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Changes in chemical composition, nutritional quality, physico-chemical and functional properties of peach kernel meal during detoxification

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The detoxification of peach kernel by distilled water decreased total protein, non-protein nitrogen, total ash, glucose, non-essential amino acids, acidic amino acids, antinutritional factors (hydrocyanic acid, tannin and phytic acid), Chemical Score, Mitchel Essential Amino Acid Index, fat absorption, emulsification capacity, foam capacity and stability. On the other hand, detoxification increased crude fibre, total carbohydrates, non-polar amino acids, polar amino acids, basic amino acids, sulphur amino acids, aromatic amino acids, essential amino acids, water absorption and also *in-vitro* protein digestibility and biological values by FAO/WHO, Gaussian Index and Mørup Olesen's Index. However, detoxification showed no effect on the limiting amino acid which was methionine for both peach meal and detoxified peach meal. Also, both protein meals were fractionated by gel filtration into three peaks with the same elution volume, but with different proportions. High-performance liquid chromatography showed the disappearance of one peak due to detoxification.

INTRODUCTION

Peach fruit (*Prunus persica*) is the second stone fruit used in Egypt after apricot fruit. The fruits are used either fresh or after processing and there is no definite use for the remaining by-products. The previous report of Rahma and Abd El-Aal (1988) was focused on the chemical and functional properties, *in-vitro* digestibility and amino acid profile of peach kernel. Therefore, this study was conducted to continue the work on the peach kernels. In this investigation, a study has been carried out on chemical, physico-chemical, nutritional and functional properties of peach kernel protein derived from the meal free of amygdalin and hydrocyanic acid after detoxification.

MATERIALS AND METHODS

Materials

Peach fruits (*Prunus persica*) were obtained from the local market of Shibin El-Kom city, Egypt. The pits were removed from the fruits by hand, washed with water and air-dried at room temperature for 3 weeks before removing the kernels by manual cracking. The kernels were then ground in a laboratory mill and stored at 0°C before detoxification treatment.

Detoxification of peach kernels

The full fat peach kernel grits were soaked in distilled water (1 : 10 (w/v) ratio) at 47°C for 30 h. The whole slurry was filtered and washed twice with 70% ethyl alcohol before drying at 50°C overnight in a forced draught air oven. Lipids were extracted by n-hexane in a Soxhlet apparatus for 24 h. The defatted meal was air-dried at room temperature (25°) and ground to pass through a 70 mesh (British Standard Screen) sieve. The undetoxified kernel meal was prepared by defatting, and used for comparison and evaluation of the detoxification process.

Analytical methods

Moisture, total protein, non-protein nitrogen, crude lipid, ash and crude fibre were determined according to the methods of the AOAC (1980). The reducing sugars were determined by the method of Dubois *et al.* (1956) using glucose as standard.

Amino acid analysis

Meal samples were hydrolysed with 6 N hydrochloric acid at 110°C for 24 h under vacuum in sealed tubes. The determination of amino acid composition was performed on an aminochrome IIOE 914 automatic amino acid analyser made in Hungary. Tryptophan

content was determined by the spectrophotometric method (Bencze & Schmid, 1957).

In-vitro protein digestibility

The *in-vitro* digestibility index by the trypsin–pancreatin system was determined according to the procedure of Salgo *et al.* (1985). Digestibility by other proteolytic enzymes in a single system such as trypsin, pepsin and pancreatin was also performed as described for apricot kernel protein by Abd El-Aal *et al.* (1986).

Antinutritional factors

The hydrocyanic acid and tannin contents of peach meal samples were determined by the method of AOAC (1980). The method of Wheeler and Ferrel (1971) was used to estimate the meal phytic acid content.

Biological value

The amino acid composition was used to estimate the nutritional value of the peach protein samples. The evaluated nutritional parameters included Chemical Score Index (CS), limiting essential amino acids, Mitchel Essential Amino Acid Index (MEAAI), FAO/WHO Index, Morup and Olesen's Index (MOI) and Gaussian Index (GI). The indices were determined by mathematical formula according to Hidvegi and Bekes (1985).

