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TRIALS TO DECREASE THE ANTINUTRITIONAL FACTORS IN SUNFLOWER CAKES

G. A. Abd El-Malak [1], S. M.Youssef [1] And M. M. Saad [2]

1-Department of Horticulture Crop Processing,Food Technology Research Institute, Agricultural Research Center, Giza, Egypt .
2-Department of Food Sci. and Technol.,Faculty of Agriculture, Minufiya University, Shibin El- Kom, Egypt.

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ABSTRACT: *Sunflower cakes for four varieties namely Euroflor, Fedok, Malabar and Allamo cultivated in three districts (El – Sadat, El – Raheb and El – Fayoum) were used efficiently as a source of protein either for man or animal feeding.Some thermal treatments (microwave and autoclave) and chemical treatments (acidic butanol, HCl 0.002 N and NaCl 2%) were used to decrease the antinutritional factors such as total phenols, chlorogenic acid and phytate content. Chlorogenic acid constituted almost 70% from the total phenols. The total phenolic compound levels were highly influnced by the type of soil rather than the cultivars under investigation. The highest effective treatments were that of 2% NaCl since percent degradation reached 72.65% of total phenolic compound while the lowest degradation was15.85% in microwaved treated samples. Whereas, the least concentration of phytic acid was observed in samples soaked in HCl 0.002N for one hour. Decreaments in antinutritional factors in protein concentrate ranged from 63.57 to 73.81% and 23.30 to 32.74% for total phenolic compounds and phytic acid,respectively, whereas the corresponding range of degradation in protein isolate were 31.36 to 41.77% and 23.21 to 41.67%.*

Key words: *Sunflower cake ,antinutritional factors.*

INTRODUCTION

The production of fat and oils in Egypt are not suficient to cover the needs of annual consumption which reached 600 thousand tons.

Egypt produces annually at present 150 thousand tons of oils extracted from cotton, soy bean and sunflower seeds.

Accordingly, many trials have been carried out to increase the cultivation of sunflower in Egypt especially in under reclaimed land.

Oil industry produces many tons of cakes which usually left over after extracting oil. These products could be used as a source of protein isolate or concentrate for man feeding. However these residues have a high level of antinutritional factors such as chlorogenic acid, total phenols and phytates.These antinutritional factors hinder the use of such products. Cheryan (1980) mentioned that phytate content in sunflower meal more than

3.5% must be reduced because of its well-documented effect on nutritional and function properties of protein. Taha and El- Nockerashy (1981) showed that single step aqueous extraction of sunflower seed meal (meal/water ratio of 1 :10) at pH 4.6 removed 84.1% phytic acid from the meal and 4 successive extractions at the same meal water ratio removed 99.9%. On the other side high concentration of chlorogenic acid in sunflower meal could become barrier to its utilization in food products. Sosulski and McClear (1972) found that chlorogenic acid was the major phenolic acid in the sunflower meals and varied between 1.5 and 2.0% of the original kernel weight .Sasulski *et al*, (1973) showed that extraction diffusion in a batch system (with 0.001 N HCl) at 80C for 6 hrs at a solvent – Kernel ratio of 120 : 1 was successful in reducing the chlorogenic acid level to 0.4 g/ 100g meal .

Rahma and Rao (1981) mentioned that removal of polyphenol could be carried out by using water, 0.002N HCl, 70%ethanol, 2% NaCl, acidic n-butanol and multiple solvents. All treatments decreased the chlorogenic acid content .

Shamanthaka Sastry and Subramanian (1985) found that processing sunflower by autoclaving cause 47% loss of chlorogenic acid after 15 min and 85.8% after 60 min at 120°C .

Madhusudhan *et al.*, (1986) reported that salt roasting of dehulled sunflower seeds at 120 °C for 5 min. reduced the polyphenol compounds by 78.2% (chlorogenic acid), 50% (coffeic acid) and 34.4% (quinic acid.).

Abd El–Magied (1986) removed chlorogenic acid from partially defatted sunflower kernels by acidic sodium chloride. The chlorogenic acid content decreased from 1.86% in the original meal to 0.53% for chlorogenic acid free meal.

