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STUDIES ON THE EFFECT OF IRRADIATION ON THE CHARACTERISTICS AND THE QUALITY OF PEANUT

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ABSTRACT

Two varieties of peanut (*Archis hypogaen* 2n = 40), namely NAGC 841 and Comet were drived from India and USA, respectively. The varieties were irradiated with gamma ray at 100, 200, and 300Kgy. The irradiated samples were planted several successive seasons for adaptation. Eight mutants were selected namely M1, M28, M52, M55, M57, M62, M72 and M73, which characterized with high yield and good agronomy characteristics. The selected mutants and two local varieties namely Giza5 and Giza6 were analyzed for chemical composition and the data revealed that the mutants resulted in high lipid content ranged from 44.3% to 46.3% and slight decrease in protein and carbohydrates, compared with local varieties. Fatty acid composition of the mutants and the local varieties were found in a slight variation between samples, which reflected the physical and chemical properties of the extracted oils. Biscuits produced by the supplementation with different levels of Giza6 defatted peanut, i.e. 5, 10, 15, 20%subjected to sensory evaluation. The data resulted in good sensory evaluation was found due to 5 and 10% and decreased the score when the supplementation of defatted peanut more than 10%. The amino acid analysis of defatted peanut was found to be a rich in cystine + methionine and tyrosine + phenylalanine and can supplemented any baked material poor in these essential amino acids.

Keywords:Peanut, irradiation, Fatty acids composition, Physical and chemical properties of peanut oil, amino acid composition, supplementation with peanut cake, biscuits.

INTRODUCTION

Peanut is considered as an important summer crop cultivated in the reclaimed land. This crop brings back quick cash money profit for farmers. An early matured cultivars, i.e. Giza5 and Giza6 were selected for cultivation in reclaimed land. About of 30 – 35% of peanut production was exported to Arabian and European countries (Thanaa, 2000). Peanut ranks as the fourth oilseed crop, in world production, following soybean, cottonseed, and rapeseed. Peanut, beside its majority in oil production, it is considered as a good source of protein (Haumann,1998). Peanut contained oil in a range of 47 - 50%. As mentioned by Zeinab *et. al*. (1995), Peanut oil is fairly stable in its physical and chemical properties, i.e., iodine number, saponification number, acetyl number and free fatty acids during heat treatments involved in the manufacture of peanut butter and salted peanut. Peanut oil contained at least eight nutritionally essential fatty acids. It is also characterized with 76 – 82% of unsaturated fatty acids of which 30 – 35% oleic acid and 30 – 35% lenoleic acid. Peanut meal was analyzed by Batal *et. al*. (2005) and they found that peanut meal contained large amount of protein ranged from 40.1 to 50.9%. The other constituents, i.e., fat, fiber and ash were found in the amounts of 2.5, 8.3 and 5.0% respectively. They mentioned that the critical amino acids such as lysine, methionine, cystine, threonine and arginine were

found in the amounts of 1.54%, 0.52%, 0.64%, 1.17% and 5.04% respectively.

The functional characteristics of peanut meal was determined by Tate *et. al.* (1990). They found that with respect to water and oil absorption, as well as foaming capacity, an inferior functional properties were found. The odor, texture, flavor and taste of cookies prepared from composite flour containing cake meal (10%, w/w) were similar to those prepared from wheat flour (100%). They observed that supplementation with peanut cake meal improved cookies protein and minerals contents.

The present study aimed to evaluate eight peanut mutants produced by irradiation exposure and cultivated for 6 years for their chemical composition, physical and chemical properties of their oils compared with the two local varieties (Giza5 and Giza6). On the other hand, Peanut cake produced from Giza6 was taken as supplementation material for preparing biscuits.