Absorption spectrum

The ultraviolet (UV) absorption spectrum of the peach meal proteins in 1 M NaCl solution was recorded at room temperature (~25°C) in a Beckman-DB-spectrophotometer in the range of 240–300 nm, and with a protein solution of approximately 0·1% (w/v).

Gel filtration

Sephadex-G 200, which had been equilibrated with Tris–HCl buffer (pH 8·3, 0·1M) containing 2·5% NaCl, was packed into a glass column (2·5 cm × 46 cm). The proteins extracted in the buffer were applied on the column and allowed to be absorbed, then eluted with the same buffer. Fractions (4 ml) were collected using an automatic fraction collector, equipped with a chart recorder and UV-monitor at 280 nm by L.K.B. 83000 UVICORD.

Size-exclusion HPLC

Proteins were extracted in 0·1 M sodium phosphate buffer of pH 7·9 containing 0·5 M sodium chloride. The protein extracts were separated by HPLC (Type Waters) on Micropack TSK-G 3000SW 300 mm × 7·5 mm column using 0·2 M NaH_2PO_4 (pH 4) containing 0·2% SDS as eluent solution. The flow rate was 2 ml/min with injection volume of 25 μl. The detection was done at 280 nm.

Functional properties

Water and oil absorption capacities were determined according to the methods of Sosulski (1962) and Sosulski *et al.* (1976), respectively. Emulsification capacity was measured by the method of Yasumatsu *et al.* (1972). Refined corn oil was used for oil absorption and emulsifying capacity studies. Foaming properties (foam capacity and stability) were measured by the method of Lawhon *et al.* (1972).

RESULTS AND DISCUSSION

Chemical composition

The proximate chemical compositions of peach meal before and after detoxification are given in Table 1. The detoxified meal showed higher contents of crude fibre and total carbohydrates, whereas the original meal was also higher in total protein, non-protein, total ash and total soluble sugars. Soaking of peach kernel grits in water removed some soluble material, particularly simple sugars, minerals and low molecular weight polypeptides. This leads to the observed increase in the crude fibre content of the detoxified meal. The reduction percentages were 9·5, 29·8, 22·1 and 39·4% for crude protein, non-protein nitrogen, total ash and total soluble sugars, respectively. Generally, there are similar observations by El-Adawy (1992) for detoxified apricot flour.

Amino acids

The amino acid compositions of peach meal and detoxified peach meal are presented in Table 2. Detoxified peach meal contained greater amounts of essential, aromatic, sulphur, basic, polar-uncharged and non-polar (hydrophobic) amino acids than undetoxified peach meal. On the other hand, peach meal had higher values of non-essential and acidic amino acids than detoxified peach meal. Generally, it can be concluded

Table 1. Proximate chemical composition of peach meal before and after detoxification (% as dry weight basis)[a]

Constituent (%)	Treatments	
	Peach meal	Detoxified peach meal
Crude protein (Nx 6.25)	53·5 ± 1·8	48·4 ± 1·45
Non-protein nitrogen	1·64 ± 0·17	1·15 ± 0·15
Crude lipids	1·30 ± 0·11	1·21 ± 0·12
Total ash	5·60 ± 0·15	4·36 ± 0·16
Crude fibre	5·80 ± 0·51	8·14 ± 0·90
Reducing sugars (as glucose)	8·60 ± 0·41	5·21 ± 0·31
Total carbohydrates (excluding glucose)	25·2 ± 2·1	32·7 ± 2·40

Moisture content values were 8·22 ± 0·30% and 10·1 ± 0·40% for peach meal and detoxified peach meal, respectively.
[a]Average of triplicate determinations.

