J. Agric. Sci. Mansoura Univ., 27 (9): 6051 - 6062, 2002

EFFECT OF GROWTH OF *Aspergillus niger* AND *Penicillium* sp ON THE OIL CONTENT AND FATTY ACIDS COMPOSITION OF STORED SOYBEAN SEEDS

Rabie, M. M.[1]; T. S. M. Shady [2] and Hoda A. E. El-Shazly[3]

[1] Food Industries Dept., Fac. of Agric., Mansoura Univ., Mansoura, Egypt.

[2] Microbiol. Dept., Soil, Water and Environ. Res. Institute, Agric. Res. Center, Giza, Egypt.

[3] Fat and Oil Res. Dept., Food Techn. Res. Institute, Agric. Res. Center, Giza, Egypt.

ABSTRACT

Uninoculated and inoculated soybeen seeds with, *Aspergillus niger* and *Penuicillium* sp, stored at different temperatures, different levels of moisture and storage times were analyzed. The results showed that soybean oil content and iodine value were decreased in the seed inoculated with *Aspergillus niger* and *Penicillium* sp and stored at 5 and 30°C, respectively. Oil content of the seed inoculated with *A. niger* was decreased sharply than those found in other ones. As the prolongation of the storage period as well as with the raising of storage temperature and moisture content %, iodine value and oil content were decreased to great amount. In contrast, free fatty acid increased greatly, in the inoculated seeds stored at the same conditions, which, palmatic (C6:0), stearic (C 18:0) and oleic acids (C 18:1) were increased sharply. While, sharply decreased were obtained of the linoleic acid (C 18:2). Total saturated fatty acids contents were higher in seeds inoculated with both fungi than those found in the uninoculated ones. Storage for 2, 4 and 6 months at 5 and 30°C and 7.3 and 11.8% as moisture content resulted in oil deterioration and reduced total unsaturated fatty acids content.

Keywords: *Aspergillus niger*, *penicillium* sp, oil content, humidity, moisture content, total saturated fatty acids (TS), total unsaturated fatty acids (TU).

INTRODUCTION

Soybean (*Glycine max*, L, Merrill) is an important source of energy and protein for both animal and human nutrition in many parts of the world. Soybean protein is one of the best vegetable proteins, because the essential amino acid pattern of soybean protein complements the other vegetable protein sources. Also, soybean is very important as a source of oil as well as it is one of the most leguminous crop in many regions of the world. Although, soybean is used as a source of vegetable oil, which is the most consumed oil in Egypt. It provides essential fatty acids and energy and is considered a carrier of the soluble vitamins. It is also used as human food and animal feed. It's importance as a food crop for human and animal is due to its high content of prolein (Liu & White, 1992; Hafez *et al.*, 1996; Zein El-Dein, 1999 and Hafez *et al.*, 2000).

Relatively little of the extensive work with deterioration of stored grains and seed has dealt with soybeans, although these have the reputation among grain handlers of being difficult to store without deterioration. Many of

the investigators attributed most of the increase in respiration rate, fatty acids and temperature and decrease in non reducing sugars in moist stored soybeans help to the growth of fungi, especially *Aspergillus glaucus* and *A. flavus*. Seed-borne fungi associated with soybean seeds, have a world wide distribution and are known to cause huge losses in the yield for its deterioration qualitatively and quantitatively. Several fungi attack soybean seeds causing deterioration and tremendous damage and finally production of toxins. Thus, its consumption may be become injurious to human and domestic animals. Most of the storage microflora, e.g., *Aspergillus* , *Fusarium* and *Penicillium* which are active at relative humidity ranging from 70 to 90%. *Aspergillus flavus*, *A. niger*, *Alternaria*, *Fusarium* and *Penicillium* were not recovered at room temperature for 10-11 months at 6.2 – 11.4% moisture content (Dhingra *et al.*, 1973; Farag *et al.*, 1981 and Hafez *et al.*, 1996).

Chemical analysis of oil extracted from soybean seeds showed differences exist of mono-glycerides and free fatty acids fractions of oil (Hafez *et al.*, 1996). Basyony *et al.* (1989) reported that oil content, acid value and iodine value of soybean seeds were 25.10, 3.11 and 133.49%, respectively But, Hafez *et al.* (1996) reported that some of fatty acids were increased, but, other were decreased sharply. Also, total saturated fatty acids contents were lower in seeds inoculated with fungi.

Therefore, the present investigation was undertaken to determine the oil content, acid value & iodine value and fatty acids composition of oil extracted from uninoculated and inoculated soybean seeds with *Aspergillus niger* and *Penicillium* sp, which stored at different temperatures, different levels of moisture contents and time.