MATERIALS AND METODS

Materials:

Two varieties of peanut (*Archis hypogaena,L*, 2n = 40), namely NGAC 841 and Comet were drived from India and USA, respectively. The two varieties were irradiated at the National Center for Radiation Research and Technology, Nasr City, Cairo. The irradiation was conducted using Russian gamma Cell, Model Isslevotel Cobalt 60 was used as an irradiation source and average dose rate was 6kGy/h. The irradiation doses were 100, 200 and 300kGy. The irradiated samples were planted many successive seasons at A.R.C., research station, Giza to obtain good plants with high yield. Eight mutants were selected, which were characterized with hereditary stability, (as a result of irradiation with 300kGy) and high yield and good agronomy characteristics. The selected mutants named M1, M28, M52, M53, M57, M62, M72 and M73. these mutants were selected and adapted by Sorour *et .al.* (1999). Oil Crops Department, Field Crops Institute, A.R.C., Giza5 and Giza6 peanut varieties were also obtained from the above mentioned department.

Methods:

Chemical composition of peanut seeds and defatted peanut:

Moisture, oil, protein, ash and crude fiber were determined according to the methods outlined in A.O.A.C. (2000). Meanwhile total carbohydrates were calculated by differences (Fraser and Holms, 1959)

Preparation of defatted peanut:

Peanut seeds were crushed and pressed by a laboratory hydraulic press. The obtained defatted peanut and oils were stored in refrigerator until be used.

Determination of amino acids:

Amino acid content of Giza6 defatted peanut was determined according to the method described by Pellet and Young (1980).

Chemical score of essential amino acids (EAA) was relatively determined according to FAO / WHO scoring pattern (1990). Chemical score was

calculated using the following equation according to FAO / WHO scoring pattern (1990)

Chemical score (%) = EAA in crude protein X 100 / EAA of FAO/WHO

Physical and Chemical properties of peanut oil

Refractive index, acid value, iodine value, peroxide value and unsaponifiable matter contents were determined according to the methods outlined in A.O.A.C. (2000).

Identification and determination of peanut fatty acids:

Peanut oil fatty acid were identified and determined using GLC as described by Ashoub *et. al.* (1989).

Preparation of biscuits:

Biscuits were processed using the method described by Waode (1988). The biscuits formula consists of wheat flour (100g), sugar (20.8g), butter (16.0g), skimmed milk powder (2.5g), salt (0.36g), sodium bicarbonate (0.54g), sodium meta-bisulfite (0.022g) and water (17.9g). Defatted peanut of (Giza6) was separately substituted of 5, 10, 15, and 20% of flour. After mixing the ingredients, the biscuits were baked at 150°C for 20 min. in an electric oven.

Sensory evaluation of biscuits:

The produced biscuits were evaluated for appearance, color, texture, cracking, flavor, bite and chewing and overall acceptability by ten panelists according to the methods described in A.A.C.C. (1985).

Statistical analysis:

The obtained data were statistically analyzed according to the method described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Chemical composition of local peanut varieties, mutants and defatted peanut:

Table (1) revealed that a slight variation in the chemical composition of local peanut varieties Giza5 and Giza6 in fresh weight. There are a slight decrease in protein, and total carbohydrates, and increase in lipids in peanut mutants compared with local varieties, while crude fiber increased in Giza 6 peanut variety On the other hand, defatted peanut was characterized with higher moisture content (6.56%), protein (43.44%), total carbohydrates (32.80%), ash (3.75%) and crude fiber (7.5%), while lipids found in amounts ranged from 1/8 to 1/9 compared with other varieties and mutants. From the above mentioned data, it could be concluded that the produced mutants characterized with high lipid content ranged from 44.3% to 46.3% and slightly decrease in protein and carbohydrates compared with the local varieties. This may be as a result of gamma ray irradiation, which play a role in the DNA structure and in parallel protein content and its components. The increase of all chemical composition of peanut cake except of oil is due to the oil extraction. The obtained results were in the line with those of Thanaa (2000) and Batal *et. al.* (2005).

Table (1): Chemical composition of peanut varieties, mutants and defatted peanut Giza 6 (on fresh weight).

