J. Agric. Sci. Mansoura Univ., 28 (7): 5757 - 5772, 2003

CHEMICAL EVALUATION OF SESAME SEEDS TREATED WITH IONIZING RADIATION AND NONIONIZING RADIATION

Abdel-Rahim, E. A.*; Ashga M. El-Adawy; O.M. Abdel-Fatah* and Badea M. Yonies****

* Dept. of Biochem., Faculty of Agric., Cairo University.

** Food Tecchnol. Dept., National Center for Research and Radiation Technol., Atomic Energy Authority (N.C.R.R.T.)

ABSTRACT

The effect of gamma radiation, microwave radiation, interaction between them; and storage of radiated sesame seeds were investigated to find out the best treatment which lead to the maximum reduction of antinutritional factors (Trypsin inhibitor and lipoxygenase activities) without significant effect on the chemical constituents. The gamma rays was used at three doses of 2.5, 5.0 and 8.0 K.Gy, microwave radiation was at 70 level power for 2 and 4 min; and the storage of seeds was at room temperature, R.H. 50-55% for six months. The results could be summarized as follow. Gamma radiation and storage showed a slight decrease in crude protein contents, significant decrease in total free amino acids, total lipids had either slightly or insignificant changes, total carbohydrates were decreased and a slight changes in total soluble sugars content were observed. Reduction of trypsin inhibitor and lipoxygenase activities were increased as the irradiation dose levels and storage time increased. Slight decrease in tannin and phenol contents and significantly decrease in phytic acid content were observed. Microwave radiation and storage showed insignificant effect on protein and total lipids contents, decrease in total free amino acids, slight changes in total carbohydrate content and insignificant changes in total soluble and reducing sugars. Trypsin inhibitor and lipoxygenase activities were significantly reduced by microwave, while lipoxygenase activity was decreased by increasing the storage period. Significant changes in tannin and phenol contents were detected, while phytic acid was decreased. The interaction between gamma and microwave radiation as well as storage showed that, protein content was changed according to the treatment, significant decrease in total free amino acids contents; slight decreases in total lipids, total carbohydrate, total soluble sugars and reducing sugars were observed. Trypsin inhibitor and lipoxygenase activities were gradually decreased with increasing the radiation dose and time of storage periods. While, tannins and phytic acid were significantly decreased, while phenol was slightly decreased.

INTRODUCTION

Sesame (*Sesamum indicum L.*) is an important annual oilseed crops (Wolf and Cowan, 1975). It has been cultivated in many countries for its high content of edible oil and protein (Salunkhe, *et al.*, 1992). Seeds of sesame are used in the manufacturing of popular and nutritious food locally called Tehina and Halawa Tehinia (Shahin, 1993). Sesame seeds are almost free of antinutritional factors and is suitable for human consumption as such or after processing (Johnson, *et al.*, 1979).

It contained about 18-26% protein in full fat seeds, that is rich in sulfur amino acids (methionine and cystine) and tryptophan, which are primarily limiting amino acids in many vegetable protein source. its lipid content ranged from 46.5 to 60% (Paredes-lpez, *et al.*, 1994 and, Saleh, 1974). Total

carbohydrate ranged between 12.6 and 20.4%, reducing sugars from 1.2 to 1.51% and total soluble sugars from 5.6 to 7.5% (Saleh, 1974).

Trypsin inhibitor activity for the used raw materials of defatted sesame flour was (12657 TUI/gm sample), while in full fat sesame flour was (5736 TUI/gm sample) (Saleh, 1974). Lipoxygenase (linoleate:oxygen oxidoreductase, EC 1.13, 11.12) is an iron-containing dioxygenase that catalyzes the hydroperoxidation of polyunsaturated fatty acids and esters containing a cis,cis-1,4-pentadiene units to the corresponding conjugated cis, trans dieonic monohydroperoxids (Veldink and Vliegenthart, 1991).

Problems involved in the use of sesame protein as a source of food is its high content of phytic acid, phytate clearly decreases the biological availability of zinc, presumably by formation of a stable insoluble complex which does not release zinc to absorption sites in the intestinal mucosa (Paredes-lpez, *et al.*, 1994). Phytic acid in the raw seeds of sesame was 850 mg/100gm, meanwhile, phytic acid in the defatted sesame flour or in full fat sesame flour ranged between 743 and 462 mg/100 gm, respectively (Saleh, 1974). Furthermore, phytic acid is believed to protect seeds against oxidative damage during storage; Blatny, *et al.*, 1995 and , Saleh, 1974 reported that, local sesame seeds contained 0.025 mg/100gm tannins. Meanwhile, full fat sesame or defatted sesame flour contained 0.179 and 0.039 gm/100gm, respectively.

Treatment of food, including seeds, by ionizing radiation called food irradiation. Food irradiation is a physical process which is applied to food for a specific purpose (Mohsen 1996 and, WHO, 1991). Radiation almost had no effect on the total protein content of sesame seeds when exposed at 0, 2, 4 and 6 K.Gy of gamma radiation. Moreover, during storage, the total protein content in all cases was almost constant or slightly decreased (Hammad, *et al.*, 1996 and , Shahin, 1993).

Irradiation had no effect on crude oil content of sesame seed sample at zero time at different dose levels of 2.0 to 6.0 K.Gy; and was slightly decreased upon storage up to 9 months (Hammad, *et al.*, 1994).

Gamma radiation had insignificant effect on carbohydrate contents of soybeans grains (Zakaria, 1983). Almost irradiation caused slight decrease in carbohydrate content; a slight increase in total soluble sugars (Mohsen, 1996). Storage caused decrease in total soluble sugars content in soybean, while, total soluble sugar was not affected in seed treated with 10 K.Gy and this may be due to Millard reaction (Ragab, 1994).