MATERIALS AND METHODS

Source of seed sample:

Sample of soybean seeds (*Glycine max*, L, Merrill) were collected after harvesting from Clark variety as the most prevalent and distributed cultivars in all growing areas of the crop in Dakhlia governorate during 2000 and 2001 soybean growing seasons.

Seed inoculation:

Apparently healthy and insect-free seeds were collected from Clark variety. The seeds were disinfected by immersing it in 2% sodium hypochloride solution for 2 min., then dried in hot air oven at 40° ± 2 for 24 hours. The seeds were inoculated with *Aspergillus niger* and *Penicillium* sp. with individual treatment according to the technique adopted by Dorworth and Christensen (1968). The seed moisture content was adjusted to 7.3 and 11.8 % in different two treatments (Christensen and Kaufmann, 1968). Seed samples inoculated with each fungi and uninoculated served as control were stored at 5 and 30°C for 0, 2, 4 and 6 months as a storage periods, then, oil was extracted at the end of each storage period for analysis.

Determinations of chemical characteristics of oils:

Free fatty acid % and iodine value were determined according to the method outlined in the A.O.C.S. (1985).

Preparation of fatty acid methyl esters:

The methyl esters of fatty acids were prepared using benzene : methanol : concentrated sulphoric acid (10:84:4) and the methylation process was carried out for one hour at 80-90°C according to the method described by Stahl (1967).

Identification of the fatty acid methyl esters by Gas Liquid Chromatography (GLC):

GLC analysis was carried out in the Central Lab., Fac. of Agric , Cairo Univ The free fatty acid methyl esters obtained from the uninoculated and inoculated soybean seeds were analyzed by a pye unicame gas liquid chromatography (model 4550) equipped with a flame ionization detector and glass coiled column (1.6 m x 4 mm) packed with 10% PEGA (polyethyllene glycol adipate) and supported on chromosorb W-AW 100-200 mesh was used. The samples (1 µl were injected into the column using a Hamilton microsyringe. The gas chromatographic conditions used for isothermal analysis were: temperature, column 170°C. detector 300°C and injector 250°C, flow rate: hydrogen 33 ml/min, nitrogen 30 ml /min and air 330 ml/min. Also, peak areas were measured using a spectra physics chromjet integrator.

RESULTS AND DISCUSSION

Effect of *Aspergillus niger* and *Penicillium* sp on oil content % of soybean seeds:

Results presented in Table (1) show that oil content of soybean seeds gradually decreased with the prolongation of storage period as well as with the raising of storage temperature and humidity content. In the same time, oil content of the inoculated soybean seeds was decreased greatly than other those of uninoculated one. Also, data illustrated in Table (1) show that, greatest amount of oil was hydrolyzed in the inoculated seeds at the end of storage period (6 months). This means that, 30°C and 11.8% as moisture content were suitable for the growth of fungi, (*Aspergillus niger* and *Penicillium* sp), which produced lipase besides the native one, which hydrolyzed triglycerides to fatty acids and glycerol, therefore, acid value increased (Table, 2) and oil content decreased. Also, over oil hydrolysis was happened with *A. niger* lipase than those found in other one. However, the inoculated seeds with *A. niger* caused a high decrease in the percentage of oil content. These observations are similar to those reported by Hafez *et al.* (1996).

Table (1): Oil content (%) of uninoculated and inoculated soybean seeds with *Aspergillus niger* and *Penicillium* sp during six months of storage.

Treatments	Storage periods and conditions (temperature and moisture content)					
	Storage temperature (°C)					
	5.0°C		15.0°C		30.0°C	
	Moisture content (%)					
	7.3	11.8	7.3	11.8	7.3	11.8
	Zero time					
Uninoculated control	29.26	29.29	29.26	29.29	29.26	29 29
A. niger	29.25	29.22	29.25	29.22	29.25	29.22
Penicillium sp	29.25	29.20	29.25	29.20	29.25	29.20
	Two months					
Uninoculated control	29.04	28.80	28.93	28.75	28.84	28.67
A. niger	27.88	27.40	27.23	25.83	24.66	23.15
Penicillium sp	27.50	26.70	25.28	24.52	24.57	23.54
	Four months					
Uninoculated control	28.70	28.24	28.35	27.98	28.30	27.88
A. niger	26.20	25.80	24.88	23.88	20.61	20.05
Penicillium sp	26.03	25.85	23.86	23.08	21.64	20.75
	Six months					
Uninoculated control	28.60	28.16	28.22	27.82	28.18	27.84
A. niger	25.20	24.91	22.49	22.46	19.00	18.85
Penicillium sp	25.61	24.45	22.34	21.35	19.42	18.92

Chemical properties of oil extracted from uninoculated and inoculated seeds:

