 4: 139-141.

FAO/WHO (1985): Energy and protein requirements". Geneva World Health Organization Technical Report Series/No., 724.

Ghazi, A.; Shalaby, S.; El-Sebaiey, L. and Ammar, K. (1992): Food from waste. I- Isolation of protein from sugar-beet leaves. Proceeding First International Conference on. "Towards An Arab African Strategy For Safe Food and Better Neutration", 23-25 June, Alex., Egypt.

Gutfinger, T. (1981): Polyphenols in olive oils. J. Am. Oil Chem. Soc., Vol. 58: 966-986.

Hailat, N.; Bataneh, Z.; Lafi, S.; Raweily, E.; Aqel, M.; Al-Katib, M. and Hanash, S. (1995): Effect of *Nigella sativa* volatile oil on Jurkat T cell leukemia polypeptides. International J. Pharm., 33(1): 16-20.

Hamerstrand, G.E.; Black, L.T. and Glover, J.D. (1981): Trypsin inhibitors in soy products. Modification of the standard analysis procedure. Cereal Chem., 58: 42-45.

Hertog, M.G.; Feskeens, E.J.; Hollman, C.H.; Katan, M.B. and Kromhout, D. (1993): Dietary antioxidant flavonoids and risk of coronary heart disease. De Zutphen elderly-Lancet, 342: 1007.

Ibrahim, A.M. (1999): Chemical, biological and microbiological studies on *Nigella sativa* L. seed. Ph.D. Thesis, Food Sci., Technol. Dept., Fac. of Agric., Cairo Univ., Egypt.

Ibrahim M.R. (1997): Effect of some plants natural products on fat metabolism in rats. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ.

Laemmeli, U.K. (1970): Cleavage of structural protein during the assembly of the head of bacteriophage T_4. J. Nutr., 227: 680-685.

Latta, M. and Eskin, N.A.M. (1980): A simple and rapid colorimeteric method for phytate determination. J. Agric. Food Chem., 28: 1313-1315.

Liener, I.E. (1986): Trypsin inhibitors: Concern for human nutrition. J. Nutr., 116: 920.

Moore, S.; Spachman, D.E. and Stein, W. (1958): Chromatography of amino acid on sulphonted polystyrene resins. Anal Chem., 30: 1185-1190.

Moussa, A.S. (2001): Utilization of protein of defatted *Nigella* flours in preparing sausage. J. Agric. Res. Tanta Univ., 27(3): 515-522.

Naroz, A.Y. (1997): "Biochemical studies on *N. sativa* L. seeds. M.Sc. Thesis, Fac. of Agric., El-Minia Univ.

Nergiz, C. (1991): Antioxidant activity of some phenolic compounds in refined olive oil. Riv. Ital. Sost. Grasse, 68: 553-554.

Nergiz, C. and Otles, S. (1993): Chemical composition of *Nigella sativa* L. seeds. Food Chemistry, 48(3): 259-261.

Ramadan, M.F.; Kroh, L.W. and Morsel, J.T. (2003): Radical scavenging activity of black cumin (*Nigella sativa* L.). Crude Seed Oils and Oil Fractions 51(24): 6961-6969.

Ramadan, M.F. and Morsel, J.T. (2002): Neutral lipid classes of black cumin (*Nigella sativa* L.) seed oils. European Food Research and Technology 214(3): 202-206.

Ranakrishnan, V.C. and Nevgi, V.G. (1951): Enzyme lipase production. Indian Acad. Sci., 33(B): 268-760. (c.f. Chem. Abst., 46: 7133e).

Salama, R.B. (1973): Sterols in the seed oil of *Nigella sativa*. Planta Med., 24: 375-377.

Salem, M.A.; Shalaby, S.M. and Kassab, H.E. (2001): Effect of some heat treatments on *Nigella* seeds characteristics. J. Agric. Res. Tanta Univ., 27(3): 502-514.