Removing or inactivation of antinutrients could be achieved by radiation treatments such as microwave (Mahrous, 1992). Microwave is a type of electromagnetic wave, the energy content or power of microwaves is sufficient to heat, but not break chemical bonds (Yeo and Shibamoto, 1991). Moreover, no noticeable changes in the values of protein content for microwave treated soybean (Serour, 1995). Sesame seeds roasted for 16 min in a microwave oven, showed no significant differences ($P > 0.05$) in the various acyl lipids (Yoshida, 1995).

Cooking by conventional or microwave method showed little decrease in carbohydrate content of soybean (Serour, 1995). Microwave heating increase the total soluble sugar in soybean. So, microwave treatment

increased the hydrolysis of polysaccharides and transformed it to simple sugars (Ragab, 1994).

Microwave radiation has a considerable inhibitory effect on both lipoxygenase and trypsin inhibitors in whole soybeans (Mahrous, 1992). This may be due to the effect of microwave on the protein bonds which led to denaturation of the soy protein related to trypsin inhibitor lipoxygenase. It was also observed that exposure to microwave to a period exceeding 4 min, highly decreased the trypsin inhibitor and lipoxygenase activities (Serour, 1995).

MATERIALS AND METHODS

Materials:

Sesame seeds (*Sesamum indicum*, L. Var. Giza 32) were obtained from the Agriculture Research Center, Giza, Egypt, during season 1994.

Experimental design:

About 12 Kg of sesame seeds were cleaned from dirt impurities and other strange seeds, and then were divided into four major parts as follows: The first part (1 Kg) was left without any treatment (control). The second part was sub-divided into three parts and exposed to ionizing radiation (gamma radiation) at levels of 2.5, 5.0 and 8.0 K.Gy. The third part (2 Kg) was sub-divided into two parts, imbibed to increase the moisture content from 8% to 14% using distilled water at room temperature, then were exposed to non-ionizing radiation (microwave) for 2 and 4 minutes at power level 70 using Samsung oven MX145 28L of 2450 MHz (Farag, *et al.*, 1994). The fourth part was sub-divided into three parts and exposed to gamma radiation at levels 2.5, 5.0 and 8.0 K.Gy, then were imbibed to increase the moisture content to 14% followed by microwave treatment using different times (2 and 4 min.) at power level 70 using Samsung oven MX 145 28L of 2450 MHz. irradiation process was achieved at National Center for Radiation Research and Technology, Nasr City, Cairo, Egypt. The ionizing radiation used in this experiment was Cobalt-60 Gamma Cell 220. The dose rate of this source was 27.7 rad/second.

Methods:

1- Chemical composition:-

Total protein content and total lipid were determined as described in the A.O.A.C. (1995). Total free amino acids were extracted and determined according to the method of Rosein, (1984). Total hydrolyzable carbohydrates and total soluble sugars were determined as described by Dubois, *et al.*, (1956). Reducing sugars were determined as reported by Flood and Priesthey (1973).

2- Antinutritional factors:

Trypsin inhibitor activity was determined according to the method described by Roy and Bhat (1974). Tannins content were determined as described by Burns (1971). Phytates were extracted according to the procedure described by Camire and Clydesdole (1982) and determined as

mentioned in the modified method by Mohamed *et al.*, (1986). Phenolic compounds were determined as described by Swain and Hillis, (1959). The lipoxygenase activity was determined according to the described method of Surrey, (1964).

Statistical analysis:

The analysis of variance was carried out to test the degree of significance of each treatment effect. Having a significant effect. Fisher's least significant difference (LSD at 0.05), as described by Ott (1984), was used to perform all possible pair comparisons between means of different treatments.

RESULTS AND DISCCUSION

Many published information are available on the use of radiation to extend the shelf-life of preferable food time and ensure their hygienic quality (Shahin, 1993). However, little is known about the effect of gamma radiation, microwave and their combination as well as storage on sesame seeds.

Effect of gamma radiation and storage:

The results in Table (1) presents the effect of treated sesame by the abovementioned gamma rays doses, on crude protein content (T.P.), total lipids (T.L.) and total free amino acids (T.FAA).

The presented data showed that, T.P. did not change under the effect of gamma radiation at doses of 2.5 and 5.0 K.Gy, while it was slightly decreased at the dose of 8.0 K.Gy (25.00%) relative to control (25.46%), at initial time. The present findings agree with those obtained by El-Niely (1996), Farag (1994) and Mahrous, (1992), who reported that T.P. of the different treated legumes was not affected by gamma radiation. This is quite explainable on basis that, even if radiation doses caused some breakdown in the legume proteins, yet the total protein determination should not be consequently affected. Meanwhile, T.P. values were slightly and gradually decreased with increasing storage time up to six months (ranged between 24.39 and 25.15%) relative to control. These finding are in agreement with results obtained by Kassis (1990), Mahrous, (1992) and Ragab, (1994).

Gamma radiation and storage up to 6 months resulted in a very slight decrease in total lipid (T.L.) relative to the control. (Table 1). These decreases in T.L. were gradually decreased parallel to the increasing both radiation dose and storage time. These data are in agreement with those of Hammad, *et al.*, (1994) and, Shahin, (1993), who reported that, gamma rays at different doses and storage had insignificant effect on T.L. of soybean seeds.

The data revealed that, T.FAA were significantly decreased as influenced by gamma radiation and storage (Table 1). These decreases were observed during all periods of storage, i.e. the values were changed from 130.90 (control) to be range between 84.30 and mg/100 gm D.W. in radiated seeds at zero time. In addition, T.FAA were reached the range between 4.50 and 52.40 mg/100 g D.W., relative their control 99.30 at the end of storage. It was observed that, the reduction in T.FAA values were parallel with

Table (1): Effect of gamma radiation (G.R.), microwave (M.W.) and their interaction (G.R.+M.W.); as well as storage on total protein, total lipid and total free amino acids contents of sesame seeds.