1- Free fatty acids:

Data presented in Table (2) show that, the free fatty acids of soybean oil extracted from the uninoculated and inoculated seeds was ranged between 3.13 to 3.18 at zero time of storage period at 5°C to 30°C. After two months as a storage period, free fatty acids increased gradually which reached to 14.17 and 8.38 for the oil extracted from seeds inoculated with *A. niger* and *Penicillium* sp., respectively. The results also, indicated that free fatty acids were increased sharply such in control (without inoculated) and/or seed inoculated. Generally, free fatty acids were increased greatly in seed inoculated with *Aspergillus niger* than those in control or/and seed inoculated with *Penicillium* sp. This means that, *A. niger* secreted lipase with much more amount and activity than other one, which hydrolyzed the oil with much more extent. In the same time, the results indicated that, free fatty acids were increased with increasing of storage temperature as well as with the increasing of storage humidity and storage period. The corresponding value of free fatty acids reached 7.4, 36.7 and 35.21 for control, seed inoculated with *A. niger* and *Penicillium* sp., respectively. The maximum free fatty acids were found at 30°C for the oil extracted from seed inoculated especially for

the seed inoculated with *A. niger*. This means that moisture content and storage temperature play an important role in the enzyme activity as well as over oil hydrolysis. These results are in agreement with those reported by Farag *et al.* (1980 & 1981) and Hafez *et al.* (1996).

Table (2): Free fatty acids of uninoculated and inoculated soybean seeds with *Aspergillus niger* and *Penicillium* sp during six months storage.

Treatments	Storage periods and conditions (temperature and moisture content)					
	Storage temperature (°C)					
	5.0°C		15.0°C		30.0°C	
	Moisture content (%)					
	7.3	11.8	7.3	11.8	7.3	11.8
	Zero time					
Uninoculated control	3.18	3.13	3.14	3.13	3.18	3.13
A. niger	3.18	3.14	3.18	3.14	3.18	3.14
Penicillium sp	3.15	3.15	3.15	3.15	3.15	3.15
	Two months					
Uninoculated control	3.71	4.03	3.68	4.04	3.77	4.13
A. niger	3.85	4.92	5.31	7.52	7.15	14.17
Penicillium sp	3.85	4.48	5.16	6.60	5.82	8.38
	Four months					
Uninoculated control	4.01	4.05	4.32	4.46	4.61	5.16
A. niger	4.45	6.88	7.09	10.80	8.04	17.89
Penicillium sp	4.15	5.65	7.36	11.73	8.70	15.93
	Six months					
Uninoculated control	4.56	4.78	5.27	6.26	6.90	7.40
A. niger	6.47	8.83	10.58	13 05	20.21	36.70
Penicillium sp	4.08	8.00	12.14	25.72	21.35	35.21

Free fatty acid % as oleic acid.

Iodine Value:

Results presented in Table (3) indicated that iodine value decreased sharply through the prolongation of storage period (for 6 months) as well as with the increasing of storage temperature and its moisture content. This decrease was sharp in oil extracted from seed inoculated with *Aspergillus niger* than other in control (without inoculated) and seeds inoculated with *Penicillium* sp. The general changes in the iodine value of soybean oil could be attributed to the fact that the storage moisture content and its temperature at high levels stimulate lipoxygenase in seed and fungi to degrade the double bonds of fatty acids to produce peroxids, which played an important role in the enzyme activity. Iodine value reached to 107.09, 57.85 and 78 62 after storage for 6 months compared with 132.88, 132.61 and 132.68 for control, seed inoculated with *A. niger* and *Penicillium* sp., respectively. These observations were similar to those reported by Hafez *et al.* (1996).

Table (3): Iodine value of uninoculated and inoculated soybean seeds with *Aspergillus niger* and *Penicillium* sp during six months storage.

Treatments	Storage periods and conditions (temperature and moisture content)					
	Storage temperature (°C)					
	5.0°C		15.0°C		30.0°C	
	Moisture content (%)					
	7.3	11.8	7.3	11.8	7.3	11.8
	Zero time					
Uninoculated control	134.72	132.88	134.72	132.88	134.72	132.88
A. niger	134.36	132.67	134.56	132.73	134.65	132.61
Penicillium sp	135.35	132.70	135.53	132.98	135.58	132.68
	Two months					
Uninoculated control	133.44	132.07	130.70	126.49	130.17	125.26
A. niger	132.82	130.73	126.21	122.98	126.50	124.13
Penicillium sp	132.24	128.14	124.31	121.57	125.29	122.19
	Four months					
Uninoculated control	123.35	118.41	119.32	118.17	115.99	115.76
A. niger	107.46	99.84	99.74	95.52	90.72	88.42
Penicillium sp	110.38	106.39	95.72	74.49	105.03	81.87
	Six months					
Uninoculated control	112.99	110.56	106.56	110.05	110.17	107.09
A. niger	106.06	107.85	108.62	97.98	64.44	57.85
Penicillium sp	110.27	106.50	60.23	75.65	99.56	78.62