Hind (1998) reported that the treatments with water (70C), boiling water, sodium bi-sulphate (0.25%) and sodium hydroxide (1N) at alkaline medium (pH=10-10.5) for 2 hours indicated that the extraction of the meal by using sodium hydroxide (1N) gave the best treatment for the removal of total polyphenols in all types of sunflower meals (Giza 1 and Hybrid varieties).

All trials to decrease the effect of such antinutritional factors are in need to make the sunflower cakes used as a source of protein efficiently from nutritional side of view.

MATERIALS AND METHODS

Two kilograms from sunflower cake varieties (*Helianthus annus L.*) cultivated in three types of districts (El-Sadat, El-Raheb and El-Fayoum). These cakes were grind, dried and kept in glass jars. Protein content was determined according to A.O.A.C. (1985). Different antinutritional factors such as, chlorogenic and polyphenols were initially determined according to A.O.A.C (1985) Whereas, methods of Mohammed *et.al.* (1986) used for determine phytate content. Thereafter a samples of such cakes were undergone thermal and chemical treatments. The thermal treatments

included autoclaving for 20min.at 120° C and subjecting to microwave (medium power) for 3min. Moisture contents were adjusted to 1:3 and 1:2 w/v for autoclaving and microwave, respectively. The chemical treatments included treating the samples with 0.002 N hydrochloric acid, 2.0% sodium chloride solution and acidic butanol. The extraction was done by mixing 50g of defatted sunflower meal with solvent at a ratio of 1:15 (w/v), stirred occasionally for 1h at room temperature (25° C) then centrifuged and the supernatant was removed Khalil *et.al*, (1993).

RESULTS AND DISCUSSION

Either total phenols or chlorogenic acid affect drastically protein digestion Also phytic acid hinders the absorption of divalent cations in general such as calcium and iron.

Table (1) represent percentage of antinutrient components in four sunflower seeds planted in different districts. These results revealed that total phenol in cakes produced from sunflower seeds planted in El-Sadat, were 3.25, 3.98 and 3.89% for Euroflor, Fedok and Malabar varieties, El-Raheb were 2.83,2.80 and 3.11 for Allamo, FedoK and Malabar and El-Fayoum were 4.86, 4.62 and 3.79% for Allamo, Fedok and Euroflor. varieties, respectively.

The Corresponding values for chlorogenic acid were 2.23, 2.76 and 2.70, 1.96, 1.94 and 2.65 and 3.35, 3.05 and 2.61%(DWB).

Table (1): Some antinutritional factor contents* of sunflower seeds.

Districts	Varieties	Total phenols	Chlorogenic acid	phytates
EL SADAT	Euroflor	3.25	2.23	1.28
	Fedok	3.98	2.76	1.43
	Malabar	3.89	2.70	1.20
EL RAHEB	Allamo	2.83	1.96	1.68
	Fedok	2.80	1.94	1.44
	Mulabar	3.11	2.65	1.73
EL FAYOUM	Allamo	4.86	3.35	1.30
	Fedok	4.62	3.05	1.03
	Euroflor	3.79	2.61	1.12

* % on dry weight basis

In general it could be observed that chlorogenic acid constitute almost 70% from the total phenols. The total phenolic compounds levels were highly

influnced by the type of soil rather than the cultivars under investigation since the highest phenolic compounds were found in the cakes produced from sunflower seeds planted in EL-Fayoum district, whereas the lowest phenolic compounds were found in cakes produced from seed planted in El-Raheb district .

As for phytic acid percentages ranged from 1.20 to 1.43, 1.44 to 1.73 and 1.03 to 1.30% (DWB) for El-Sadat, El-Raheb and El-Fayoum, respectively. These fluctuations could be ascribed to both the kind of cultivar as well as the soil type. It could be concluded that total phenolic compound could be considered high while phytate concentration was moderate, however both affect directly the nutritional value of the residual cakes. These results are in agreement with Graf (1983) who found that phytic acid content of sunflower seed was 1.9% and Sabir *et al.*, (1974) who reported that the amount of chlorogenic acid in sunflower was varied between 3.0 and 3.5% in flour (DWB).

Data in Table (2) represent the effect of different treatments on the degradation of phenolic compounds in different cakes produced from different sunflower seeds planted in different soils types. These results indicated that chemical treatments highly affected on the degradation of total phenolic compounds compared to thermal treatments. Thermal treatments were able to decrease percentage of total phenolic compounds since percent decrements on avarage were 23.58 for autoclaved and 15.85 for microwaved samples. whereas percent decrements, on avarage as a result of chemical treatments were 72.65, 64.74 and 46.43% for 2% NaCl, HCl 0.002 N and acidic butanol, respectively.