Peanut varieties and mutants	Moisture %	Crude Protein %	Total carbohydrate %(*)	Crude Fiber %	Total Lipids %	Ash %
Giza 5	4.55	27.13	19.36	6.16	40.60	2.30
Giza 6	4.20	27.80	21.00	4.80	39.80	2.40
Mutant 1	4.10	25.14	18.65	5.71	44.30	2.10
Mutant 28	3.75	25.31	18.26	5.16	45.22	2.30
Mutant 52	3.75	24.91	17.58	6.16	45.50	2.10
Mutant 53	3.40	25.10	18.13	5.85	45.41	2.11
Mutant 57	4.10	25.30	18.06	5.22	46.00	2.30
Mutant 62	5.00	23.41	19.51	4.92	45.10	2.21
Mutant 72	4.90	24.21	17.77	5.00	46.30	2.10
Mutant 73	4.60	24.42	17.67	5.30	45.81	2.20
Defatted peanut of Giza6	6.56	43.44	32.80	7.50	5.94	3.75

(*) Tatal carbohydrates calculated by differences.

Physical and chemical properties of oils extracted from peanut varieties and mutants:

Table (2) shows the physical and chemical properties of oils extracted from peanut varieties and mutants. The data revealed that the refractive index of oils under study varied in the fourth decimal which ranged from 1.4660 to 1.4668. This means that the degree of unsaturation slightly varied. Acid value showed a value of 5.8 and 4.9 for G5 and G6. Meanwhile, it showed a value of 3.9 for M1 and ranged from 4.0 to 6.9 for other mutants. This may be due to the lipase activity, which play a role in lipid synthesis. Unsaponifiable matter showed a value of 2.72% and 2.5% for G5 and G6, respectively. On the other hand, the mutants resulted in lower amounts on the unsaponifiable, compared with the local varieties except that of M72, which shows an increase by about 30%. This decrease in the unsaponifiable matter may affect the stability of oil. Iodine value ranged from 68.33 to 78.68, which reflected the unsaturation content. The iodine value were in parallel with refractive index. Peroxide value ranged from 1.7 to 7.0meq/k, which is in accordance with Egyptian codex (2005). In conclusion, the extracted oils were acceptable, and addition of antioxidants must be taken place

Table (2) :Physical and chemical properties of oils extracted from peanut varieties and mutants.

Peanut oils	Refractive index (at 25°C)	Acid Value (mg KoH / g)	Unsaponifiable matter (%)	Iodine Value	Peroxide value (m.eq. / Kg oil)
Giza 5	1.4662	5.80	2.72	73.50	3.50
Giza 6	1.4668	4.90	2.5	78.68	5.20
M1	1.4663	3.90	2.05	74.36	1.70
M_{28}	1.4661	6.90	2.40	72.64	5.20
M_{52}	1.4668	4.00	1.77	78.68	7.00
M_{53}	1.4666	4.70	2.33	76.95	3.50
M_{57}	1.4666	6.50	2.18	68.33	1.70
M_{62}	1.4660	5.80	2.27	71.78	3.50
M_{72}	1.4661	5.30	3.78	72.64	5.20
M_{73}	1.4661	6.50	2.88	72.64	3.50

Fatty acids composition of ois extracted from peanut varieties and mutants :

Table (3) shows the fatty acids composition ofoils extracted from peanut varieties (G5 and G6) and mutants (M1, M28, M52, M53, M57, M62, M72 and M73). The GLC analysis showed that palmetic acid found in all varieties and mutants in the range of 1.40 to 12.0%. M28 was characterized with the lowest amount, meanwhile M52 resulted in highest one. It is worth mentioning that palmetoleic acid was found in M28 only by amount of 11.70%. M28 was also characterized by highest amount of stearic acid, which amounted in 6.58%, which was about double to three folds as that of other varieties and mutants (2.1% - 3.48%). Oleic acid found to be a major fatty acid for all varieties and mutants, which ranged from 44.77% to 55.86%. Lenoleic acid found to compose about one third of fatty acid composition, which ranged from 26.25% to 36.70%. Concerning arachidic acid, behenic acid and lignoceric acid, they represented the minor components, which ranged from 1.22 to 2.52%, 0.68% - 1.26% and 1.87 – 2.77%, respectively.

Table (3): Fatty acids composition of oils extracted from peanut varieties and mutants.