Fatty acids composition of uninoculated and inoculated soybean oil:

As regard to the results presented in Tables (4, 5, 6 and 7) easily observed that some of fatty acids were increased with a slight amount and others were produced in a small amount, but others were decreased. This is may be due to the oil hydrolysis with lipases and some of interestrification was happened. The results presented in these Tables also show that the inoculation with *A. niger* and *Penicillium* sp. caused a high increase in the short and medium chain fatty acids especially with *A. niger* at 11.8% moisture content. The TU/TS ratio being 2.37:1, 2.09:1 & 2.01:1, 1.77:1 & 1.94:1, 1.48:1 and 1.82:1 & 1.32:1 for oil extracted from soybean seeds inoculated with *Penicillium* sp at zero time and after 2, 4 and 6 months as storage period at 5 & 30°C under 11.8% as moisture content, respectively. While, it was 1.51:1 & 1.48:1, 1.10:1 & 1.29:1, 1.08 & 1.28:1, 1.03:1 & 1.03.1, respectively, for oil extracted from seeds inoculated with *A. niger* under the same conditions. The new short chain fatty acids may be due to the moisture content and higher storage temperature, which encourages the endogenous enzymes of seeds and other ones of seed-borne fungi, which caused degradation in the unsaturated fatty acids with long chain fatty acids and produce short chain. This was clear in decrease of TU/TS ratio in the inoculated seeds especially at high temperature and moisture content. This

means that this ratio was decreased with the inoculation with *A. niger* than those found with the oil extracted from seeds inoculated with *Penicillium* sp. Concerning the inoculation with *A. niger* and *Penicillium* sp at 7.3 and 11.8% as moisture content and at 5 and 30°C, as storage temperature, an increment of C 16:0 and C 18:0 and C 18:1 were present when compared to uninoculated soybean seeds and a remarkable decrease in C 18.2 was also present. this is under storage for 2, 4 and 6 months. Also, considerable importance has been focused on the role of oleic acid to linoleic acid ratio (O/L), which governing the oil stability and shelf life.

Table (4): Fatty acids composition of uninoculated and inoculated soybean oil by *Aspergillus niger* and *Penicillium* spp stored at 5 and 30C under 7.3 and 11.870 as moisture content of zero time.

Fatty acids	Inoculated fungi											
	Uninoculatede control		*A. niger*		*Penicillium* sp		Uninoculatede control		*A. niger*		*Penicillium* sp	
	Storage temperature (C)											
	5°C						30°C					
	Moisture content%											
	7 3	11.8	7 3	11.8	7.3	11 8	7 3	11 8	7.3	11.8	7.3	11 8
$C_{6:0}$	0.36	0.40	0 22				0 26	0.34	0.28	0.50		0 62
$C_{7:0}$	0.15			0 88		0.37		0.30				
$C_{8:0}$	0.01	0.46	0 34		0.47		0.33	0.48	0.42	0.90	0 10	0.64
$C_{10:0}$	0.51			0.50	2.00					0 60		
$C_{11:0}$		0.80	0.43	0.74		0 90		0.78	0.74			1.04
$C_{11:1}$	1.46	0.77		1.18	1.79	1.08	1.24	1.60	1 34	2.70	0.79	2.22
$C_{12:0}$				0.99	0.33		0.10	0.80	0.12	0.30	0.13	0.16
$C_{12:1}$	0.35	0.12		0.70								
$C_{13:0}$	0 69	0 31	0 15	0.27	0.53	0.44	0.39	0.12	0.46	1.33	0.25	0.88
$C_{14:0}$				0.25	0.17					0.48	0.11	0.41
$C_{14:1}$	0.21			0.22								
$C_{15:0}$				1.60				0.30	0.27			
$C_{15:1}$	0 53	0.50	0.55	0.24	0.24	0.58	0.90	0.52	0.41	1.22	1.03	0.44
$C_{16:0}$	14.54	15.18	22.36	27.70	20.95	21.60	22.13	25.17	26.37	33.43	18.07	26.87
$C_{16:1}$	0.35	0.37	0.21	0.67	0.36	0.43	0.28	0.31	0.18	0.20	0.15	0.44
$C_{18:0}$	1 38	1.73	3.75	7.01	2.02	4.33	2 18	2.27	2.31	3.13	1.47	2.40
$C_{18:1}$	26.65	26.60	31.93	37.85	43.60	46.28	30.80	41.16	30 45	33.76	28.78	35.33
$C_{18:2}$	48.85	48.68	32 95	18.16	21 56	16.93	41.78	29 34	36.66	20.77	50 65	30.03
$C_{18:3}$	1.25	0.34	1.97	1.00	0.89	0 30	0.65	0.82	0 50	1.65	1 52	0.61
Tu	79.65	77 38	67.61	60.02	68.44	65.60	75.55	73.75	69 54	60.30	82.92	69.07
Ts	17.64	18 88	27.25	39.84	26.47	27.64	25.39	30 96	30.95	40.67	20.13	33.02
Tu/Ts	4.52:1	4.10:1	2.48:1	1.51:1	2.59:1	2.37:1	2.98:1	2 38:1	2.25:1	1.48:1	4.12:1	2.09:1
Du	1.29	1.25	1.04	0.77	0.90	0.81	1.17	1.03	1.06	0.81	1.51	0.97
O/LR.	0.55	0.55	0.97	4.64	2.02	2.73	0.74	1.40	0.83	1.63	0.49	1.18

