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CHLOROGENIC ACID AND OLIGOSACCHARIDES EXTRACTION FROM SUNFLOWER SEEDS MEAL WITH NON-DENATURING SOLVENT

The use of sunflower meal protein in food products is presently limited by the occurrence in the meal of chlorogenic acid and other phenolic compounds.

In the present paper a method is described for the exhaustive extraction of such compounds from the meal under conditions which do not appreciably alter the meal proteins. The extraction is carried out with a polar solvent (consisting of n-butanol and dilute aqueous HCl). The protein concentrate obtained after extraction is practically free of undesirable components and is suitable for the preparation of protein isolates which remain colourless even after treatment with alkali.

Meals were prepared by dehulling seeds and grinding kernels at 4°C using an Omnimixer Sörvall Waring blendor. Oil was extracted from ground kernels with n-hexane for 16 hr at room temperature. The proximate composition of the meals was measured by the AOAC 1975 procedure for moisture, protein, lipid and crude fiber contents. A Kjeldahl macro-method was used to measure the nitrogen content of the meals; both factors 5.7 and 6.25 were employed, as indicated later, for converting the Kjeldahl nitrogen value into per cent protein content. Chlorogenic acid, caffeic acid, sucrose and raffinose were detected as TMS (trimethylsilyl) derivatives by gas liquid chromatography according to Sabir et al. Undesirable o-diphenols and oligosaccharides were extracted from sunflower meals by using as solvent 92% n-butanol in 0.005 N HCl, for 15 min under magnetic stirring at room temperature. The meal to sol-

vent ratio was 1:20. The initial pH of the slurry was around 6. During the extraction the PH was adjusted to 5.0±0.1 by the addition of 0.5 N HCl. At this pH the solubility of sunflower proteins is at a minimum. Eight successive extractions were carried out on each sample. The optical density of the extracts was monitored at 328 nm in order to follow the extraction of chlorogenic acid and other orto-diphenolic compounds. Protein isolates were prepared from sunflower meals by conventional methods. The pH nitrogen solubility profiles of sunflower meal, of protein concentrates and of protein isolates were obtained according to Gheyassudin et al. The amino acid composition of sunflower meal and of protein concentrates was measured after hydrolysis in 6 N HCl at 110°C for 24 hr with a Beckman model 120 C autoanalyzer using a 0.9 x 17 cm column packed with Spinco PA-35 resin.

The composition (nitrogen, protein, crude fiber, chlorogenic acid, caffeic acid, sucrose and raffinose contents) of the four varieties of Italian sunflower meals used in the present study is reported in Table 1. Typical o-diphenol extraction curves from the four above varieties of sunflower meal are reported in Fig. 1. It is evident that the phenolic compounds are extracted with a similar efficiency from the four varieties, even though the initial chlorogenic acid contents varies considerably (cf. Table 1). The chemical composition of the meals submitted to eight successive extractions with acidic n-butanol and dryed in air is shown in Table 2. The high nitrogen content qualifies the material as a protein concentrate. The level of residual phenolic compounds (chlorogenic acid and caffeic acid) is quite low; the sucrose content is more than one order of magnitude less than in the original meal, while that of raffinose is only scarcely affected by the extraction. The amino acid composition of

Table 1

Composition of Sunflower Meal (% per dry matter)

Sunflower variety	Nitrogen	Protein (Nx6.25)	Protein (Nx5.7)	Crude fiber	Chlorogenic acid	Caffeic acid	Sucrose	Raffinose
Ala (VNIIMK 8931)	9.72	60.7	55.4	4.4	2.59	0.11	5.16	3.75
Albinia (Smena)	10.05	62.8	57.3	3.9	1.57	0.12	4.90	3.09
Amiata (Yenisei)	9.79	61.2	55.8	4.2	1.56	0.14	4.70	3.32
Argentario (Peredovik)	9.75	60.9	55.6	4.1	2.46	0.15	5.45	3.72

Table 2

Composition of Sunflower Protein Concentrate after Butanol-HCl Extraction (% per dry matter)

Sunflower variety	Nitrogen	Protein		Crude fiber	Chloro-genic acid	Caf-feic acid	Su-cro-se	Raffi-nose
		(Nx6.25)	(Nx5.7)					
Ala	10.82	67.6	61.7	≤4.9	0.05	0.04	0.31	3.27
Albinia	11.33	70.8	64.6	≤4.6	0.05	0.04	0.23	2.44
Amiata	11.50	71.9	65.6	≤4.8	0.05	0.05	0.19	-
Argentário	11.56	72.2	65.9	≤4.6	0.05	0.05	0.35	2.93