Peanut varieties and mutants / **Fatty acids**	**G5**	**G6**	**M1**	**M28**	**M52**	**M53**	**M57**	**M62**	**M72**	**M73**
Palmitic acid (C16 : 0)	11.92	11.74	10.00	1.40	12.00	11.25	9.43	10.73	11.25	10.44
Palmitoleic acid (C16 : 1)	-	-	-	11.70	-	-	-	-	-	-
Stearic acid (C18 : 0)	2.71	2.10	2.80	6.58	3.47	3.61	3.41	2.80	2.50	2.26
Oleic acid (C18 : 1)	52.20	44.83	55.86	44.77	45.64	47.31	55.85	53.80	54.41	51.52
Lenioleic acid (C18 : 2)	33.17	36.70	26.25	29.50	34.92	33.57	27.10	30.58	31.85	31.10
Arachidic acid (C20 : 0)	-	1.26	1.43	2.52	1.41	1.52	1.50	1.23	-	1.22
Behenic acid (C22 : 0)	-	1.10	1.19	0.77	0.68	0.80	0.78	0.85	-	1.26
Lignoceric acid (C24 : 0)	-	2.27	2.47	2.77	1.87	1.94	1.92	-	-	2.20
USF % (*)	85.37	81.53	82.11	85.97	80.56	80.88	82.95	84.38	86.26	82.62
SF % (**)	14.63	18.47	17.89	14.04	19.43	19.12	17.04	15.61	13.75	17.38
USF / SF	5.83	4.41	4.60	6.12	4.15	4.23	4.87	5.41	6.27	4.75

(*) USF means unsaturated fatty acids.
(**) SF means saturated fatty acids.

Arachedic, behenic and lignoceric acids were not detected for G5 and M72. The ratio between the total unsaturated fatty acids to the saturated ones showed a slight variation between the varieties and mutants, which ranged between 4.15 to 6.27. The high ratio may be due to the absence of some saturated fatty acids, such as arachidic, behenic and lignoceric. This means that the produced mutants slightly differ or almost the same as that of other varieties.

Amino acid composition of defatted peanut (Giza 6):

Table (4) showed the non essential and essential amino acids of defatted peanut (Giza6). The data showed that the total essential amino acids composed 36.76% of the total protein of which cystein + methionine and tyrosine + phenyl alanine were the predominant, which composed 4.23 and 14.92% of total amino acids. The chemical score of the essential amino acids shown in table (5). The chemical score of the essential amino acids found in

lower percentage than FAO/WHO (1990) except that of cystein + methionine and tyrosine + phenyl alanine, which resulted in highest chemical score of 120.86 and 213.14%. This means that peanut cake is rich in cystine + methionine and tyrosine + phenyl alanine and can supplement any baked product poor in this essential amino acids.

Table (4): Amino acids composition of defatted peanut (Giza6).

Amino acid composition (g / 100g protein)				FAO / WHO Professional pattern (1990)
Non essential	**%**	**essential**	**%**	
Aspartic	10.05	Lycine	3.28	5.50
Serine	4.23	Therionine	2.47	4.00
Glutamic	17.48			
Proline	4.28	(Cystine +	2.47	
Glycine	5.57		4.23	3.50
Alanine	4.12	Methionine)	1.76	
Histidine	2.52			5.00
Arginine	11.97	Valine	3.54	4.00
		Isoleucine	2.66	7.00
		Leucine	5.66	
		(Tyrosine +	2.41	7.00
			14.92	
		Phenyl alanine)	12.51	
Total	60.22		36.76	

Table (5): Chemical score of peanut cake amino acids.

Amino acids	Chemical score
Lycine	59.60
Cystine + Methionine	120.86
Thereonine	61.57
Isoleucine	66.50
Leucine	80.86
Valine	70.80
Tyrosine + phenyl alanine	213.14

Sensory characteristics of biscuits substituted with different levels of defatted peanut:

Sensory evaluation of biscuits substituted with different level of defatted peanut i.e. 5,10,15, and 20% was recorded in table (6). The obtained data revealed that there were non significant differences of biscuits characteristics substituted with 5 and 10% defatted peanut, compared with control. Meanwhile, increasing the substituted material resulted in significant decrease in all sensory parameters, compared with either control and 5 and 10% substitutions. This means that increasing substitution level decrease the sensory parameters score and this may be due to the increase of some sulpher amino acids, such as cystine and methionine.