Table (2): Effect of some different treatments on total phenols content (%)* in sunflower cakes

Districts	Sunflower varieties	Raw defatted sunflower seeds	Autoclave 20 min.	Loss %	Microwave 3 min.	Loss %	Acidic butanol	Loss %	HCl 0.002 N	Loss %	NaCl 2%	Loss %
EL – SADAT	Euroflor	3.25	2.62	19.38	2.89	11.08	1.78	45.23	1.20	63.08	1.03	68.31
	Fedok	3.98	3.08	22.61	3.26	18.09	2.15	45.98	1.52	61.81	1.31	67.09
	Malabar	3.89	2.99	23.14	3.18	18.25	2.26	41.90	1.27	67.35	1.18	69.67
EL - RAHEB	Allamo	2.83	2.24	20.85	2.39	15.55	1.45	48.76	1.05	62.90	0.69	75.62
	Fedok	2.80	2.03	27.50	2.46	12.14	1.53	45.36	0.93	66.79	0.78	72.14
	Malabar	3.11	2.47	20.58	2.58	17.04	1.74	44.05	1.12	63.99	0.71	77.17
EL- FAYOUM	Allamo	4.86	3.50	27.98	4.03	17.08	2.58	46.91	1.66	65.84	1.41	70.99
	Fedok	4.62	3.30	28.57	3.76	18.61	2.22	51.95	1.57	66.02	1.07	76.84
	Euroflor	3.79	2.97	21.64	3.23	14.78	1.98	47.76	1.33	64.91	0.91	75.99

* % on dry weight basis

It could be observed that the highest effective treatment was that of 2% NaCl since percent degradation reached 72.65 compared to other treatments which caused percent degradation ranged from 15.86% (microwave) to 64.74% (0.002N HCl).It could be advisable to use the method which caused the maximum degradation of total phenolic compounds. These results are in agreement with those reported by Rahma and Rao (1981), Taha and El Nockerashy (1981) and Shamanthaka Sastry and Subramanian (1985).

Results in Table (3) reveal the percent degradation of phytic acid which could be arranged in descending order on avarage as follows : 58.56, 39.29, 30.96, 27.37 and 20.03% for HCl 0.002 N, autoclave, microwave, acidic butanol and 2% sodium chloride treated samples, respectively. These results indicated that the highest effective treatment in degraded phytic acid was treating by HCl 0.002 N, whereas the lowest effective treatment that of 2% sodium chloride.

Table (3): Effect of some treatments on phytate percentages* in sunflower cakes

Districts	Sunflower Varieties	Raw defatted sunflower seeds	Autoclave 20 min.	Loss %	Microwave 3 min.	Loss %	Acidic butanol	Loss %	HCl 0.002 N	Loss %	NaCl 2%	Loss %
EL- SADAT	Euroflor	1.28	0.94	26.56	0.90	29.69	0.98	23.44	0.54	57.81	1.08	15.63
	Fedok	1.43	0.82	42.66	1.01	29.37	1.02	28.67	0.62	56.64	1.13	20.98
	Malabar	1.20	0.74	38.33	0.84	30.00	0.89	25.83	0.45	62.50	1.01	15.83
EL- RAHEB	Allamo	1.68	0.98	41.67	1.06	36.90	1.15	31.55	0.70	58.33	1.36	19.05
	Fedok	1.44	0.86	40.28	0.98	31.94	1.00	30.56	0.56	61.11	1.15	20.14
	Malabar	1.73	0.95	45.09	1.20	30.64	1.26	27.17	0.76	56.07	1.31	24.28
EL- FAYOUM	Allamo	1.30	0.81	37.69	0.89	31.54	0.96	26.15	0.59	54.62	0.97	25.38
	Fedok	1.03	0.56	45.63	0.75	28.18	0.77	25.24	0.42	59.22	0.84	18.45
	Euroflor	1.12	0.72	35.71	0.78	30.36	0.81	27.68	0.44	60.71	0.89	20.54

* % on dry weight basis

Fluctuation in percent degradation for the different cultivars using the same treatment were narrow.The least concentration of phytic acid in the final product could be reached when using HCl 0.002 N soaking treatment.