Table 2. Amino acid compositions of peach meals before and after detoxification (g/100 g protein)

Amino acid	Treatments	
	Peach meal	Detoxified peach meal
Aspartic acid	12·5	11·7
Threonine[a]	2·50	2·51
Serine	4·67	4·29
Glutamic acid	24·5	22·3
Proline	4·47	4·20
Glycine	6·45	5·60
Alanine	4·42	4·39
Cystine[a]	1·87	1·86
Valine[a]	3·88	4·16
Methionine[a]	0·47	0·97
Isoleucine[a]	2·31	2·11
Leucine[a]	5·96	6·60
Tyrosine[a]	2·89	3·75
Phenylalanine[a]	3·86	4·63
Lysine[a]	2·43	2·97
Histidine	3·53	2·83
Tryptophan[a]	0·52	0·47
Arginine	12·7	14·7
Classified distribution of amino acids:		
Essential amino acids	26·7	30·0
Non-essential amino acids	73·3	70·0
Hydrophobic (non-polar) amino acids	25·9	27·5
Hydrophilic (polar) amino acids	11·9	12·4
Basic amino acids	18·7	20·5
Acidic amino acids	37·0	34·0
Aromatic amino acids	6·75	8·38
Sulphur amino acids	2·34	2·83

[a]Essential amino acids according to FAO/WHO (1975).

that the detoxification treatment improved the amino acid profile, especially essential amino acids. This could be due to leaching out and removal of free amino acids and proteins containing non-essential amino acids such as glutamic acid and aspartic acid.

Antinutritional factors

Table 3 gives the changes in some antinutritional factors such as phytic acid, hydrocyanic acid, tannin and amygdalin during water detoxification. Detoxification treatment caused marked reduction in antinutritional factors of peach kernel meal. The reduction rates in hydrocyanic acid and amygdalin were more than 99%. On the other hand, tannin removal was 50·3% and phytic acid reduction was 38·6%. These results are in good agreement with those reported by Cruess (1958), Khairy *et al.* (1975), Abd El-Aal *et al.* (1986) and El-Adawy (1992) for hydrocyanic acid and amygdalin of apricot kernels. El-Adawy (1992) found some reduction in tannins and phytic acid contents during water detoxification of apricot kernels.

Table 3. Contents of antinutritional factors in peach meal before and after detoxification[a]

Antinutritional compound	Treatments	
	Peach meal	Detoxified peach meal
Phytic acid (mg/100 g sample)	16·0	9·83
% Reduction	—	38·6
Hydrocyanic acid (mg/100 g sample)	183	0·09
% Reduction	—	100
Tannin (mg/100 g sample)	163	81·1
% Reduction	—	50·3
Amygdalin (mg/100 g sample)	3097	1·50
% Reduction	—	100

[a]Average of two determinations.

In vitro protein digestibility

The *in-vitro* digestibility by several enzyme systems of undetoxified and detoxified peach meal are shown in Table 4. The results show that the digestibility was improved due to detoxification. The rates of increase in digestibility after detoxification were 7·1% for trypsin–pancreatin, 8·2% for pancreatin, 12·0% for trypsin and 11·7% for pepsin. The increase in trypsin digestibility for detoxified meal could be due to the decrease or destruction of trypsin inhibitor content during detoxification. Also, trypsin–pancreatin digestibility was the highest, followed by pancreatin, pepsin and trypsin, respectively. Similar digestibility trends were reported by Abd El-Aal *et al.* (1986) and El-Adawy (1992) for apricot flour and Rahma and Abd El-Aal (1988) for peach flour. Generally, the observed improvement in digestibility by these enzyme systems could be due to removal of antinutritional factors especially tannins and some enzyme inhibitors during soaking; also the temperature of soaking (47°C) enhanced the protein digestibility.

Biological value

Table 5 illustrates the biological value of raw and detoxified peach meals. Peach meal had higher values for CS and MEAAI than did detoxified peach meal. On the other hand, detoxified peach meal had higher values for FAO/WHO Index, MOI and GI than did peach meal. The first limiting amino acid was methionine for both meals. The increase in the biological value after detoxification was due to the increase in the essential amino acid levels compared to untreated peach meal.

Table 4. *In-vitro* protein digestibility of peach meal before and after detoxification[a]

Enzyme system	Treatments	
	Peach meal	Detoxified peach meal
Trypsin–pancreatin	83·2 ± 1·90	89·6 ± 1·80
Pancreatin	75·9 ± 1·20	82·7 ± 1·26
Trypsin	66·2 ± 2·10	75·3 ± 2·30
Pepsin	71·4 ± 1·80	80·9 ± 1·96

[a]Average of three determinations.