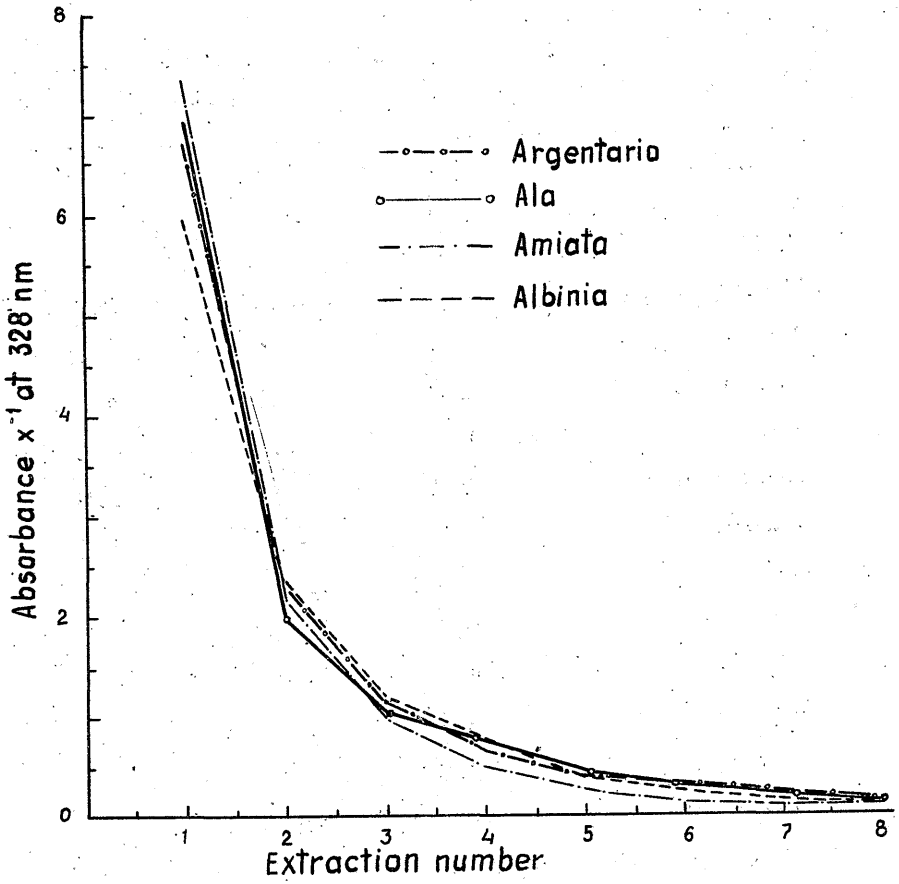

Fig. 1. Course of the extraction of chlorogenic acid in butanol HCl extracts from four different sunflower meal varieties
Extraction conditions: final ratio meal/solvent extraction 1/160 (w/v) at pH 5.0 and 25°C for 15 min of each single step extraction

Table 3

Amino Acid Composition of Amiata Sunflower Meal and Butanol-HCl Extracted Meal (protein concentrate) (g/16 gN)

Amino acid	Meal	Concentrate	FAO/WHO
Lysine	3.7	3.0	4.2
Methionine + cystine	3.4	3.3	4.2
Phenylalanine	4.3	4.2	2.8
Tyrosine	2.4	2.4	2.8
Isoleucine	3.8	3.5	4.2
Leucine	6.2	5.2	4.8
Threonine	3.4	3.0	2.8
Valine	4.7	4.2	4.2
Histidine	2.6	2.0	
Arginine	9.8	7.9	
Glycine	5.1	5.1	
Serine	3.7	3.8	
Alanine	3.8	3.7	
Aspartic acid	8.4	8.3	
Glutamic acid	20.6	26.2	
Proline	3.8	3.7	

