Biochemical Evaluation Of Sunflower Seeds And Its By-Products

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The chemical composition, removal of phenolic compounds, factors affecting the extraction of sunflower seeds and kernels were studied. Also, the bioavailability of sunflower protein concentrate, isolate and by-products were evaluated. The results indicated that total protein was higher in by-products (52.8%) than in sunflower seeds and kernels, 22.55 and 26.68%, respectively. However, fat content in sunflower seeds, kernels and by-products were 41.85, 55.40 and 5.45%, respectively.

The optimum pH for the removal of polyphenolic compounds was pH 5.0 and the optimum numbers of extraction was 6 times.

Free and bound of polyphenols were 2.29, 1.58% and 2.99, 1.51% in kernel meals and by-products. While, the chlorogenic acid contents for the abovementioned materials were 2.72 and 3.39. Phytic acid and trypsin inhibitor contents were 4.32, 3.45% and 1.5, 1.1 mg/g for kernel meals and by-products, respectively.

Treatment with methanol at acidic pH (5.0) gave the highest removal of polyphenols, 92.14 and 95.4%, while using ascorbate as a reducing salt, remove the polyphenols by 68.21 and 67.77% from kernel and by-products meals. Also, protein content increased after acidic treatments to 67.90 and 61.10 for sunflower kernels and by-products. On the other hand, the results indicated that treatment with sodium hydroxide solution (pH 10.0) the percentage of reduced polyphenols was 91.20 and 93.1% for kernel and by-products, but the color of isolated protein was green and dark green. However, treatment with reducing salts (pH 10.0) reduced polyphenols, 90.7 and 92.4% with a good white protein isolate.

The SDS-PAGE protein patterns of the overall polypeptides in sunflower kernel and by-products protein dissociate in 11 subunits with molecular weights ranging from 95.49 to 14.12 K.D.

In-vitro protein digestibility index of untreated sunflower samples was 80.47 and 78.46% in kernel and by-products, but the treatment with acidic solution increases the digestibility to 87.84 and 85.21%. However, treating with alkaline solution gave the highest digestibility index 93.65 and 93.70% from kernel and by-products meals, respectively.

Treating the kernel and by-products with different alkaline solution were more effective in removing phytic acid and trypsin inhibitor (antinutritional factors) than in different acidic medium.

Also amino acids of sunflower kernel, by-products meals, protein concentrate and isolates of sunflower were studied. The results indicate that

sunflower protein has a higher essential/total (E/T) ratio than the proposed 36% for an ideal protein, however, dehulled kernel and protein isolate increased this ratio slightly.

INTRODUCTION

unflower is an important source of edible oil, also the meal after extraction of oil a valuable source of protein. The major difficulty in the utilization of sunflower eal in human diets is the presence of hulls and polyphenols in the seed. unflower seeds contain a significant quantities of phenolic compounds which emain in the flour after oil extraction. The phenolic compounds in sunflowers aried between 3.0 and 3.5% of flour. Chlorogenic acid and caffeic acid onstituted about 70% of the total phenolic compounds in the defatted flour **(Sripad and Rao (1987), Trevino *et al.* (1998) and Carmen *et al.* (1999).**

Shamanthaka and Narasinga (1990) found that chlorogenic, caffeic and quinic acids are the phenolic acids present in sunflower seeds, the major acids being chlorogenic acid and caffeic acid (70%). They observed that the presence of polyphenols can affect the quality of sunflower protein in several ways such as reducing the digestibility and adversely altering the functional properties and behavior of sunflower protein in food systems.

Abu-Shama (1998) reported that the polyphenols contents of sunflower kernel meal of Giza (1) and hybrid varieties were 1.46 and 1.88% respectively. However, phytic acid content of sunflower seeds and meal were 1.38 and 1.90%, respectively. Also, she reported that chlorogenic acid and other phenolic compounds were oxidized to O-quinones and formed covalent linkages with the extracted protein in alkaline medium to yield protein isolate with grey white color. On the other hand, extraction by ethanol (70%) gave the highest removal of polyphenols (84.74%). Treatment with methanol (70%) removed 89.20% and 98.4% from total polyphenols of sunflower seeds and kernels meal.

Phytic acid chelate several mineral elements, especially the divalent metals such as Ca, Zn, Fe, Mn, Cu, Mg and Mo and reduce their availability in the intestinal tract by forming insoluble complexes with cations **(Beleia *et al.*, 1993 and Ann-Safie *et al.*, 1999).**

Saeed and Cheryan (1988) found that protein concentrates and isolates from sunflower essentially free of polyphenols and low in phytate were prepared from dehulled seeds by a sequential extraction procedure using organic solvents, such as hexane for defatting and acidic butanol for removing polyphenols. Phytate was removed by aqueous extraction and separation at acidic or alkaline conditions. Reduced phytate in protein concentrates and isolate developed off-colors unless the polyphenol concentration was less than 0.05%. Also, they found that chlorogenic acid in sunflower seeds ranged from 1.49 to 1.55%, in the kernels 1.62 to 1.66% and the defatted meal 3.06 to 3.18%.