Treatment	Storage time (months)											
	Zero time			2 month			4 month			6 month		
	T.P.	T.L.	T.FAA	T.P.	T.L.	T.FAA	T.P.	T.L.	T.FAA	T.P.	T.L.	T.FAA
Control	25.46	52.42	130.90	25.31	52.40	111.50	25.31	52.30	104.60	25.23	52.01	99.30
Gamma rad. 2.5 K.Gy	25.46	52.34	105.10	25.43	52.35	84.60	25.29	52.13	71.20	25.15	51.98	56.90
,, ,, 5.0 K.Gy	25.40	52.11	90.80	24.81	52.11	81.60	25.22	52.05	63.40	25.05	51.89	52.40
,, ,, 8.0 K.Gy	25.00	52.00	84.30	24.81	52.00	76.50	24.53	51.93	61.70	24.39	51.73	40.50
Microwave rad. 2 min	25.40	52.00	95.10	25.09	51.94	75.80	24.91	51.88	59.30	24.75	51.81	43.90
,, ,, 4 min	25.20	51.49	109.90	25.09	51.25	93.50	24.88	51.45	79.10	24.79	51.21	58.20
G.R. + M.W. Interaction:												
2.5 K.Gy + M.W 2 min	25.34	52.00	74.70	25.10	51.99	61.10	24.98	51.83	52.60	24.79	51.79	30.70
5.0 K.Gy + M.W. 2 min	25.31	51.84	70.20	25.21	51.80	58.40	25.01	51.74	40.00	24.83	51.71	28.60
8.0 K.Gy + M.W. 2 min	25.29	50.91	66.40	25.11	51.00	51.30	24.93	50.84	38.10	24.77	50.76	25.90
2.5 K.Gy + M.W. 4 min	25.34	51.31	90.00	25.15	51.16	79.90	25.10	51.09	60.60	25.06	51.00	48.70
5.0 K.Gy + M.W. 4 min	25.41	51.15	81.10	25.33	51.10	63.50	25.17	51.01	50.90	24.99	50.94	38.60
8.0 K.Gy + M.W. 4 min	25.19	51.00	69.80	25.11	50.97	51.10	25.07	51.90	38.20	25.00	50.92	22.50

T.P.= Total protein (gm/100gm D.W.); T.L.= Total lipids (gm/100gm D.W.); T.FAA = Total free amino acids (mg/100gm D.W.).

L.S.D. $_{0.05}$: T.P. $\geq$ 0.0273; T.L. $\geq$ 0.0247; T.FAA $\geq$ 0.2143.

increasing either gamma radiation dose or storage time. The obtained data are in accordance with those obtained by Hafez, *et al.*, (1985) and Kassis, (1990), who mentioned that, the decrease in T.FAA as affected by storage and gamma radiation may be due to energy effects of the radiation which were increased parallel with the increasing of their doses.

The influences of gamma radiation and storage time on total carbohydrate (T.C.), reducing sugar (R.S.) and total soluble sugars (T.S.S) are presents in Table (2). The data indicated that, gamma radiation at different doses had insignificant decreasing effect on T.C. and T.S.S., at initial time. While, R.S. was significantly reduced only at the dose of 8.0 K.Gy (1.01%) relative to control (1.94%). On the other hand, storage caused a gradually decrease with the same trend of significance up to six months in both of T.C. and T.S.S.; while the R.S. was significantly decreased either the unradiated seeds or the radiated ones at all doses of radiation (ranged between 0.50 and 0.54%). These findings are in the line of Farag (1994), and Zakaria, (1983) who mentioned that, storage led a decrease in carbohydrate content. Also, with the data of Mohsen, (1996) and, Ragab, (1994), who reported that, the decrease in T.S.S. which affected by gamma rays and storage may be due to the interconversion between the sugar fractions i.e., the conversion of soluble to nonsoluble or polysaccharide which is stable starage fractions.

The data in Table (3) showed that, trypsin inhibitor activity (T.I.A) and lipoxygenase activity (L.A.) were significantly decreased parallel with the increasing gamma radiation doses at initial time, relative to the control. The same trend was observed during storage up to six months in control and radiated seeds. These results are in accordance with the data reported by Farag (1994), and Zakaria, (1983) who found that, T.I.A. of sesame seed was decreased by increasing radiation levels. Also with those of Hafez, *et al.*, (1989), and Mahmoud (1991) who found that, the lipoxygenase activity was inhibited in oilseeds by gamma radiation treatments.

Increasing both radiation dose and storage time slightly and gradually decreased tannin and phytic acid contents (Table 4), relative to their initial time controls. But these decreases were significant at the end of storage period of six months. On the other hand, phenols contents were affected in different way. Where it was slightly increased than control value at initial time to be 0.93, 0.92 and 0.91 mg/100 gm, for the doses of 2.5, 5.0 and 8.0 K.Gy, respectively, relative to the control value (0.83 mg/100 gm). These values were insignificantly and gradually decreased during storage up to six months, with keeping their relative values to each other. The present results are confirmed by Khokhar and Chauhan (1986) who found that, the tannic acid of sorghum grains did not show any significant changes by exposing to gamma radiation. The reduction in phytic acid might be due to the effect of gamma rays in destruction complex of organic and inorganic components as well as phytic acid (Mohsen, 1996). These results are not in agreement with those obtained by Abu-Daya (1990) who reported that, the radiation significantly decreased the phenolic compounds in the olive oil cake.

Table (2): Effect of gamma radiation (G.R.), microwave (M.W.) and their interaction (G.R.+M.W.); as well as storage on total carbohydrates, total soluble sugars and reducing sugars contents of sesame seeds.