Results in Table (4) represent the effect of preparing methods of either protein isolate and protein concentrate on percent of total phenolic compound in the final products. These results Indicate that the method of preparing protein concentrate was more effective in decreasing the level of total phenolic compounds than the method of preparing of protein isolate since the range of degradation percent of total phenolic compound in different protein concentrates were from 63.57 to 73.81%, whereas the corresponding values of protein isolate were from 31.36 to 41.77 in all cases total phenolic compounds in protein concentrate were far beyond that of protein isolate. However, range of degradation in either protein concentrate or protein isolate were moderately fluctuated. These results could be attributed to the process of soaking the material for long time in HCl 0.002N solution as a vital step when preparing protein concentrate.

Table (4): Effect of the preparing methods of protein concentrate and isolate on decreasing total phenols percentages*in sunflower cakes .

Districts	El-Sadat			El-Raheb			El-Fayoum		
Varieties	Euroflor	Fedok	Malabar	Allamo	Fedok	Malabar	Allamo	Fedok	Malabar
Sunflower cake	3.25	3.98	3.89	3.83	2.80	3.11	4.86	4.62	3.79
Protein concentrate	0.97	1.45	1.19	0.90	0.95	0.98	1.33	1.21	1.14
Loss %	70.15	63.57	69.41	68.20	66.07	68.48	72.26	73.81	69.92
Protein isolate	2.18	2.34	2.67	1.83	1.74	1.86	2.83	2.94	2.31
Loss %	32.92	41.21	31.36	35.33	37.86	40.19	41.77	36.36	39.05

* % on dry weight basis

Results in Table (5) indicate that both procedures of preparing either protein concentrate or protein isolate had almost the same effect on the degradation level of phytic acid since degradation percent of phytic acid was almost always the same in both protein concentrate and protein isolate prepared from different cultivars. The degradation percentages in case protein concentrate ranged from 23.30 to 32.74 while degradation percent of phytic acid through preparing protein isolate ranged from 23.21 to 41.67. The fluctuation in degradation percentages of phytic acid were moderately in both cases of either protein concentrate or protein isolate.

It could be concluded that the preparing method in all cases had a moderate effect on final degradation of phytic acid in the treated products.

Table (5): Effect of the preparing methods of protein concentrate and isolate on decreasing phytate percentages*in sunflower cakes .

Districts	El-Sadat			El-Raheb			El-Fayoum		
Varieties	Euroflor	Fedok	Malabar	Allamo	Fedok	Malabar	Allamo	Fedok	Malabar
Sunflower cake	1.28	1.43	1.20	1.68	1.44	1.73	1.30	1.03	1.12
Protein concentrate	0.93	1.00	0.88	1.13	1.05	1.23	0.95	0.79	0.78
Loss %	27.34	30.07	26.67	32.74	28.08	28.90	26.92	23.30	30.36
Protein isolate	0.90	0.87	0.80	1.07	0.84	1.05	0.85	0.69	0.86
Loss %	29.69	39.16	33.33	36.31	41.67	39.31	34.62	33.01	23.21

* % on dry weight basis

REFERENCES

Abd El – Magied, M. M. (1986). Preparation, evaluation and utilization of chlorogenic acid – free sunflower protein isolates, First Conference of Food Sci.and Tech. for Mediterranean Countries, Cairo , A.R.E.

A.O.A.C. (1985). Official Methods of Analysis Association Official Analytical Chemists, Washington, Dc, U.S.A.

Cheryan, M. (1980). Phytic acid interactions in food systems CRC Crit. Rev. Food Sci. Nutr., 13 : 297.

Graf, F. (1983). Application of phytic acid. J.Am. Oil Chem. Soc., 60 : 1861-1867.

Hind, S. A. (1998). Chemical and technological studies on sunflower meals. M.Sc. Thesis, Fac. of Agric., Cairo University Egypt.

Khalil, K. E., Y. G. Saleh and S. S. Rizk (1993). Preparation of polyphenol – free sunflower protein isolates. Res. Bul. Home Econ. Minufiya Univ.3(4) : 51-61 .

Madhusudhan, K. T., M. C. Shamanthaka Sastry and H. Srinivas (1986). Effect of roasting and the physico – chemical properties of sunflower proteins lebensmittel – wissnschaft and technologie, 19 : 292 – 296 C.F . FSTA, 19, 5J177 (1987).