Nuria *et al.* (1999) reported that the digestibility of protein isolate from sunflower was 81.6% and biological value ranged between 63.8 and 73.2%.

Sen and Bhattacharyya (2001) noticed that the nutritional effect of sunflower seed protein fraction (SSPF) extracted with isopropanol on rats did not show much variation in growth, plasma and tissue lipid profile, protein content and erythrocyte membrane lipid profile compared with casein fed rats.

The purpose of the present investigation is to study the removal of polyphenolic substances from sunflower (kernels and by-products) by using organic solvents either in the presence or absence of reducing agents in acidic and alkaline medium. Also, the evaluation of its protein concentrate and isolate, molecular weights, amino acids, phytic acid, trypsin inhibitor and in-vitro protein digestibility index were investigated.

MATERIALS AND METHODS

Sampling

Sunflower seeds (*Helianthus annuus* L.) variety previdwic obtained from Agricultural Research Center, Giza, Egypt.

By-products: sunflower seed meal were obtained from Misr Edible Oil and Soap Company, El-Baderashine Branch, Giza, Egypt.

The seeds were dehulled by blending the seeds for 2 sec. followed by separation the seeds and hulls. The dehulled kernels were cleaned and finally grounded using an electrical cyclon mill provided with 80μ screans. Hexane (B.P. 40-60°C) was used for the extraction of oil from the ground seeds and by-products.

Experimental designs

- pH of the extraction

The pH of the extracting solution was adjusted by HCl (to give an acidic solution) or NaOH (to assure an alkaline solution). The pH values for the extraction solutions were adjusted to cover the range from pH 3 to 9.

- Number of extraction

Variable numbers of extraction required for extraction polyphenolic compounds were studied. Eight numbers were used for different extraction process. The other parameters were constant as noticed before.

Removal of phenolic compounds in acidic media at pH 5.0

- By using organic solvents

The defatted kernels and the defatted by-product were suspended in acidified organic solvents in a ratio of 1: 20 (w/v). Acidified organic solvent such as (methanol, ethanol, butanol and acetone) was prepared by mixing one of the organic solvent with 0.005 N HCl, and the pH was adjusted to 5.0 with 0.5 N HCl, according to **Rahma and Rao (1981)**. The final residue (protein concentrate) was dried under nitrogen at room temperature.

- By using reducing salts

The defatted kernels and by-products were suspended in 0.25% aqueous of sodium sulfite, ascorbate and dithionate in a ratio of 1: 20 (w/v). according to **Demeczky *et al.* (1983)**. The other treatments was adjusted as previously mentioned before.

Removal of phenolic compounds in alkaline media

Defatted sunflower samples were extracted by using 0.02 N of sodium hydroxide according to the method described by **Melnychyn and Wolcott (1971)**.

The meal was extracted with 0.25% aqueous sodium sulfite, ascorbate and dithionate at pH 10.5 (according to **Gheyosuddin *et al.*, 1970)**. The extract was filtered by squeezing through cheese cloth and the filtrate was centrifuged for 20 min. at 2000 r.p.m. The clear supernatant was adjusted to pH 5 with 0.02 N HCl. The precipitate was washed with distilled water and freeze dried (protein isolate).

Chemical analysis

Moisture, crude fat, total protein, crude fiber and ash content were determined in sunflower seeds, kernels, and by products according to the methods described in **A.O.A.C. (1995)**. Total soluble sugars were determined as glucose by the phenol-sulfuric acid method **(Dubois *et al.*, 1956)**.

Determination of polyphenolic compounds

- Total polyphenolic compounds

The free, bound (or conjugated) and total phenols were calorimetrically determined in the ethanolic extracts by using the Folin Denis reagent as described by **Gutfinger (1981)**.

- Determination of chlorogenic acid

The chlorogenic acid was determined with HPLC according to **Dreher and Padmanaban (1983)**.

- Determination of phytic acid

The phytic acid was determined according to the method described by **Mohammed *et al.* (1986)** using chromogenic solutions standard.

- Determination of amino acids

Amino acid analyzer (Model 121) was used for determination of amino acid in sunflower meal as described by **Moore *et al.* (1958)**.

- Assay of trypsin inhibitor (TI)

The trypsin inhibitor activity (TIA) was measured as described by **Hamerstrand *et al.* (1981)**.