Treatment	Storage time (months)											
	Zero time			2 month			4 month			6 month		
	T.C.	T.S.S	R.S.	T.C.	T.S.S	R.S.	T.C.	T.S.S	R.S.	T.C.	T.S.S	R.S.
Control	21.29	4.38	1.94	20.18	3.95	1.08	20.00	3.69	0.89	19.81	3.56	0.5
Gamma rad. 2.5 K.Gy	20.67	4.16	1.94	20.93	3.41	1.02	20.73	3.13	0.77	20.19	2.97	0.54
,, ,, 5.0 K.Gy	19.52	3.66	1.13	19.51	3.53	0.96	19.33	3.38	0.64	19.01	3.10	0.54
,, ,, 8.0 K.Gy	19.13	3.77	1.01	19.11	3.56	0.85	19.01	3.37	0.60	18.76	3.11	0.50
Microwave rad. 2 min	20.91	2.88	1.39	20.71	3.50	0.94	20.20	3.39	0.82	20.13	3.11	0.68
,, ,, 4 min	20.11	3.57	0.98	19.81	3.06	0.69	19.69	2.94	0.65	19.41	2.86	0.50
G.R. + M.W. Interaction:												
2.5 K.Gy + M.W 2 min	20.81	3.97	0.79	20.71	3.63	0.78	20.49	3.49	0.77	20.21	3.20	0.74
5.0 K.Gy + M.W. 2 min	20.65	3.50	0.61	20.60	3.38	0.59	20.35	3.19	0.57	20.14	3.03	0.56
8.0 K.Gy + M.W. 2 min	20.01	3.44	0.73	19.91	3.16	0.72	19.63	2.97	0.70	19.01	2.91	0.69
2.5 K.Gy + M.W. 4 min	20.00	3.57	0.64	19.63	3.03	0.62	19.11	2.91	0.61	19.26	2.87	0.60
5.0 K.Gy + M.W. 4 min	20.81	3.31	0.50	19.89	3.14	0.44	18.53	2.97	0.48	18.31	2.89	0.45
8.0 K.Gy + M.W. 4 min	19.99	3.68	0.54	18.97	3.54	0.53	18.93	3.43	0.51	18.19	3.16	0.50

T.C.= Total carbohydrates; T.S.S.= Total soluble sugars; R.S.= Reducing sugars;
L.S.D. $_{0.05}$: T.C. $\geq$ 0.0242; T.S.S. $\geq$ 0.0172 ; R.S. $\geq$ 0.0174; Values: gm/100gm D.W.

Table (3): Effect of gamma radiation (G.R.), microwave (M.W.) and their interaction (G.R.+M.W.); as well as storage on trypsin inhibitor and lipoxygenase activities of sesame seeds.

Treatment	Storage time (months)							
	Zero time		2 month		4 month		6 month	
	T.I.A.	L.A.	T.I.A.	L.A.	T.I.A.	L.A.	T.I.A.	L.A.
Control	29.90	63.60	26.30	57.40	20.90	37.00	18.10	25.00
Gamma rad. 2.5 K.Gy	27.40	60.60	23.80	46.60	20.00	27.60	16.50	23.20
,, ,, 5.0 K.Gy	23.80	54.20	19.30	44.66	16.90	23.00	13.20	17.60
,, ,, 8.0 K.Gy	20.50	40.40	16.50	37.20	13.60	12.00	10.10	15.80
Microwave rad. 2 min	24.30	43.40	20.90	44.40	18.70	27.60	16.10	13.60
,, ,, 4 min	27.30	56.80	22.50	33.60	18.90	23.60	16.40	15.40
G.R. + M.W. Interaction:								
2.5 K.Gy + M.W 2 min	21.50	38.80	19.20	35.20	17.30	18.60	14.40	15.20
5.0 K.Gy + M.W. 2 min	18.10	36.60	15.30	29.40	13.70	9.20	11.60	16.40
8.0 K.Gy + M.W. 2 min	15.60	29.80	13.90	16.40	11.10	3.80	9.30	8.60
2.5 K.Gy + M.W. 4 min	23.70	48.20	20.00	35.80	17.10	12.00	14.80	7.40
5.0 K.Gy + M.W. 4 min	17.60	35.40	15.30	28.60	12.60	8.20	11.00	8.40
8.0 K.Gy + M.W. 4 min	11.90	22.00	10.10	20.60	9.30	4.40	5.50	1.40

T.I.A.= Trypsin inhibitor activity (values: T.I.U.); L.A.= lipoxygenase activity (values: A.U.)

L.S.D. $_{0.05}$: T.I.A. $\geq$ 0.2315 ; L.A. $\geq$ 0.0174

Effect of microwave radiation and storage:

The results in Table (1) presents the effect of treated sesame by the microwave for 2 and 4 min on crude protein content (T.P.), total lipids (T.L.) and total free amino acids (T.FAA). The data revealed that, microwave radiation (either 2 or 4 min) slightly decreased both T.P. (25.40 and 25.20%) and T.L. (52.00 and 51.49%) relative to their controls (25.46 and 52.42%, respectively) at initial time. While the T.FAA. was significantly decreased under the same microwave treatment (95.10 and 109.90 mg/100 gm) relative to control (130.90 mg/100 gm). On the other hand, storage caused a gradually decrease with the same trend of significance up to six months in all of T.P., T.L. and T. FAA. for both microwave treatments. These results are in agreement with those of Ragab (1994) and Serour (1995) who found that microwave led to a slight decrease in protein solubility, but did not affect total protein. Also, are confirmed by the data of Paquet and Kalab (1988) and, Sales, *et al.*, (1984) who reported that microwave treatments decreased the total free amino acids relative to control. And, in accordance with results of Ragab, (1994), Snyder, *et al.*, (1991) and, Yoshida, (1995) who observed insignificant effect on total lipid content in sesame seeds at the low time of microwave heating and after the storage period of six months.