Table 5. Biological values of peach meals before and after detoxification

Evaluation method	Treatments	
	Peach meal	Detoxified peach meal
Chemical Score (CS) %	23·7	11·5
Mitchel Essential Amino Acid Index (MEAAI)%	51·2	47·9
FAO/WHO Index %	34·8	43·3
Morup and Olesen's Index (MOI)	57·6	84·0
Gaussian Index (GI)	51·7	92·1
Limiting amino acid	Methionine	Methionine

Ultraviolet absorption spectrum

The ultraviolet absorption spectrum of peach meal and detoxified peach meal in 1 M NaCl solution is given in Fig. 1. Both meals gave a typical protein spectrum with a maximum absorption at 280 nm and minimum at 260 nm. Also, both meal proteins gave a broad peak at the maximum and minimum absorption wavelengths. The ratios of absorbance at the maximum to that at the minimum were 1·11 and 1·16 before and after detoxification treatment, respectively. Layne (1957) has reported that proteins not conjugated with nucleic acid and other UV-absorbing impurities give a ratio of 1·5. From this criterion, both meal proteins were contaminated and associated with nucleic acid and other UV-absorbing impurities. The nucleic proteins were calculated from conversion tables (Chaykin 1966), and found to be 2·35

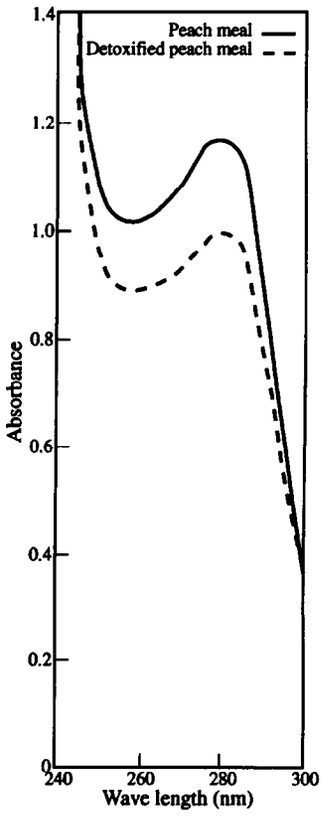

Fig.1. Ultraviolet absorption spectrum of peach meal and detoxified peach meal.

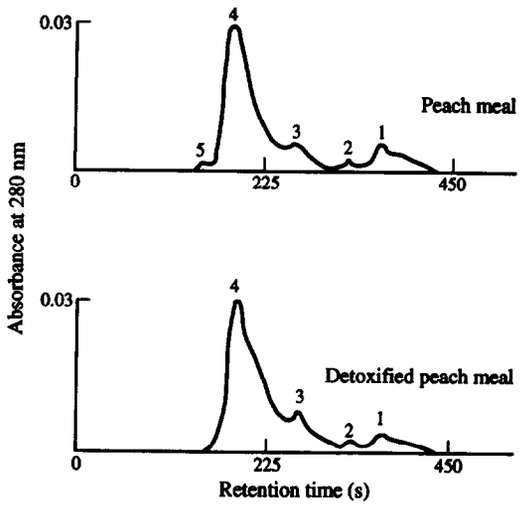

Fig. 2. Protein fractionation by high-performance liquid chromatography of peach meal and detoxified peach meal.

and 2·00% for peach and detoxified peach meals, respectively.

Size-exclusion HPLC

The fraction numbers and molecular weights of undetoxified and detoxified peach meal proteins, as revealed by high-peformance liquid chromatography, are shown in Fig. 2. The following points were deduced:

(1) The number of fractions for undetoxified and detoxified peach meals were 5 and 4 peaks, respectively. Peak number 1 for both meals was beyond 321 s of elution time and are non-proteinaceous substances that elute from the column beyond the exclusion limit.