- In-vitro protein digestibility

In-vitro digestibility index for protein was carried out according to the method described by **Singh and Jumbunathan (1981)**.

- Electrophortic analysis

Molecular weights of subunits of protein extracted by using (0.02 N NaOH) from different flours were determined by using sodium dodecyl sulphate polyacrylamide

gel electrophoresis (SDS-PAGE) according to the method described by **Laemmeli (1970)**.

RESULTS AND DISCUSSION

Chemical composition of sunflower seeds, kernels and by-products

Chemical composition of sunflower seeds, kernels and by-products are presented in Table (1). The results show that fat content is higher in sunflower kernels and seeds than in by-products since its ratios were 55.4, 41.85 and 5.45%, respectively.

The above mentioned results indicate that dehulled sunflower meal (kernels) contains lower crude fiber content (9.3%) when compared with sunflower seeds and by-products (20.9and 29.96%). The crude protein was found to be higher in by-products (52.8%) than in sunflower seeds and kernels (22.55 and 26.68%), respectively. Also, the values of total soluble sugars content were 5.27, 0.50 and 3.22% in seeds, kernels and by-products, respectively.

These results are in agreement with those obtained by **Shamanthaka and Subramanian (1984), Abu-El-Seoud (1989) and Abu-Shama (1998)**.

Table (1): Chemical composition of sunflower seeds, kernels and by-products (g/100 g dry weight).

Components	Sunflower seeds	Kernels	By-products
Moisture	5.37	4.15	9.12
Fat	41.85	55.41	5.45
Total protein	22.55	26.68	52.80
Ash	4.15	4.04	6.45
Total soluble sugars	5.27	0.50	3.22
Crude fiber	20.91	9.30	29.96

Factor affecting the extraction of polyphenols

The effect of pH and numbers of extraction on polyphenolic compounds were studied. Data presented in Fig. (1 and 2) showed that the maximum polyphenol extraction was achieved at pH 5.0 and 6 times extraction.

These results are in agreement with that obtained by **Giancarlo and Marco (1977)** who found that the ability of acidic butanol (pH 5.0) to remove the polyphenols and oligosaccharides from sunflower meal without detectable protein denaturation.

Also, **Nuria *et al.* (1999)** reported that the complete removal of polyphenol compounds from sunflower seeds and by-products required long periods of shaking with polar organic solvents.

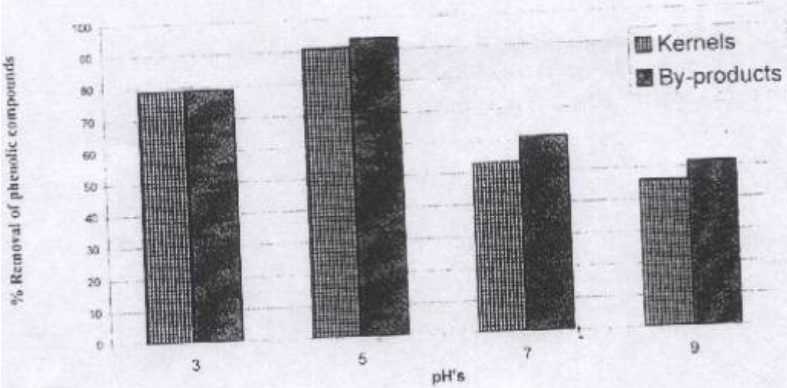


Fig. (1): Effect of pH on the extraction of polyphenol from sunflower kernels and by-products meal.

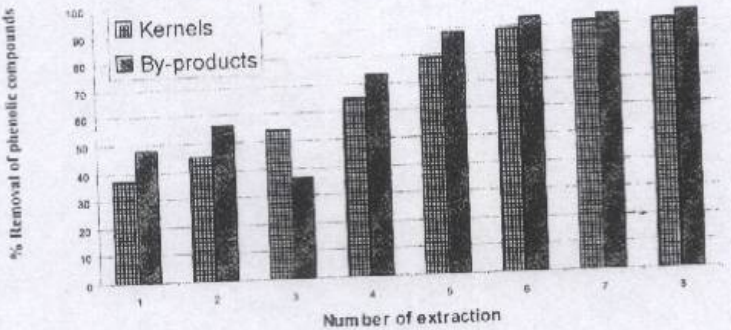


Fig. (2): Effect of extraction number on polyphenol from kernels and by-products meal.

Removal of polyphenolic compounds in acidic medium

The total polyphenols and its removal percent from sunflower kernels meal and by-products were determined after extraction with different organic solvents such as ethanol, methanol, acetone, butanol and different reducing salts such as sodium sulfite, ascorbate and dithionate: in acidic medium (pH 5.0). The obtained results are shown in Table (2 and 3).