Table (6): Sensory characteristics of biscuits substituted with different levels of peanut cake.

Sample	Appearance (20)	Color (10)	Texture (30)	Cracking (10)	Flavor (10)	Bite & chewing (20)	Overall acceptability (100)
Biscuits from wheat flour	(18.50 ± 1.179)(*)	9.40 ± 0.699	28.10 ± 1.729	8.95 ± 0.685	9.60 ± 0.516	19.10 ± 0.994	93.65 ± 3.958
Biscuits with 5% peanut cake replacement	17.30(**) ± 1.494	8.30(**) ± 1.059	27.50(**) ± 1.269	8.90(**) ± 0.738	9.20(**) ± 0.632	18.50(**) ± 1.434	89.70 ± 4.715
Biscuits with 10% peanut cake replacement	17.30(**) ± 1.252	8.30(**) ± 0.949	27.20(**) ± 1.033	8.80(**) ± 0.789	9.10(**) ± 0.738	18.40(**) ± 1.075	89.10 ± 3.035
Biscuits with 15% peanut cake replacement	15.70 (**)± 2.452	7.10 (**)± 1.101	25.20 (**)± 2.658	7.60 (***)± 1.075	8.10 (***) ± 1.101	17.10 (**) ± 2.283	80.80 ± 5.432
Biscuits with 20% peanut cake replacement	14.30(***)± 2.869	7.00(**) ± 1.155	24.40(***) ± 3.836	7.20(***) ± 1.229	7.40(***) ± 1.647	15.40(***) ± 2.675	75.70 ± 9.334
L.S.D. at 1%	1.853	3.153	2.82	1.127	0.812	2.190	4.198

(*) (Means ± standard deviation)
(**) No significant differences comparing with control, for the same parameter.
(***) Significant differences at *(P < 0.01)* comparing with control, for the same parameter.

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دراسة مدى تأثير الإشعاع على صفات وجودة الفول السوداني

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تمت الدراسة على صنفين من الفول السوداني ، هما Comet ،NAGC 841 وقد تم الحصول عليهما من الهند والولايات المتحدة الأمريكية، على التوالي.

تم تشعيع الصنفين بأشعة جاما بجرعات ١٠٠ , ٢٠٠ ، ٣٠٠ كيلو جراى، وتم زراعة هذة العينات عدة مرات خلال عدة مواسم بنجاح تمهيدا لتطبيقها.

تم اختيار ٨ طفرات وهى M1, M28, M52, M55, M57, M62,M72 M73 والتي تتميز بالمحصول العالي والصفات الزراعية الجيدة. تم تقدير التركيب الكيماوي للطفرات المنتخبة والصنفين المحليين (جيزة ٥ و جيزة ٦) وأظهرت النتائج أن الطفرات تتميز بارتفاع نسبة الزيت و التي تتراوح بين 44,3 % و 46,3 % وانخفاض طفيف في البروتين والكربوهيدرات مقارنة بالأصناف المحلية. وجد اختلاف طفيف في تركيب الأحماض الدهنية للطفرات والأصناف المحلية والذي يعكس الصفات الطبيعية والكيماوية للزيت المستخلص.

تم إنتاج بسكويت مدعم بنسب مختلفة من الفول السودانى منزوع الدهن، صنف جيزة (٦) بنسب ٥، ١٠، ١٥، ٢٠ % وتم تقدير الصفات الحسية له. أوضحت النتائج أن الصفات الحسية جيدة للنسب ٥ ، ١٠ % يحدث نقص في الدرجة عندما يصل التدعيم بالفول السوداني منزوع الدهن أكثر من ١٠ %.

أظهرت النتائج أيضا من تحليل الأحماض الامينية أن الفول السوداني منزوع الدهن غنى في كل من السستين + الميثيونين ، و التيروزين + الفينيل الانين. يمكن تدعيم المخبوزات الفقيرة في هذة الأحماض الامينية الأساسية بالفول السوداني منزوع الدهن.