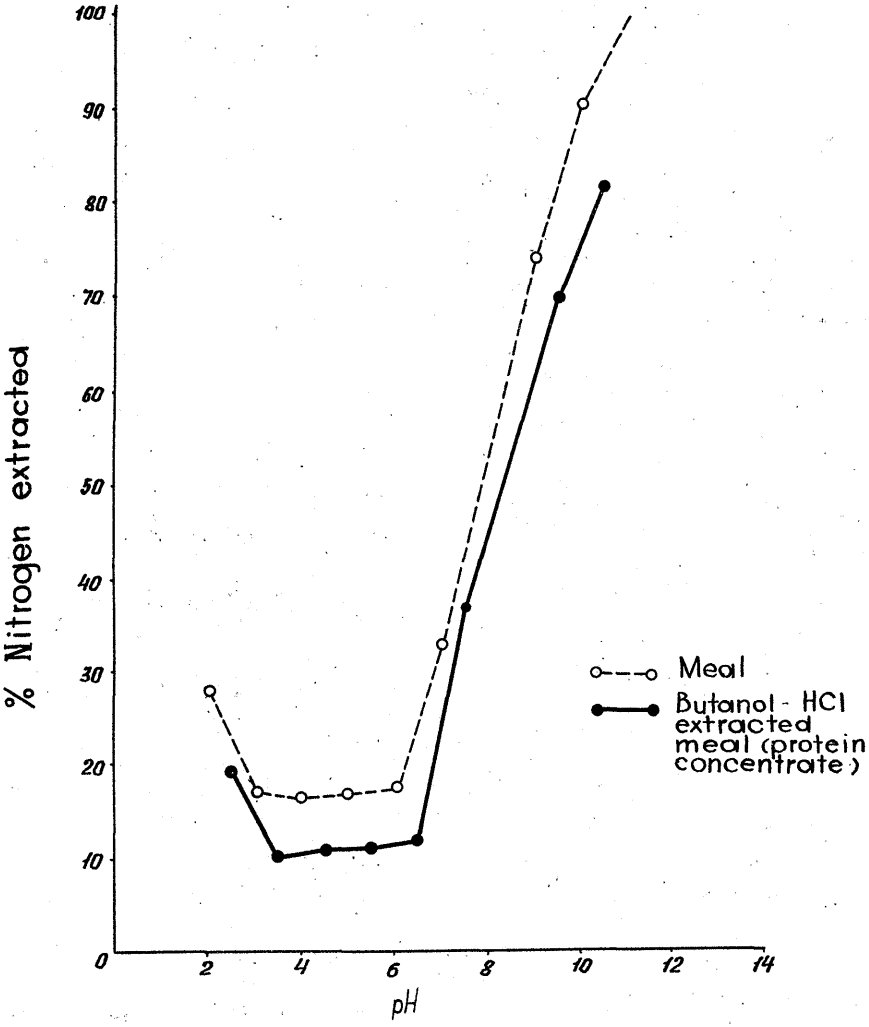

Fig. 2. Nitrogen solubility profile of sunflower kernel meal before and after removal of chlorogenic acid

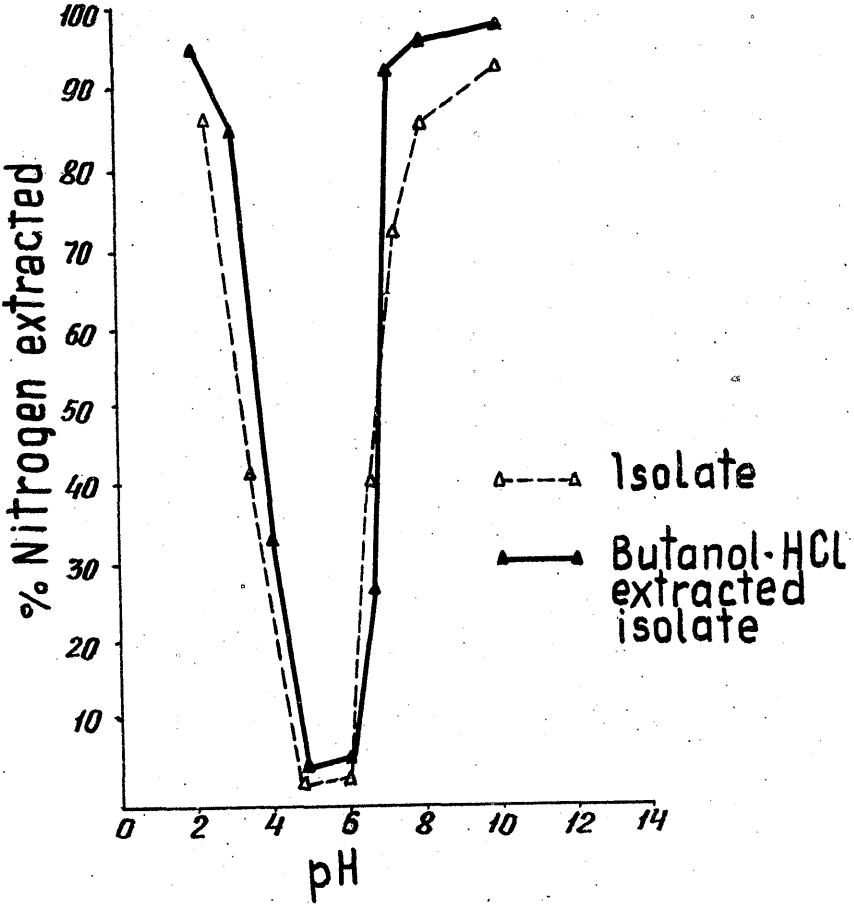

Fig. 3. Nitrogen solubility profile of sunflower protein isolate before and after removal of chlorogenic acid

Amiata sunflower meal and pattern concentrate is reported in Table 3. The protein isolate obtained as described under methods by conventional alkali extraction (pH 9.5) and acid precipitation (pH 5.2) contains 95.4% protein and is completely off-colour free even at pH as high as 10.5.

The nitrogen solubility profiles of meal, protein concentrates and protein isolates from n-butanol HCl treated and untreated meal at different pH are reported in Figs 2 and 3. It is evident that the HCl and n-butanol treatment does not modify protein solubility.

The above results show that the present method allows an exhaustive removal of chromogenic o-diphenolic components under non denaturing conditions, and provides a basis for further technological developments.

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