From the results recorded in Tables (2) it is shown that treatment with methanol solution at acidic pH gave the highest removal of polyphenols about 92.14 and 95.4% from kernel and by-products meals, respectively. **Rahma and Rao (1981)** mentioned similar results with this study.

Also, results in Table (2) show that using ascrobate as a reducing salt was suitable for the removal of polyphenols from sunflower kernels and by-product meals. The removal percentage were 68. 21 and 67.77% for the above materials, respectively.

The results in Table (3) indicate that treatments with methanol at acidic pH (5.0) gave the highest removal of polyphenols fractions free, bound and chlorogenic acid about (92.5 and 97.1%), (91.6 and 91.9%) and (97.9 and 96.6%) from kernel and by-products meals, respectively.

Table (2): Total polyphenols content and removal percent of sunflower kernels and by- product meals at pH 5.0.

Treatments	Kernels meal			By-products meal		
	Total residue of polyphenol (g/100g)	% removal of polyphenols	Color	Total residue of polyphenol (g/100g)	% removal of polyphenols	Color
Control	3.87	-	Creamy	4.50	-	Brown
Ethanol	0.422	89.09	Yellow White	0.370	91.7	Grey
Methanol	0.304	92.14	Yellow White	0.207	95.4	Grey
Acetone	0.332	91.42	Yellow White	0.284	93.68	Grey
Butanol	0.353	90.87	White	0.291	93.53	Grey
Sodium sulfite	1.34	64.08	Creamy	1.86	58.66	Grey
Ascorbate	1.23	68.21	White	1.45	67.77	Grey
Dithionate	1.81	53.22	White	2.09	53.55	Grey

Chemical composition of protein concentrate after treatment by different organic solvents and reducing salts

The results concerning the effect of different treatments (organic solvents and reducing salts) on the chemical composition of protein concentrate from sunflower kernel and by-products meals are tabulated in Table (4).

Table (3): Effect of different treatments on the removal of polyphenols fractions from sunflower kernel and by-products meals

Treatments	Kernel meals						By- product meals					
	Polyphenols				Chlorogenic acid		Polyphenols				Chlorogenic acid	
	% Free polyphenols	% Removal	% Bound polyphenols	% Removal	% Chlorogenic acid	% Removal	% Free polyphenols	% Removal	% Bound polyphenols	% Removal	% Chlorogenic acid	% Removal
Control	2.29	-	1.58	-	2.72	-	2.99	-	1.51	-	3.39	-
Ethanol	0.172	92.5	0.132	91.6	0.117	95.6	0.230	92.3	0.140	90.7	0.176	94.8
Methanol	0.172	92.5	0.132	91.6	0.065	97.9	0.086	97.1	0.121	91.9	0.114	96.6
Acetone	0.224	90.2	0.108	93.2	0.100	96.32	0.089	97.1	0.147	90.3	0.158	95.3
Butanol	0.184	91.96	0.169	89.3	0.078	97.13	0.138	95.4	0.153	89.9	0.137	95.9
Na_2So_3	0.82	94.14	0.56	94.6	0.362	86.6	1.11	52.9	0.56	62.9	0.421	87.5
Ascorbate	0.72	98.6	0.51	97.7	0.454	83.3	0.96	96.8	0.49	67.5	0.513	84.3
Dithionate	1.07	53.27	0.74	53.2	0.562	79.3	1.38	53.5	0.71	52.9	0.621	81.6

* Fractionation of chlorogenic acid by using HPLC.

Table (4): Chemical composition of protein concentrate after treatment by using several organic solvents and reducing salts.

Samples	Kernels meal				By-products meal			
Components / Treatments	Protein %	Ash %	Fiber %	Carbohydrates %	Protein %	Ash %	Fiber %	Carbohydrates %
Untreated	60.67	4.04	9.3	21.99	52.80	6.45	29.96	33.18
Methanol	67.90	3.06	7.3	13.07	61.10	5.72	31.96	22.8
Ethanol	66.18	3.91	7.5	15.80	61.90	5.53	32.33	24.9
Acetone	65.51	3.10	8.3	16.20	60.31	5.60	31.63	24.7
Butanol	66.34	3.90	8.1	14.90	61.50	5.91	31.89	23.90
Sodium sulfite	63.54	3.07	8.9	16.69	58.10	5.37	30.79	27.17
Dithionate	61.08	3.33	8.8	19.2	55.39	6.10	29.93	30.17
Ascorbate	63.39	3.17	8.5	16.5	57.90	6.27	29.91	28.95

The data presented in Table (4) indicated that protein content of all samples was increased after treatments. It could be noticed that sunflower kernels and by-products meals contain higher amount of protein in all treatments compared with the content of sunflower seed meal. The increase of protein may be due to the solubility of major amount of carbohydrates especially when using the above solvents. These results are in agreement with those reported by **Abu-Shama (1998)**.