DU = Degree of unsaturation = 1 x oleic acid + 2 x linoleic + 3 x linoleinic / 100.
or = % monoene/100 + 2 (diene/100) + 3 (triene/100). O/L = Oleic/linoleic ratio.

Table (5): Fatty acids composition of uninoculated and inoculated soybean oil by *Aspergillus niger* and *Penicillium* spp stored for two months at 5 and 30C under 7.3 and 11.8 as moisture content.

Fatty acids	Inoculated fungi											
	Uninoculatede control		*A. niger*		*Penicillium* sp		Uninoculated e control		*A. niger*		*Penicillium* sp	
	Storage temperature (C)											
	5°C						30°C					
	Moisture content%											
	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8
$C_{6:0}$	0.15	0.24	0.09					0.11	0.21	0.39		0.52
$C_{7:0}$	0.09			0.91		0.39		0.49				
$C_{8:0}$	0.09	0 44	0.33		0.39		0.41		0.52	0.96	0 12	0.65
$C_{10:0}$	0.49			0.40	2.05					0.31		
$C_{11:0}$		0.77	0.40	0.65		0.97		0.76	0.58			1.15
$C_{11:1}$	1.39	0.89		1.37	1.70	1.26	1.20	1.64	1.39	2.66	0 87	2.55
$C_{12:0}$				0.98	0.35		0.23	0.11	0.14	0.33	0.11	0.15
$C_{12:1}$	0.32			0.73								
$C_{13:0}$	0.67	0.29	0.14	0.26	0.51	0.41	0 32		0.38	1.31	0.21	0.85
$C_{14:0}$				0.27	0.18					0 50	0.14	0.43
$C_{14:1}$	0.21			0.23								
$C_{15:0}$				1.66				0.33	0.23			
$C_{15:1}$	0.56	0.53	0.59	0.26	0.25	0.62	0.88	0.55	0.46	1.30	1.12	0.47
$C_{16:0}$	16.36	18.84	25.16	34.4	23.58	26.82	22.22	26.28	26.49	34.37	18 15	27.62
$C_{16:1}$	0.32	0.35	0.19	0.64	0.33	0 41	0.23	0 33	0.15	0.19	0.13	0.47
$C_{18:0}$	1.63	1.94	4.43	7.80	2.40	4.87	4.31	4.10	4.58	5.66	2.92	4 34
$C_{18:1}$	27 76	27.37	33.27	38.90	45.42	47.63	33.47	44.66	33.10	36 64	31 28	38.34
$C_{18:2}$	48.24	48.00	32.55	8 00	21.43	16.70	40.41	20.28	35.46	14.36	53.73	20.76
$C_{18:3}$	1.09	1.71	1.72	2.10	0.77	0.63	0.59	0.68	0.46	1.37	1.38	0.50
Tu	79.89	77.85	68.32	52.23	69.90	67.25	86.78	68.14	71.02	56.52	88.51	63.09
Ts	19.48	22.52	30.55	47.33	29.46	33.46	27.49	32.18	33.13	43.83	21 65	35.71
Tu/Ts	4.10:1	3.46:1	2.24:1	1.10:1	2.37:1	2.01:1	3.15.1	2.12:1	2.14:1	1.29:1	4 09:1	1.77:1
Du	1.28	1.33	1.03	0.61	0.90	0.83	1.16	0.73	1.05	0.70	1.49	0.82
O/LR.	0.58	0.58	1.02	4.86	2.12	2.85	0.83	3.36	0.93	2.55	0.55	1.85

The results in Tables (4, 5 and 6) showed that this ratio is higher in seeds inoculated than those found in uninoculated one. Also, raising storage temperature decreased it compared to others at 5°C as storage temperature. This means that, oil stability and its shelf life was lowest when compared with those stored at healthy conditions. These results are higher than those reported by Chiou *et al.* (1995) and Crosso & Guzman (1995). They reported that O/L ratio were 1.77 and 0.98, respectively. Thus, it may be considered that the local varieties are of good quality for export. These results are similar to those reported by Hafez *et al.* (1996 & 2000) and Aziz (2001).