The influences of microwave radiation and storage time on total carbohydrate (T.C.), reducing sugar (R.D.) and total soluble sugars (T.S.S) are presents in Table (2). The data indicated that, microwave radiation (either for 2 or 4 min) insignificantly decreased T.C. (20.91 and 20.11%) relative to control (21.29%), respectively at initial time. While the T.S.S. and R.S. were significantly decreased under the same microwave treatment (2.88 and 3.57%, for T.S.S; and 1.39 and 0.98%, respectively), relative to their controls (4.38 and 1.94%, respectively). On the other hand, storage caused a gradually decrease with the same trend of significance up to six months in all of T.C., T.S.S. and R.S. for both microwave treatments. The obtained results are in accordance with those of Kavas and Karakaya (1993) and Serour (1995) who found that, the carbohydrate contents of seeds was slightly changed by storage and microwave radiation. But, not completely in the line of Ragab (1994), who found insignificant changes in total soluble sugar and reducing sugar of sesame seeds either between microwave or six months storage samples. The microwave radiation coupling with storage may help in conversion of some soluble and reducing sugars to nonsoluble polysaccharide or help in conversion of carbohydrate to other organic compound i.e., protein. Or lead to the destruction of carbohydrate.

Trypsin inhibitor activity (T.I.A.) was significantly decreased from 29.90 T.I.U. of control sample to 24.30 and 27.30 T.I.U. in microwave heated seeds after 2 and 4 minutes, respectively, at initial time (Table 3). Moreover, T.I.A. was gradually and significantly decreased. During storage up to six months under both times of microwave treatments, compared to the initial time. These data are in agreement with Mahrous (1992), Serour (1995) and Yoshida and Kajimoto (1988) who revealed that, the microwave treatment and storage highly inhibited the T.I.A., and this may be due to the effect of microwave on the protein structure that led to denaturation of the soy protein.

lipoxygenase activity (L.A.) was significantly decreased from 63.60 A.U. of control sample to 43.40 and 56.80 A.U. in microwave heated seeds after 2 and 4 minutes, respectively at initial time (Table 3). In addition, LA. was gradually and highly significant decreased during storage up to six months under both times of microwave treatments, compared to the initial time. These data are in accordance with Mahmoud (1991) and , Ramesh, *et al.*, (1995) who observed that, microwave radiation inhibited the L.A. which was gradually decreased parallel with the increase of storage periods of sesame seeds.

The effect of microwave radiation and storage on tannin, phytic acid and phenols contents (as mg/100 g D.W.) are present in Table (4). The data showed insignificant decreases in tannin (0.15 and 0.13 relative to control 0.18), phytic acid (0.58 and 0.58 relative to control 0.59) and phenols (0.75 and 0.79 relative to control 0.83) contents for seeds treated for 2 and 4 min with microwave, respectively. Also, storage of microwaved seeds for 2 and 4min significantly decreased all of the tannin, phytic acid and phenols contents, compared to their initial time controls, after six months of the storage. The obtained results are in agreement with that obtained by Mutlak and Mann (1984) who found that tannin content was insignificantly changed by microwave heating. Concerning phenol contents. And with the data of Cunha, *et al.*, (1995) and Young-Hoon and Chong-Ouk (1996) who stated that, microwave and storage led to remarkable changes in phytic acid content of sesame seeds.

Effect of interaction between the gamma and microwave radiation, and storage:

It is worthy to note that, no or very little data are available in the literature about this influence of interaction between gamma and microwave radiation as well as storage on different plant seed.

The data concerning the contents on total protein (T.P.), total lipid (T.L.) and total free amino acids (T.FAA.) of sesame seeds as affected by interaction between gamma radiation, microwave radiation and storage are present in Table (1). The data revealed that, interaction treatments at initial time insignificantly reduced both T.P. (ranged between 25.19 and 25.41%) and T.L. (ranged between 50.91 and 52.0%) relative to their controls (25.46 and 52.42%), respectively. While the T.FAA. was significantly decreased under the same treatments (ranged between 66.40 and 90.00 mg/100 gm) relative to control (130.90 mg/100 gm). On the other hand, storage caused a gradually decrease with the same trend of significance up to six months in all of T.P., T.L. and T. FAA. for interaction treatments. Where T.P. ranged between 24.77 and 25.06%; T.L. ranged between 50.76 and 51.79%; and T.FAA. ranged between 22.500 and 48.70 mg/100 gm. It is worthy to mention that, the treatment of gamma radiation 8.0 K.Gy + microwave for 4 min was the most effective one either at initial time or through storage period, in comparison to the other treatments. Also, the treatments including microwave for 4 min were more effective than the treatments including the microwave for 2 min.

Table (4): Effect of gamma radiation (G.R.), microwave (M.W.) and their interaction (G.R.+M.W.); as well as storage on phenols, tannins and phytic acid contents of sesame seeds.