On the other hand, the ash content was decreased in all investigated samples. These results are confirmed with the results stated by **Shamanthaka and Subramanian (1984)** who reported that three times extraction of kernels with those solvents reduced the ash content from 8.3 to 2.3%.

However, crude fiber content was also affected by the above mentioned treatments as shown in the same Table (4). The percentage of crude fiber was relatively increased after treatment of sunflower by-products meals with the above different solvents. On the contrary, it was found that crude fiber was reduced in sunflower kernels meal after treatments. This reduction in crude fiber may be to the separation of translucent layer or testa from kernels during the treatment as explained by **Sosulski (1979).**

These results are in agreement with those reported by **Sodini and Canella (1977)** who described the use of acidic butanol reagent for removing phenolics from sunflower meal without causing detectable protein denaturation.

Effect of alkaline medium on the removal of polyphenolic compounds from sunflower kernels and by-product meals

The total polyphenols of sunflower kernels meal and by-products were extracted with NaOH and different reducing salts such as sodium sulfite, ascorbate, dithionate and sodium sulfite with iso-propanol in alkaline medium (pH 10.0).The obtained results are shown in Table (5).

Table (5): Effect of alkaline medium on the removal of polyphenolic compounds from sunflower kernels and by-product meals at pH 10.0.

Treatments	Kernel meal			By-product meal		
	Total residue of polyphenol (g/100g)	% removal	Color	Total residue of polyphenol (g/100g)	% removal	Color
Control	3.87	-	Yellow	4.50	-	Brown
NaOH	0.34	91.20	Green	0.31	93.1	Dark green
Sodium sulfite	0.36	90.70	White creamy	0.34	92.4	Dark creamy
Ascorbate	0.51	86.80	Creamy	0.48	89.4	Dark yellow
Dithionate	0.52	86.60	Creamy	0.48	89.4	Dark yellow
Sodium sulfite + isopropanol	0.35	90.96	White	0.34	92.4	Dark yellow

Data reported in Table (5) indicate that treatment with NaOH gave the highest removal of polyphenols (91.20 and 93.1%) from kernel meals and by-product meals, respectively. But, the color of isolated protein after treatment was found to be green and dark green. Which is due to the oxidation of chlorogenic acid in alkaline medium and therefore limits the use of protein from sunflower seeds in food industry.

From the above mentioned results, it is indicated that treatment of sunflower kernel and by-products with the above reducing salts removed most polyphenols 86.6-90.7 and 89.4-92.4%. These reducing agents prevents the accumulation of quiniones which may be participate in reactions leading to colored products **(Gheyasuddin *et al.*, 1970).**

On the other hand, using sodium sulfite with isopropanol for extraction produced good white isolate protein because the alcohol is able to break H-bonds as it is known that polyphenols at acidic pH remain combined with protein in unusually strong H-bonds, **(Pomenta and Burns, 1971).**

Determination of sunflower protein subunits molecular weight by using SDS-PAGE

Polyacrylamide gel electrophoresis in the presence of detergent sodium dodecyl sulphate (SDS-PAGE) was used for determination the subunit molecular weights (M.W.) of protein extracted by alkaline solutions from both sunflower kernel and by-products after different treatments. The molecular weight of the subunits dissociation from both samples protein were determined (Fig., 3). The obtained results show that both sunflower kernel and by-products protein dissociate into 11 subunits with molecular weight (MW) ranging from 95.499 to 14.125 KD.

Data in Fig. (3) showed that subunits of kernel protein having similar bands with by-products, but having strong intensity bands than by-products in the all treatments.

Effect of different treatments on the removal of phytic acid and trypsin inhibitor activity from sunflower meals