Table (6): Fatty acids composition of uninoculated and inoculated soybean oil by *Aspergillus niger* and *Penicillium* spp stored for four months at 5 and 30C under 7.3 and 11.8 as moisture content.

Fatty acids	Inoculated fungi											
	Uninoculatede control		*A. niger*		*Penicillium* sp		Uninoculatede control		*A. niger*		*Penicillium* sp	
	Storage temperature (C)											
	5°C						30°C					
	Moisture content%											
	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8
$C_{6:0}$		0.03	0.20						0.30	0.50		0.66
$C_{7:0}$	0.06			0.98		0.44		0.56				
$C_{8:0}$	0.13	0.40	0.48		0.56		0.45		0.51	0.95	0.11	0.64
$C_{10:0}$				0.56	2.63					0.34		
$C_{11:0}$			0.25	0.70		0.96			0.63			1.50
$C_{11:1}$	1.32	0.90		1.39	1.72	1.27	1.28	1.68	1.48	2.72	0.95	2.61
$C_{12:0}$				1.20	0.43		0.12	0.09	0.16	0.39	0.05	0.12
$C_{12:1}$				0.90								
$C_{13:0}$	0.63	0.26	0.14	0.28	0.48	0.37	0.30		0.36	1.28	0.19	0.86
$C_{14:0}$				0.37	0.41					0.52	0.12	0.43
$C_{14:1}$				0.34								
$C_{15:0}$				2.09				0.35	0.26			
$C_{15:1}$	0.57	0.55	0.60	0.27	0.26	0.65	0.90	0.55	0.47	1.39	1.17	0.51
$C_{16:0}$	18.00	20.61	27.68	35.62	25.94	28.34	22.55	27.11	26.93	35.45	18.46	28.49
$C_{16:1}$	0.30	0.40	0.18	0.73	0.31	0.47	0.21	0.35	0.14	0.20	0.12	0.50
$C_{18:0}$	1.80	2.18	4.95	8.84	2.68	5.47	5.23	5.79	5.56	1.99	3.54	6.12
$C_{18:1}$	29.79	29.46	35.70	41.92	48.75	51.26	35.83	45.99	35.43	37.73	33.49	39.48
$C_{18:2}$	43.63	43.04	29.44	7.22	19.38	14.97	36.11	13.69	31.68	9.69	45.69	14.01
$C_{18:3}$	1.00	0.65	1.74	1.91	0.71	0.57	0.51	0.63	0.39	1.27	1.19	0.47
Tu	76.61	75.00	67.66	54.68	71.03	69.19	74.84	62.93	69.59	53.00	82.61	57.58
Ts	20.64	23.48	33.70	50.64	32.93	35.58	28.69	33.90	34.71	41.42	22.47	38.82
Tu/Ts	3.71:1	3.19:1	2.01:1	1.08:1	2.16:1	1.94:1	2.61:1	1.86:1	2.00:1	1.28:1	3.88:1	1.48:1
Du	1.20	1.18		0.72	0.90	0.83	1.10	0.75	0.99	0.61	1.39	0.69
O/LR.	0.68	0.68	1.21	5.81	2.52	3.42	0.99	3.36	1.12	3.89	0.73	2.82

Table (7): Fatty acids composition of uninoculated and inoculated soybean oil by *Aspergillus niger* and *Penicillium* spp stored for six months at 5 and 30C under 7.3 and 11.8 as moisture content.