Shaker, E.S.; Abo El-Fetoh, S.S.; El-Malt, E.A. and Ghazy, M.A. (1997): Effect of on the antioxidative activity of some monophenolic compounds. Second International Conference: Romania and Romanians in Contemporary Science.

Singh, U. and Jumbunathan, R. (1981): Studies on the desi and kabull ckick pea (*Cicer arietinum* L.) cultivars: levels of protease inhibitors levels of polyphenolic compounds and *in vitro* protein digestibility. J. Food Sci., 48: 1364-1367.

Sosulski, F.W. (1979): Organoleptic and nutritional effects of phenolic compounds on oil seed protein products. A review. J. Am. Oil Chem. Soc., 56: 711-715.

Stauffer, C.E. (1993): Trypsin inhibitor measurement: Effect of order of reagent addition. Cereal Chem., 70: 111-112.

Talaat, I.M. and El-Din, K.M.G. (2005): Physiological effect of putrescine and heat hardening of *Nigella sativa* L. plants. International J. of Agric. And Biology 7(3): 358-362.

Thampson, L.U. (1993): Potential health benents and problems associated with antinutrients in foods. Food Res. Int. 26: 31-37.

Toppazada, H.; Mazloum, H.A. and El-Dakhakhny, M. (1965): The antibacterial properties of the *Nigella sativa* L. seeds active principle with some clinical application. J. Egypt. Med. Assoc., 48: 187.

Vogel, A.R. (1975): A text book practical chemistry 3rd Ed. English language. Book Socity and Longman Group Ltd.

Yoshida, H. Hirooka, N. and Kajimoto, G. (1990): Microwave energy effects on quality of some seed oils. J. Food Sci., 55: 1412.

Yoshida, H. Hirooka, N. and Kajimoto, G. (1992): Effects of microwave energy on the relative stability of vitamin E in animal fats. J. Food Agric.., 58: 531.

تداعيات فترات تسخين مختلفة على بعض المكونات الكيميائية والقيمة الغذائية لحبة البركة

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يهدف البحث إلى دراسة تأثير التسخين على درجة ١٠٠°م لفترات زمنية مختلفة (١٠، ٢٠، ٣٠، ٤٠ دقيقة) على بعض المكونات الكيميائية والقيمة الغذائية للحبة السوداء.

ومن النتائج المتحصل عليها وجد أن الحبة السوداء غنية فى محتواها من الزيت والبروتين والكربوهيدرات. حيث احتوت على هذه المكونات بنسب ٣٥,٢٢%، ٢٦,٧٣%، ٢٦,٩٥% على الترتيب. كما احتوت على مضادات التغذية مثل المركبات الفينولية وحمض الفيتيك ومضاد التربسين ونشاط أنزيم الليبيز. كما وجد أن تسخين الحبة السوداء لفترات زمنية مختلفة أدى إلى انخفاض تدريجى فى محتواها من مضاد التربسين والمركبات الفينولية وحمض الفيتيك كما أدى التسخين لمدة ٣٠ دقيقة إلى تحطم كامل لنشاط أنزيم الليبيز.

وقد وجد أن الأحماض الدهنية السائدة فى زيت حبة البركة هى حمض البالمتيك، والأوليك، واللينوليك. كما أدى التسخين إلى حدوث تغير فى الصفات الكيميائية وكذلك فى نسب الأحماض الدهنية فى الزيت المستخلص من حبة البركة. كما وجد أن الأحماض الأمينية السائدة فى بروتين حبة البركة هى الجلوتاميك والأسبارتيك وأقل الأحماض الأمينية تواجدا هى السستين والميثيونين. كما أدى التسخين لفترات مختلفة إلى انخفاض بسيط وتدريجى فى معظم الأحماض الأمينية.

ولقد أوضحت الدراسة أن التسخين على درجة ١٠٠°م لفترات امتدت إلى ٤٠ دقيقة أدى إلى خفض أو التخلص من بعض مضادات التغذية مما أدى إلى تحسين فى معامل هضم البروتين.