(2) Peak 5 with a molecular weight of 910 kilodaltons disappeared due to detoxification. This may be due to the dissociation of high molecular weight protein during detoxification.

(3) The size-exclusion chromatographic patterns clearly indicate that both meal proteins had the major peptide peak corresponding to molecular weights of 228 and 210 kilodaltons for undetoxified and detoxified peach meals, respectively (peak 4). There were two minor peptide peaks corresponding to 11 (peak 3) and 0·9 kilodaltons (peak 2) for both meals.

Gel filtration

The gel filtration patterns of peach meal proteins and detoxified peach meal proteins are shown in Fig. 3. Both meal proteins fractionated into three peaks, with the same elution volumes; the peaks were eluted at 49, 108 and 121·4 ml, respectively. The v_e/v_o values of the three peaks were 1, 2·2 and 2·48. The differences in the relative proportions of high molecular weight proteins (peak 1) were quite minor, but the detoxification process reduced the concentrations of peaks 2 and 3 (low molecular weight and water-soluble proteins). Possibly, this is due to the removal of low molecular weight proteins during detoxification by distilled water.

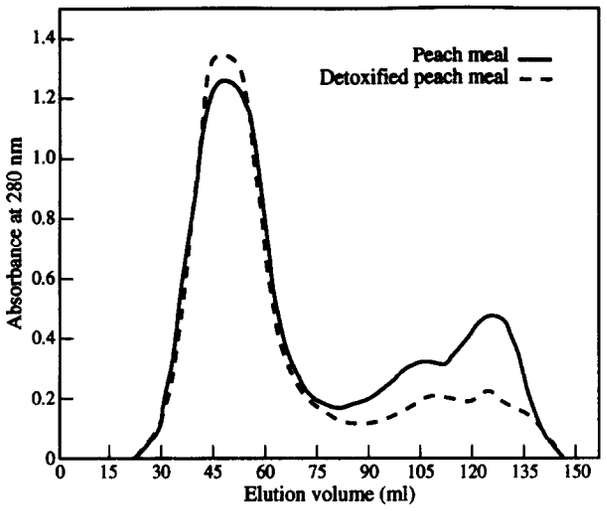

Fig. 3. Gel filtration pattern of peach meal and detoxified peach meal.

Functional properties

The functional properties of peach meal and detoxified peach meal are given in Table 6. Water absorption of detoxified peach meal was higher than for peach meal; this may be attributed to the ability of detoxification to dissociate or alter the protein molecules to monomeric subunits which may have more water-binding sites (Lin *et al.*, 1974). On the other hand, detoxification caused a decrease in fat absorption; this decrease could be due to one of the following: (a) binding of tannin residues to ϵ-amino groups of lysine; (b) removal of materials such as simple sugars which are oil-binding sites; or (c) alteration of the proteins by the treatment, which changed their conformational structure so as to bury a greater number of oil-binding sites. Emulsification capacity and foam capacity of the peach meal were high compared with those of the detoxified peach meal. The higher values for the peach meal may be due to the high protein solubility of peach meal. Kinsella (1976) reported that emulsification capacity depended upon the amount of soluble protein in solution. In general, foam stability tended to decrease with time at room temperature, which may be due to collapsing and bursting of the formed air bubbles (Kinsella, 1976). The detoxified sample exhibited the lowest foam stability. This could be due to alteration of configurational structure in protein molecules during detoxification.

In general, detoxified peach kernel meal appeared to be a good source of protein for food products. However, the present results are based on processing a single sample. Studies on a broader range of meals are required to confirm these findings.

Table 6. Functional properties of peach meal before and after detoxification[a]

Functional properties	Treatments	
	Peach meal	Detoxified peach meal
Water absorption (g H_2O/100 g sample)	160 ± 1·90	275 ± 1·60
Fat absorption capacity (ml oil/g sample)	228 ± 2·60	167 ± 3·10
Emulsification capacity (ml oil/g sample)	64 ± 1·20	58 ± 3·10
Foam capacity (% volume increase)	26 ± 2·3	18 ± 1·9
Foam stability (ml) at:		
0·0 min	14 ± 2·20	7 ± 1·20
15 min	14 ± 1·90	6 ± 1·30
45 min	13 ± 1·20	4 ± 1·10
60 min	12·5 ±1·20	3 ± 0·80

[a]Average of three determinations.