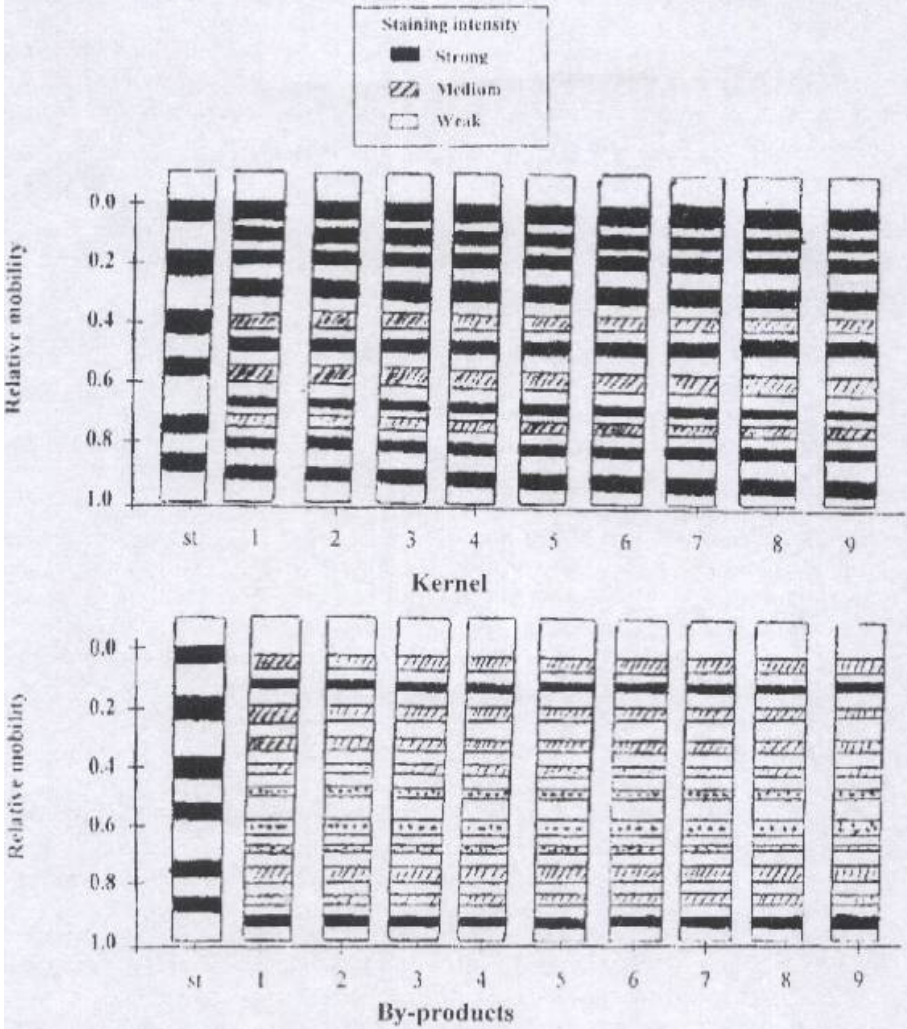
The removal of phytic acid and trypsin inhibitor activity from kernel and by-products meal at acidic and alkaline medium are shown in Table (6)

The results indicate that treatments of the kernel and by-products with different alkaline solutions were more effective in removing phytic acid and trypsin inhibitor (antinutritional factors) than different acidic media.

These results are in agreement with those reported by **Saeed and Cheryan, (1988) and Abu El-Seoud(1989).**

Effect of different treatments on sunflower in vitro protein digestibility

In-vitro protein digestibility of raw and treated sunflowers was performed and the results are shown in Table (7). The results show that the digestability index for sunflower kernel and by-products before treatments was found to be 80.47 and 78.46%, respectively. While, after treatment of sunflower kernel and by- products with different organic solvents at acidic medium (pH.5.0) protein digestibility



1- Untreated
2- Treated with Methanol
3- Treated with Ethanol
4- Treated with Butanol
5- Treated with Acetone
6- Treated with Sodium Sulfite
7- Treated with Dithionate
8- Treated with Ascorbate
9- Treated with NaOH

ig. (3):SDS-PAGE pattern of sunflower (kernel and by-products meal) protein extracted after different treatments.

Table (6): Effect of different treatments on phytic acid and trypsin inhibitor from kernel and by-products meal.

Treatments	Phytic acid %		Trypsin inhibitor (mg/g)	
	Kernel	By-product	Kernel	By-product
Untreated	4.32	3.45	1.5	1.1
Acidic medium				
Ethanol	1.31	1.12	0.521	0.50
Methanol	1.15	0.92	0.53	0.42
Butanol	0.88	0.71	0.54	0.41
Acetone	0.99	0.84	0.56	0.44
Sodium sulfite	1.62	1.29	0.98	0.83
Dithionate	1.71	1.51	0.96	0.85
Ascorbate	1.72	1.49	0.96	0.81
Alkaline medium				
NaOH	0.32	0.25	0.0	0.0
Sodium sulfite	0.29	0.21	0.0	0.0
Dithionate	0.34	0.27	0.0	0.0
Ascorbate	0.33	0.27	0.0	0.0
Sodium sulfite + Isopropanol	0.22	0.18	0.0	0.0

Table (7): Effect of different treatments on sunflower meal in- vitro protein digestibility.