Treatment	Storage time (months)											
	Zero time			2 month			4 month			6 month		
	Phen.	Tann.	Phy.A.	Phen.	Tann.	Phy.A.	Phen.	Tann.	Phy.A.	Phen.	Tann.	Phy.A.
Control	0.83	0.18	0.59	0.79	0.16	0.46	0.78	0.14	0.20	0.67	0.12	0.30
Gamma rad. 2.5 K.Gy	0.93	0.16	0.58	0.82	0.15	0.39	0.81	0.13	0.29	0.77	0.11	0.29
,, ,, 5.0 K.Gy	0.92	0.14	0.53	0.80	0.13	0.45	0.77	0.12	0.24	0.73	0.10	0.24
,, ,, 8.0 K.Gy	0.91	0.13	0.51	0.79	0.12	0.41	0.76	0.11	0.20	0.74	0.11	0.20
Microwave rad. 2 min	0.75	0.15	0.58	0.70	0.14	0.36	0.69	0.12	0.25	0.67	0.10	0.19
,, ,, 4 min	0.79	0.13	0.58	0.75	0.11	0.40	0.74	0.10	0.31	0.67	0.06	0.27
G.R. + M.W. Interaction:												
2.5 K.Gy + M.W 2 min	0.81	0.15	0.56	0.59	0.13	0.47	0.56	0.11	0.35	0.63	0.09	0.22
5.0 K.Gy + M.W. 2 min	0.82	0.13	0.54	0.79	0.12	0.39	0.77	0.09	0.31	0.71	0.08	0.17
8.0 K.Gy + M.W. 2 min	0.86	0.12	0.51	0.83	0.12	0.48	0.81	0.10	0.32	0.79	0.08	0.15
2.5 K.Gy + M.W. 4 min	0.80	0.14	0.57	0.78	0.10	0.38	0.75	0.09	0.22	0.64	0.05	0.15
5.0 K.Gy + M.W. 4 min	0.79	0.09	0.54	0.76	0.07	0.41	0.74	0.6	0.31	0.66	0.04	0.13
8.0 K.Gy + M.W. 4 min	0.86	0.09	0.50	0.87	0.06	0.39	0.97	0.04	0.26	0.81	0.03	0.19

Phen.= Phenols; Tann.= Tannins; Phy.A.= Phytic acid;

L.S.D. $_{0.05}$: Phenols $\geq$ 0.0021; Tannins $\geq$ 0.0017 ; Phytic acid $\geq$ 0.0280; Values: mg/100gm D.W.

The data of the effect of interaction between gamma radiation, microwave heating and storage on carbohydrate contents (T.C.), reducing sugars (R.D. and total soluble sugars (T.S.S.) are present in Table (2). The results showed a little decrease in T.C., it was ranged from 19.99 to 20.81% relative to the control value (21.19%), under the effect of interaction treatments. These values were decreased during storage up to six months to reach the range of 18.19-20.21%.

The data showed slight decrease in T.S.S. for all treated samples comparing with control. storage for 6 months caused a decrease in T.S.S in samples under investigation in comparison with control. This decrease in T.S.S. may be attributed to millard reaction. The reduction effect was significant in R.S. among all treatments and during storage periods, in comparison to the control at initial time.

Trypsin inhibitor activity (T.I.A.) was significantly reduced from 29.90 T.I.U. of the control sample to be ranged from 11.90 to 23.70 T.I.U, under the effect of interaction treatments, at initial time (Table 3). Moreover, T.I.A. was gradually and significantly reduced during storage up to six months under the same treatments, compared to the initial time. It was also observed that, the treatments including 4 min microwave were more effective than the treatments including 2 min microwave heating. Further more, all interaction treatments were more significantly effective than the effect of either gamma radiation or microwave alone, even through out storage period. Also, the interaction treatments including 8.0 K.Gy. were the most significant ones in their reduction effect of T.I.A. This may be due to the effect of gamma radiation and microwave on the protein structure that led to denaturation of the sesame protein.

The same trends of effects and observation on T.I.A. were noticed on the lipoxygenase activity (L.A.) as affected by the interaction between gamma radiation and microwave, and also through out storage period of six months (Table 3). In addition, L.A. was highly inhibited (8.60 and 1.40 A.U.) under the effect of treatments including 8.0 K.Gy. gamma radiation, either with 2 or 4 min microwave, respectively.

The data of the effect of interaction between gamma radiation, microwave heating and storage on tannin, phytic acid and phenols contents (as mg/100 g D.W.) are present in Table (4).

The data showed slightly decreases in both tannin and phytic acid in all interaction treatments, relative to control at initial time. Also, storage of all treated samples significantly decreased both of the tannin and phytic acid contents, compared to their initial time controls, after six months of the storage. Meanwhile the reduction of tannin content was higher in the treatments including 4 min microwave, than the others including 2 min microwave. Concerning phenol content, the data showed a slight decrease under the effect of interaction treatments including 2.5 and 5.0 K.Gy of gamma radiation (ranged between 0.79 and 0.82, relative to control value of 0.83 at initial time. While, phenol content was increased than control under the treatments including 8.0 K.Gy gamma radiation. On the other hand, its content was gradually and significantly decreased with the same trend of effect as at initial time. No high variations were observed between the effect

of either gamma radiation or microwave alone and the interaction between them at the end of storage period.

It can concluded that, the effects of interaction treatments were more effective than the treatment with microwave or gamma radiation alone. These may be due to the synergetic system between gamma and microwave radiation (more energy of both of each other). It can be recommended that the interaction treatments (gamma radiation + microwave radiation) can be used in case of small amounts of seeds, but at the large amounts of seed, gamma rays can be used alone.

REFERENCES

A.O.A.C. (1995). Official Methods of Analysis of official Analytical Chemists. Pub. by the Association of Official Analytical Chemists, Inc., Arlington, West Virginia, USA.

Abu-Daya, Y.M.I. (1990). Biochemical studies on olive cake Ph.D., Agricultural Sci. Biochemistry, Faculty of agriculture Cairo Univ.

Blatny, P.; F. Kvasnicka; E. Kenndler (1995). Determination of phytic acid in cereal grains, legumes, and feeds by capillary isotachophoresis. J. Agric. Food Chem., 43: 129.

Burns, E. R. (1971). Method for estimation of tannin in grain sorghum. Agronomy Journal., 63: 511..

Camire, A.L. and M. Clydesdole (1982). Analysis of phytic acid in Food by HPLC. J. Food Sci., 74: 575.

Cunha, M.F.; V.C. Sgarbieri and M.H. Damasio (1993). Effect of pretreatment with gamma rays or microwave on storage stability of dry beans. J. Agric. Food Chem., 41: 1710.