Fatty acids	Inoculated fungi											
	Uninoculatede control		*A. niger*		*Penicillium* sp		Uninoculatede control		*A. niger*		*Penicillium* sp	
	Storage temperature (C)											
	5°C						30°C					
	Moisture content%											
	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8	7.3	11.8
$C_{6:0}$			0.60						0.25	0.58		0.72
$C_{7:0}$	0.01					0.50		0.60				
$C_{8:0}$	0.28	0.36	0.51		0.64		0.47		0.60	0.96	0.14	0.75
$C_{10:0}$				0.56	2.63					0.30		
$C_{11:0}$			0.50	0.73		1.00			0.16			1.52
$C_{11:1}$	1.29	0.92		0.40	1.59	1.30	1.15	0.17	0.20	0.28	0.83	0.26
$C_{12:0}$				0.08	0.41		0.08		0.19	0.30	0.04	
$C_{12:1}$				0.84								
$C_{13:0}$	0.60	0.23	0.13	0.21	0.46	0.33	0.28		0.33	0.77	0.18	0.64
$C_{14:0}$				0.24	0.15					0.23		0.32
$C_{14:1}$				0.24								
$C_{15:0}$		0.35		1.71				0.39	0.16			0.18
$C_{15:1}$	0.59	0.58	0.62	0.28	0.27	0.68	0.94	0.62	0.49	1.47	1.20	0.53
$C_{16:0}$	19.70	21.71	28.30	36.14	28.39	30.90	23.14	27.92	27.58	36.51	18.90	29.34
$C_{16:1}$	0.28	0.41	0.17	0.75	0.29	0.48	0.19	0.37	0.12	0.21	0.11	0.53
$C_{18:0}$	2.21	2.47	6.01	9.91	3.25	6.20	6.70	6.80	7.12	9.38	4.54	7.20
$C_{18:1}$	31.45	31.17	37.69	40.35	51.46	54.24	36.97	49.66	36.56	40.74	34.55	42.63
$C_{18:2}$	41.16	39.12	27.77	6.56	18.29	13.61	31.40	9.21	27.55	6.52	41.75	9.43
$C_{18:3}$	0.89	0.59	1.40	1.74	0.63	0.52	0.39	0.55	0.30	1.11	0.91	0.41
Tu	75.66	72.79	68.27	52.16	72.53	70.83	70.59	60.58	65.22	50.33	79.35	53.78
Ts	22.80	25.12	36.05	50.58	35.93	38.93	30.97	35.71	36.39	49.03	23.80	40.67
Tu/Ts	3.32:1	2.90:1	1.89:1	1.03:1	2.02:1	1.82:1	2.30:1	1.70:1	1.79:1	1.03:1	3.33:1	1.32:1
Du	1.17	1.11	0.98	0.58	0.91	0.83	1.01	0.70	0.93	0.57	1.22	0.73
O/LR.	0.76	0.80	1.36	6.15	0.81	3.99	1.18	5.39	1.33	6.25	0.83	4.52

REFERENCES

A.O.C.S. (1985). Official and Tentative Methods of American Oil Chemist's Society. 3 rd Ed., Published by American Oil Chemist's Society 508, South Sixth Street, Champaign, Illinois 61820.

Aziz, S. Y. (2001). Evaluation of some sunflower seed hybrids for oil properties and fungal infection. Egypt. J. Agric. Res., 79: 1075-1084.

Basyony, A. E.; I. El-Refaei; M. S. Galal and M. I. E. Barakat (1989). Effect of gamma irradiation on seed-borne fungi and soybean seed components during storage. Agric. Res. Rev., 67: 619-628.

Chiou, R. Y.; C. P. Liu; C. J. Hou and C. D. Liu (1995). Composition of fatty acid composition and oxidative stability of peanut oils prepared from spring and fall crops of peanut. J. Agric. Food Chem., 43: 676-679.

Christensen, C. M. and H. H. Kaufmann (1968). Grain storage, the role of fungi in quality loss. Univ. of Minnesota Press, Minneapolis, P. 127.

Dhingra, O. D.; J. F. Nicholson and J. B. Sinclair (1973). Influence of temperature on recovery of *Aspergillus flavus* from soybean seed. Plant Desease Reporter, 57: 185-187.

Dorworth, C. E. and C. M. Christensen (1968). Influence of moisture content, temperature and storage time upon changes in fungus flora, germinability and fat acidity values of soybean. Phytopath., 58: 1457-1459.

Farag, R. S.; F. A. Khalil; F. A. Taha and A. A. Shihata (1981). Comparison between the lipid classes and fatty acid composition of peanut and cotton seeds infected by *Aspergillus flavus*. Grassay Aceities, 32. 19-24.

Farag, R. S.; F. A. Taha and F. A. Khalil (1980). Effect of *Aspergillus flavus* on the cotton seed, peanut and maize oils. Grassay Aceities, 31: 411-416.

Grosso, N. R. and C. A. Guzman (1995). Chemical composition of aboriginal peanut (*Arachis hypogaea* L.). J. Agric. Food Chem., 43: 102-105.

Hafez, S. A.; Amal H. Mahmoud and M. I. E. Barakat (1996). Effect of growth of fungi on the fatty acid composition of stored soybean seeds. Egypt. J. Agric. Res., 74: 429-442.