Mohammed, A., P.J. Perera and Y. Hafez (1986). New chromophore for phytic determination. Cereal Chem., 63: 475 – 478 .

Rahma, E. H. and M. S. Rao (1981). Removal of polyphenols from sunflower meal by various solvents : Effects on functional properties. J. Food Sci ,46 : 1521 – 1522 .

Sabir , M. A., F. W. Sosulski and A. J. Finlayson (1974). Chlorogenic acid-protein interactions in sunflower. J. Agric. Food Chem.,22 : 575-578.

Saeed, M. and M. Cheryan (1988). Sunflower protein concentrates and isolates low in polyphenols and phytate. J . Food Sci., 53 , 1127 – 1131 .

Shamanthaka Sastry, M.C. and N. Subramanian (1985). Effect of heat processing on phenolic constituents and nutritional quality of sunflower flours. J, Am.Oil Chem. Soc. , 62 : 1131 – 1134.

Sosulski, F. W. and C. W. McClear (1972). Diffusion extraction of chlorogenic acid from sunflower kernels. J .Food sci ., 37, 253 – 256.

Sosulski, F. W., M. A. Sabir and S. E. Fleming (1973). Continuous diffusion of chlorogenic acid from sunflower kernels. J. Food Sci., 38 : 468 – 470.

Taha, F. S. and A. S. El-Nockerashy (1981). low phytate, low chlorogenic acid sunflower seed protein concentrate. Nahrung, 25 : 759 – 764. C.F. FSTA, 14, 3G144 (1982).

محاولات لخفض مثبطات التغذية في كسب عبادالشمس

جورج عبيد عبد الملاك[١] ، سعد ميخائيل يوسف[١]

و محمود محمد مصطفي سعد[٢]

١- قسم تصنيع الحاصلات البستانية -معهد بحوث تكنولوجيا الأغذية- مركز البحوث الزراعية- جيزة- مصر.

٢- قسم علوم و تكنولوجيا الأغذية - كلية الزراعة- جامعة المنوفية- شبين الكوم- مصر.

الملخص العربي

تم استخدام أربعة أنواع من كسب عباد الشمس وهي لأصناف إيروفلور والفيدوك وألمالابار والامو والتي تم زراعتها في ثلاث مناطق مختلفة وهي السادات والراهب والفيوم كمصدر للبروتين والذي يمكن الاستفادة منه في تغذية الإنسان أو الحيوان وتم دراسة تأثير بعض المعاملات الحرارية مثل الميكروويف والأتوكلاف وبعض المعاملات الكيماوية مثل البيوتانول المحمض وحامض الهيدروكلوريك بتركيز ٠,٠٠٢ عياري وكلوريد الصوديوم بتركيز ٢% وذلك لخفض بعض مثبطات التغذية مثل الفينولات الكلية و حمض الكلوروجنيك كذلك المحتوي من الفيتات .أظهرت النتائج أن المحتوي من حمض الكلوروجينك يمثل حوالي ٧٠% من الفينولات الكلية . أيضاً الفينولات الكلية تأثرت بنوع التربة التي تم الزراعة بها ،كما أعطت المعاملة بواسطة كلوريد الصوديوم ٢% أعلي تأثير علي خفض المحتوي الكلي من الفينولات حيث بلغت نسبة الخفض ٧٢,٦٥%

أما أقل تأثير علي الفينولات الكلية فكانت بواسطةالمعاملة بالميكروويف فكانت ١٥,٨٥% .

وكان أعلى انخفاض لتركيز حامض الفيتك عند استخدام النقع في حامض الهيدروكلوريك ٠,٠٠٢ ع لمدة ساعة واحدة.حيث تراوحت نسبة الانخفاض في العوامل المثبطة للمغذيات عند عمل بروتين مركز بين(٦٣,٥٧ إلى ٧٣,٨١%) و (٢٣,٣٠ إلى ٣٢,٧٤%) للفينولات الكلية وحمض الفيتيك على التوالي.في حين أن نسب الانخفاض المماثلة عند عمل البروتين المعزول كانت تتراوح بين (٣١,٣٦ إلى ٤١,٧٧%) و(٢٣,٢١ إلى ٤١,٦٧%).