Dubois, M., K.A. Gilles; J.K. Hamilton; P.A. Rebers and F. Smith (1956). Colorimetric method for determination of sugar and related substances. Anal. Chem., 28: 350.

El-Niely, H.F.G. (1996). Chemical constituents and digestibility of broad beans subjected to radiation treatment. M.Sc. department of biochemistry and nutrition women's college, Ain Shams Univ.

Farag, M.F.S. (1994). Effect of gamma radiation on proteins of some agricultural products. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Cairo.

Farag, R.S.; M.M. Rasheed and A.A.A. Abo-Hagger (1994). Aflatoxin destruction by microwaves. J. Agric. Sci. Mansoura Univ., 19: 3979.

Flood, A.E. and C.A. Priesthey (1973). Two improved methods for the determination of soluble carbohydrate. J. Sci. Food Agric., 24: 953.

Hafez, Y.S.; A. Mohamed; G. Singh and F.M. Hewedy (1985). Effect of gamma radiation on protein and fatty acids of soybeans.

Hafez, Y.S.; A. Mohammed; P.A. Perera; G. Singh and A. Hussein (1989). Effect of microwave heating and gamma radiation on phytate and phospholipids contents of soybean (*Glucine max*. L.). J. Food Sci., 54: 958.

Hammad, A.A.I.; M.M. Ragab; E.A. Zaher and A.A.M. Shahin (1994). Effect of irradiation and fungal infection on the chemical composition and oil properties of sesame seeds. Seventh congers of phytopathology, April 19-21, 1994, Giza, Egypt: 155.

Hammad, A.A.I.; M.M. Ragab; E.A. Zaher and A.A.M. Shahin (1996). Changes in sesame seeds of high moisture content as affected by fungal infection and irradiation. Egypt. J. Rad. Sci. and Applic., 9(1): 101.

Johnson, L.A.; T.M. Suleiman and E.W. Lusas (1990).Sesame protein: a review and prospects. J. Am. Oil Chem. Soc., 56: 463. (1979)

Kassis, S.R.: Biochemical study on some stored grains and seeds. Ph.D. Thesis, Fac. of Agric., Cairo Univ.

Kavas, A. and S. Karakaya (1993). Effect of microwave and conventional cooking on nutritive value of semitendinosus muscle. Chemic Mikrobiologie Technologie Devlebensmittel, 15(1-2): 30.

Khokhar, S. and B.M. Chauhan (1986). Antinutritional factors in moth bean (Vigna aconitifolia): Varietal differences and effects of methods of domestic processing and cooking. J. Food Sc., 51: 591.

Mahmoud, O.S. (1991). Effect of some treatments on vitality of stored soybean seeds. M.Sc. Thesis. Faculty of Science, Al-Azhar Univ. for Girls.

Mahrous, S.R. (1992).Effect of some treatments on some toxic compounds present in foods. Ph.D. Thesis, Fac. of Agric., Cairo Univ.

Mohamed, A.; Perera, P.A.J. and Hafez, Y.S. (1986). New chromophore for phytic acid determination. Cereal Chem., 63: 475.

Mohsen, G.I.M. (1996). Effect of gamma radiation on microbial contamination and poisoning substances in some oil seeds and their products. Ph.D. Thesis, Fac. of Agric., Al-Azhar Univ.

Mutlak, H.H. and J. Mann (1984). Darkening of dates: control by microwave heating. Date-palm. Journal., 3(1): 303.

Ott, L. (1984). An introduction to statistical methods and data analysis. 2nd. edition, PWS publisher, Boston, Ma, USA

Paquet, A. and M. Kalab (1988). Amino acid composition and structure of cheese baked as pizza ingredient in conventional and microwave ovens. Food microstructure, 7: 93.

Paredes-lópez, O.; H. Guzman-Maldonado and C. Ordorica-Falomir (1994). Food proteins from emerging seed sources. New and Developing sources of food proteins Edited by B.J.F. Hudson. Published in 1994 by Chapman & Hall. ISBN 0 412 58370 4.

Ragab, E.A. (1994). Effect of gamma radiation and temperature on some biochemical components of plant. Ph.D. Thesis, Fac. of Agric., Ain Shams, Univ.

Ramesh, M.; P. Haridas Rao; C.S. Ramadoss (1995). Microwave treatment of groundnut (*Arachis hypogaea*): extractability and quality of oil and its relation to lipase and lipoxygenase activity. Lebensmittel-Wissenschaft und-Technologie., 28(1): 96.

Rosein, H. (1957). A modified ninhydrine calorimetric analysis for amino acids. Arch. Biochem. Biophys, 67: 10.

Roy, D.N. and R.V. Bhat (1974). Trypsin inhibitor content in some varieties of soybean (*Glycine, max*, L.) and sunflower seeds (*Helianthus annuus*, L.). J. Sci. Food Agric., 25: 765.

Saleh, H.S. (1996). Production and evaluation of extrudates from yellow corn grit blends. M.Sc., Thesis, Fac. of Agric., Cairo Univ.

Sales, M.G.; G.A. Maia; F.F.F. Tales; J.W. Stull; C.W. Weber; J.W. Berry, and R.R. Tylor (1984). Cowpea solids prepared by mild alkali treatment, dry, roasting, and microwave heating Nutr. Rep. Int., 30(4): 973.

Salunkhe, D.K.; J.K. Chavan and S.S. Kadam (1992). World oil seeds: Chemistry, technology and utilization. An, AVI Book, Published by van Nostv and Reinhold, New York.

Serour, E.A.: Effect of microwave heating on some biochemical reactions in foods. M.Sc. Thesis, Fac. of Agric., Cairo Univ. (1995)

Shahin, A.A. (1993). Control of fungus diseases during storage of certain economic crops using gamma radiation. Ph.D. Thesis, Fac. of Agric., Cairo Univ. .