REFERENCES

Abd El-Aal, M. H., Hamza, M. A. & Rahma, E. H. (1986). *In-vitro* digestibility, physico-chemical and functional properties of apricot kernel proteins. *Food Chem.*, **19**, 197–211.

AOAC (1980). *Official Methods of Analysis*, 13th Edn. Association of Official Analytical Chemists, Washington, DC.

Bencze, W. L. & Schmid, K. (1957). Determination of tyrosine and trytophan in proteins. *Anal. Chem.*, **29**, 1193–6.

Chaykin, S. (1966). *Biochemistry Laboratory Techniques*. Wiley Eastern Private Ltd, New Delhi.

Cruess, W. V. (1958). *Commercial Fruit and Vegetable Products*. 4th edn. McGraw-Hill, New York, 738.

Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. & Smith, F. (1956). Colorimetric method for determination of sugar and related substances. *Anal. Chem.*, **28**, 350–7.

El-Adawy, T. A. (1992). Chemical, technological studies and characterization of apricot kernel proteins. PhD thesis, Faculty of Agriculture, Mnofiya University, Egypt.

FAO/WHO (1975). Energy and protein requirements. *PAG Bull.*, **5**, 30–35, PAG, New York.

Hidvegi, M. & Bekes, F. (1985). Mathematical modeling of protein nutritional quality from amino acid composition. In *Amino Acid Composition and Biological Value of Cereal Proteins*, ed. R. Lasztity & M. Hidvegi. Reidal Publishing Co., Dordrecht, pp. 205–86.

Khairy, M. S., El-Wakeil, F. & Hallabo, S. A. S. (1975). Biological evaluation of apricot kernel cake. *Egypt. J. Food Sci.*, **3**, 7-12.

Kinsella, J. E. (1976). Functional properties of proteins in foods: A survey. *CRC Crit. Rev. Food Sci. Nutr.*, **7**, 219–49.

Lawhon, J. T., Cater, C. M., Mattil, K. F. (1972). A whippable extract from glandless cottonseed flour. *J. Food Sci.*, **37**, 317–21.

Layne, E. (1957). Spectrophotometric and turbidimetric methods for measuring proteins. In *Methods in Enzymology, Vol. III*, ed. S. P. Colowiek & N. O. Kaplan. Academic Press, New York, p. 453.

Lin, M. J., Humbert, E. S. & Sosulski, F. W. (1974). Certain functional properties of sunflower meal products. *J. Food Sci.*, **39**, 368–72.

Rahma, E. H. & Abd El-Aal, M. H. (1988). Chemical characterization of peach kernel oil and protein: Functional properties, *in-vitro* digestibility and amino acid profile of the flour. *Food Chem.*, **28**, 31-43.

Salgo, A., Ganzler, K. & Jecsai, J. (1985). Simple enzymic methods for prediction of plant protein digestibility. In *Amino Acid Composition and Biological Value of Cereal Proteins.*, ed. R. Lasztity & M. Hidvegi. Reidal Publishing Co., Dordrecht, pp. 311–23.

Sosulski, F. W. (1962).The centrifugal method for determining

flour absorption in hard red spring wheats. *Cereal Chem.*, **39**, 344-8.

Sosulski, F. W., Humbert, E. S., Bui, K. & Jones, J. D. (1976). Functional properties of rapeed flour, concentrate and isolate. *J. Food Sci.*, **41**, 1349-52.

Wheeler, E. I. & Ferrel, R. E. (1971). A method for phytic acid determination in wheat and wheat fractions. *Cereal Chem.*, **48**, 312–15.

Yasumatsu, K., *et al.* (1972). Studies on the functional properties of food grade soybean products. IV. Whipping and emulsifying properties of soybean products. *Agric. Biol. Chem.*, **36**, 517–23.