Hafez, S. A.; S. A. Ismael and Mona H. Mahmoud (2000). Chemical changes of soybeans during germination. Egypt. J. Agric. Res., 78: 795-817.

Liu, H. R. and P. J. White (1992). High temperature stability of soybean oils with altered fatty acid composition. J.A.O.C.S., 69: 533-537.

Stahl, E. (1967). Thin layer chromatography. A lab. Hand Book. Published by Springer Verloag, Berlin, Heidelberg, New York.

Zein El-Dein, G. E. I. (1999). Chemical and technological studies on oils and oil products and some of its preservation and stability. Ph. D. Thesis, Food Industries, Fac. of Agric. Mansoura Univ., Mansoura, Egypt, PP. 1-3.

تأثير نمو الأسبرجلس نيجر والبنيسليوم على محتوى الزيت وتركيب الأحماض الدهنية فى بذور فول الصويا المخزنة

ممدوح محمد ربيع[1] و توفيق سعد محمد شادى[2] و هدى أحمد عليوة الشازلى[3]

[1] قسم الصناعات الغذائية – كلية الزراعة – جامعة المنصورة – المنصورة – مصر

[2] قسم الميكروبيولوجى – معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

[3] قسم بحوث الزيوت والدهون – معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة – مصر

يعتبر فول الصويا من أهم المحاصيل الزيتية وكأحد أهم مصادر البروتين سواء للإنسان أو الحيوان فى مصر والعالم أجمع ولذا يجب الإهتمام بهذا المحصول وبمحتوياته من البروتين حيث يدخل فى صناعة الهامبورجر وغيرها كبديل للحوم ، وكذلك بروتين فول الصويا والذى يماثل كازين اللبن فى معظم خصائصه ومن ثم يدخل فى صناعات لبنية عديدة . فضلاً عن ذلك يعتبر أحد أهم مصادر الزيت محلياً وعالمياً جنباً إلى جنب مع زيت بذرة القطن وزيت عباد الشمس ولذلك يجب الاهتمام بهذا المحصول الحيوى الهام ولذلك فقد إتجهت الدراسة فى هذا البحث إلى دراسة التغيرات التى تحدث فى زيت فول الصويا ومحتواها من الأحماض الدهنية نتيجة التلقيح بفطريات الأسبرجلس نيجر والبنيسليوم على درجات رطوبة وحرارة مختلفة وذلك عند تخزينه وذلك لمدد زمنية متباينة وقد أوضحت الدراسة النتائج التالية :

١- إنخفض محتوى بذور فول الصويا من الزيت وكذلك إنخفض الرقم اليودى للزيت فى البذور الملقحة بفطر الأسبرجلس نيجر والبنيسليوم سواء عند تخزينها على درجة ٥ أو ٣٠م ، على الترتيب .

٢- إنخفضت نسبة الزيت بدرجة عالية وذلك فى حالة بذور فول الصويا الملقحة بفطر الأسبرجلس نيجر عن المعاملات الأخرى .

٣- تناقص الرقم اليودى للزيت وكذلك محتوى البذور من الزيت بدرجة كبيرة وذلك بزيادة مدة التخزين ورفع درجة حرارة ورطوبة المخزن .

٤- على العكس من السابق إرتفع رقم الحامض تحت نفس الظروف السابقة .

٥- الأحماض الدهنية المشبعة ذات الستة عشرة ذرة كربون و ١٨ ذرة كربون وكذلك حمض الأوليك قد زادت زيادة كبيرة بينما إنخفض الحمض الدهنى لينولينك تحت نفس الظروف السابقة .

٦- قد زاد محتوى البذور الملقحة بتلك الفطريات من الأحماض الدهنية المشبعة عن البذور الغير ملقحة وذلك خلال تخزينها لمدة ٦ شهور عند ٥ و ٣٠م ونسبة رطوبة ٧,٣ و ١١,٨% وهذا يرجع لحدوث فساد فى الزيت بينما إنخفض محتوى الزيت من الأحماض الدهنية الغير مشبعة تحت نفس الظروف .

ومن هنا فقد أوضحت الدراسة أن تلقيح بذور فول الصويا أو تخزينها تحت ظروف تؤدى إلى نشاط الفطريات عليها إلى تغير فى الخواص الكيميائية للزيت وتغيير محتواه من الأحماض الدهنية المشبعة أو الغير مشبعة ولذلك ينصح دائما بتخزين هذه البذور الزيتية تحت ظروف صحية محكمة وآمنة حتى لايحدث أى تغير للزيت سواء كميا أو كيفيا ، وتجنبا لحدوث أى تغيرات غير مرغوبة فى تركيب الزيت أو إفراز سموم فطرية به قد تؤدى إلى الإضرار بصحة الفرد والمجتمع .