Snyder, J.M.; T.L. Mounts and R.K. Holloway (1991). Volatiles from microwave-treated, stored soybeans. JAOCS, 68(10): 744.

Surrey, K. (1964). Spectrophotmetric method for determination of lipoxygenase activity. Plant Physiol, 3: 965.

Swain, T. and W.E. Hillis (1959). The quantitative analysis of phenolic constituent. J. Sci. Food Agric., 10: 36.

Veldink, G.A. and J.F.G. Vliegenthart (1991). Substrates and products of lipoxygenase catalysis. Stud. Nat. Pred. Chem., 9: 559.

WHO (1988). World health organization of the United Nations "Food radiation". A technique for preserving and improving the safety of food.

Wolf, W.J. and J.C. Cowan (1975). Soybeans as a food source. Boca Raton, FL: CRC Press.

Yeo, H.C.H. and T. Shibamoto (1991). Microwave-induced volatiles of the millard model system under different pH conditions. J. Agric. Food Chem. 39: 370.

Yoshida, H. and G. Kajimoto (1988). Effects of microwave treatment on the trypsin inhibitor and molecular species of triglycerides in soybeans. J. Food Sci., 53(6): 189.

Yoshida, H.; Mieno, A.; Takagi, S.; Yamaguchi, M. and Kajimoto, G. (1995). Microwave Roasting effects on acyl lipids in soybeans *(Glycine Max. L.)* at different moisture contents. J. of Food Sci. 60(4): 801.

Young-Hoon, C. and R. Chong-Ouk (1996). Effect of microwave heating on the content of phytic acid and phosphorus in soybeans. Agricultural Chemistry and Biotechnology, 39(1): 32.

Zakaria, S.M. (1983). Nutritive value of some feed stuffs treated with radiation. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Cairo.

التقييم الكيميائى لبذور السمسم المعاملة بالأشعة المؤينة والأشعة الغير مؤينة

إمام عبدالمبدئ عبدالرحيم*، أشجا محمود العدوى**، أسامة محمد عبدالفتاح*، بديعة محمد محمد يونس**

*قسم الكيمياء الحيوية -كلية الزراعة جامعة القاهرة ** مركز بحوث وتكنولوجيا الإشعاع

أجريت هذه الدراسة لمعرفة تأثير كل من أشعة جاما (مؤينة) وأشعة الميكروويف (غير مؤينة) والتداخل بينهما على تخزين بذور السمسم المشعة لمعرفة أفضل معاملة لخفض العوامل المضادة للتغذية (نشاط مضاد أنزيم التربسين والليبوكسجينيز) بدون تأثير معنوى على بنية التركيب الكيميائى لتلك البذور.وقد استخدمت أشعة جاما على ثلاث جرعات (٢,٥، ٥، ٨ كيلوجراى) بينما كانت أشعة الميكروويف ٧٠ قوى قصوى ولمدة ٢، ٤ دقيقة وقد تم تخزين الحبوب على درجة حرارة الغرفة، وكانت الرطوبة النسبية ٥٠-٥٥ % لمدة ٦ شهور .وكان تأثير تلك المعاملات على التركيب الكيميائى والعوامل المضادة للتغذية كما يلى:

تأثير أشعة جاما، والتخزين:

- لوحظ انخفاض المحتوى البروتينى، انخفاض معنوى فى الأحماض الأمينية الحرة الكلية، لم يتأثر محتوى الدهون، انخفاض النسبة المئوية للكربوهيدرات الكلية، تغير محتوى السكريات الذائبة الكلية والمختزلة.
- انخفاض نشاط كل من مضاد أنزيم التربسين وأنزيم الليبوكسجينيز بزيادة جرعات الإشعاع وفترات التخزين.
- حدوث انخفاض طفيف فى محتوى التانينات والفينولات، بينما حدث انخفاض معنوى فى محتوى حمض الفيتيك.

تأثير أشعة الميكروويف، والتخزين:

- لم يتأثر كل من محتوى البروتين والدهون الكلية، انخفاض محتوى الأحماض الأمينية الحرة الكلية، حدوث تغير طفيف فى محتوى الكربوهيدرات الكلية بالتخزين بينما لم يحدث تغير فى السكريات الذائبة الكلية والمختزلة.
- انخفاض معنوى فى نشاط كل من مضاد أنزيم التربسين و انزيم الليبوكسجينيز، وكان الإنخفاض فى نشاط انزيم الليبوكسجينيز تدريجى مع زيادة مدة التخزين.
- حدوث تغير فى محتوى كل من التانينات والفينولات بينما حدث انخفاض فى حمض الفيتيك.

تأثير التداخل بين أشعة جاما والميكروويف، والتخزين:

- اختلاف المحتوى البروتينى تبعا للمعاملة، انخفاض معنوى فى محتوى الأحماض الأمينية الحرة الكلية، مع انخفاض بسيط فى كل من محتوى الدهون والكربو هيدرات الكلية والسكريات الذائبة والمختزلة.
- انخفاض فى نشاط كل من مضاد أنزيم التربسين وانزيم الليبوكسجينيز بزيادة جرعات الإشعاع وزمن التعريض لأشعة الميكروويف على مختلف فترات التخزين.
- حدوث انخفاض فى محتوى كل من التانينات وحمض الفيتيك، بينما حدث انخفاض طفيف فى محتوى الفينولات.

يتضح من الدراسة أنه يمكن استخدام أشعة الميكروويف الغير مؤينة بأمان فى القضاء على أو خفض محتوى مضادات التغذية مع عدم تأثيرها المعنوى على المكونات الغذائية الأخرى لبذور السمسم كما يمكن تخزينها بعد المعاملة بالميكروويف لفترة طويلة دون حدوث تغيرات معنوية ملموسة.