Treatments	Protein digestibility index %	
	Kernel	By-product
Untreated	80.47	78.46
Acidic medium		
Methanol	87.54	84.01
Ethanol	87.84	85.21
Butanol	85.45	84.89
Acetone	84.53	83.95
Sodium sulfite	79.90	79.43
Dithionate	79.42	79.12
Ascorbate	80.83	79.39
Alkaline medium		
NaOH	93.65	93.70
Sodium sulfite	93.52	93.53
Dithionate	93.11	93.14
Ascorbate	93.12	93.15
Sodium sulfite + Isopropanol	93.57	93.62

index increased from (79.42 to 87.84%) and (79.12 to 85.21%) respectively at different treatments except sod-sulfite, dithionate and ascorbate comparing with untreated materials.

The highest amount of protein digestibility index was found to be 93.65% for kernel and 93.70% for by-products when treated by NaOH (alkaline solution).

This increment due to decreasing the amount of polyphenols and trypsin inhibitor activity under these conditions. These results are in agreement with those reported by **Nuria *et al.* (1999)** who found that polyphenols can affect the quality of sunflower protein in several ways such as reducing the digestibility, prolongoing or shortening the storage life and stability and adversely altring the functional properties and behaviour of sunflower protein in food systems.

Effect of different treatments on the amino acidscomposition

The amino acids composition of kernel meals, by-products meal protein concentrate and protein isolate of sunflower are determined and presented in Table (8).

Table (8): Effect of different treatments on the amino acids components of kernel and by – product meals (g/100 g protein).

Components of amino acids	Kernel meals protein	By- product meals		
		Without treatment	Protein concentrate after Butanol treatments	Protein isolate after Na_2So_3 treatments
Essential amino acids (E.A.A.):				
Lys	3.90	3.83	3.51	3.82
Leu	7.50	7.40	7.32	7.36
Iso- Leu	4.20	4.40	4.38	4.43
Cys+ Met	1.50+2.34	1.30+2.30	1.2+2.27	1.3+2.3
Phe + Tyr	4.80+3.30	4.90+3.10	4.98+3.20	5.11+3.20
Try	1.44	1.40	1.42	1.40
Thr	3.65	3.70	3.50	3.60
Val	4.76	4.75	4.23	4.60
T.E.A.A.	37.39	37.08	36.01	37.12
Non essential amino acids (N.E.A.A.):				
His	2.70	2.60	2.50	2.62
Arg	8.10	8.20	8.10	7.93
Asp	8.30	8.10	7.90	7.80
Glu	19.50	18.70	19.80	20.20
Ser	4.40	4.20	4.30	20.40
Pro	4.70	4.60	4.80	4.80
Gly	5.40	5.20	5.30	5.20
Ala	4.40	4.40	4.20	4.40
T.N.E.A.A.	57.50	56.00	56.90	57.35
T.A.A	94.89	93.08	92.91	94.47
Classified distribution of amino acids:				
E/T %	15.49	15.71	15.18	15.21
Acidic %	29.29	28.79	29.81	29.63
Basic %	39.40	39.83	39.75	39.29
Aromatic %	12.89	12.89	13.02	13.05

The obtained results indicate that total essential amino acid contents were 37.39, 37.08, 36.01 and 37.12 for kernel, by-products meal, protein concentrate and isolate.

Bodwell and Hopkins (1985) found that essential amino acids of oil seed protein ranged from 35 to 45% of their total amino acids. Also they reported that these levels of essential amino acids equal or exceed from those specified in reference patterns that are based on human requirements. These results are in agreement with those **Bau *et al.* (1983), Niazi *et al.* (1994) and Alaa (2002).** They reported that the amino acid components of proteins from extracted sunflower meal at acidic butanol medium was similar to that of the unextracted meal. Also, they reported that no significant differences were observed in dehulled and defatted sunflower meals in essential amino acid content except for lysine which was slightly reduced.

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التقييم الكيميائى الحيوى لبذور عباد الشمس ومخلفاته

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يعتبر عباد الشمس من المحاصيل ذات الأهمية الاقتصادية كمصدر غنى بالبروتين النباتى وأيضا كمحصول زيتى وتعتبر المشكلة الكبرى فى بروتين عباد الشمس والتى تعيق استخدامه فى تغذية الإنسان هى احتوائه على نسبة عالية من المركبات الفينولية والألياف بالإضافة إلى أن لون البروتين المفصول اخضر غامق والمركز يبدأ من اللون الأصفر إلى البنى الغامق. أجريت هذه الدراسة على الحبة الداخلية بعد إزالة القشرة منها ومخلف بذور عباد الشمس بعد استخلاص الزيت منه (المنتج الثانوى). واشتملت الدراسة على الطرق المختلفة للتخلص من المركبات الفينولية ودراسة تأثيرها على البروتين المفصول والمركز.

أهم النتائج المتحصل عليها :

- أشارت نتائج التحليل الكيميائى لبذور ولب ومخلف عباد الشمس أن نزع القشرة والزيت أدى إلى زيادة نسبة البروتين من ٢٦,٦٨ إلى ٥٢,٨% وأن نزع القشرة أدى إلى نقص كبير فى نسبة الألياف من ٢٠,٩١ إلى ٩,٣%.
- أفضل معاملة لإزالة الفينولات كانت باستخدام مذيب الميثانول فى وسط حامضى حيث أعطت نسبة ٩٢,١٤% و ٩٥,٤٠% لكل من الحبة الداخلية والمخلف.
- المذيبات المستخدمة فى إزالة الفينولات يعاد تقطيرها واستخدامها مرة أخرى والفينولات المستخلصة يمكن استخدامها كمضادات أكسدة بمفردها.
- أفضل معاملة لإزالة الفينولات باستخدام الأملاح المانعة للأكسدة كانت باستخدام الأسكوربيت وكانت نسبة الإزالة ٦٧,٧٧% و ٦٨,٢١% لكل من المخلف والحبة الداخلية وبالرغم من أن الأملاح كانت أقل فى إزالة الفينولات عن المذيبات إلا أنها أعطت أفضل لون لكسب عباد الشمس الناتج.

- استخدام الأملاح المانعة لأكسدة الفينولات فى وسط قاعدى عند درجة حموضة ١٠ وترسيب البروتين عند درجة حموضة ٥ أعطت بروتين ذو لون أبيض مرغوب فيه وكانت أحسن معاملة بواسطة الصوديوم سلفيت وتراوحت نسبة إزالة الفينولات من ٩٠,٧ إلى ٩٢,٤% فى كل من البروتين المستخلص من الحبة الداخلية والمخلف.
- إزالة الفينولات باستخدام المذيبات والأملاح فى الوسط الحامضى أدى إلى زيادة نسبة البروتين المركز من ٦٠,٦٧ إلى ٦٧,٩٠% ومن ٥٢,٨ إلى ٦١,٩%.
- البروتين المركز والبروتين المفصول تحلل إلى ١١ وحدة تراوحت أوزانها الجزيئية بين ٩٥٠٠٠ - ١٤٠٠٠ دالتون باستخدام طريقة الفصل الكهربى SDS-PAGE ولم تظهر أى فروق واضحة فى الأوزان الجزيئية لوحدات البروتين المركز والمفصول فى كل من الحبة الداخلية والمخلف.
- احتوت البذرة الداخلية والمخلف على مثبط إنزيم التربسين (١,٥ - ١,١ ملليجرام / جرام) وحمض الفيتيك (٤,٣٢ - ٣,٤٥%).
- البروتين المركز الناتج من المعاملة بالميثانول أدى إلى انخفاض نسبة مثبط إنزيم التربسين من (١,٥ إلى ٠,٥٣ ملليجم / جم) و (١,١ إلى ٠,٤٣) فى كل من الحبة الداخلية والمخلف.
- كما أن البروتين المفصول انعدمت نسبة مثبط التربسين.
- البروتين المركز الناتج من المعاملة بالبيوتانول والإيثانول أدى إلى انخفاض نسبة حمض الفيتيك من (٤,٣٢ إلى ٠,٨٨%) و (٣,٤٥ إلى ٠,٧١%) فى كل من الحبة الداخلية والمخلف.
- البروتين المفصول احتوى على نسبة بسيطة من حمض الفيتيك تتراوح بين (٠,٣٤ إلى ٠,١٨%) فى كل من الحبة الداخلية والمخلف.
- معدل الهضم للبروتين لكل من الحبة الداخلية والمخلف وجد أنها ٨٠,٤٧% و ٧٨,٤٦% ، بينما البروتين المركز كان معدل هضم البروتين ٨٧,٥٤ و ٨٤,٠١% ، بينما البروتين المفصول كان معدل هضم البروتين ٩٣,٦٥ و ٩٣,٧% لكل من الحبة الداخلية والمخلف.
- بروتينات عباد الشمس تحتوى على نسبة عالية من الأحماض الأمينية الأساسية إلى الأحماض الأمينية الكلية عند مقارنتها بالبروتين القياسى (٣٦%).
- الأحماض الأمينية الحامضية والقاعدية والاروماتية تمثل حوالى (٢٩,٨١-٢٩,٦٣ و(٣٩,٧٥-٣٩,٢٩) و (١٣,٠٢-١٣,٠٥%) من الأحماض الكلية فى كل من البروتين المركز والمفصول ولا يوجد تأثير ملحوظ على كل من الأحماض الأساسية و الغير أساسية.