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Phytic Acid in Sunflower Seeds, Pressed Cake and Protein Concentrate

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ABSTRACT

High levels of phosphorus (P) and zinc (Zn) were observed in sunflower seeds. Most of the phosphorus is present in the form of phytic acid. The contents of phytic acid in sunflower seeds, pressed cake and protein concentrate were found to be 1·6%, 4·3% and 3·1%, respectively.

INTRODUCTION

Amongst vegetable oil-producing crops, sunflower seed ranks third in the world (Tranchino *et al.*, 1983). The cake resulting from the oil extraction process is high in protein and is a potential protein source. The main limiting factors of sunflower protein are the high fibre content (13%–16%) (Rossi & Germondari, 1982), the presence of chlorogenic acid or other phenolic compounds (Sosulski, 1979) and the relatively low lysine content (Gassmann, 1983).

Many authors who describe the production of sunflower products report the high protein and low fibre and chlorogenic acid contents (Sosulski, 1979), but the presence of phytic acid in these products is mentioned by few researchers.

Phytic acid usually occurs in the form of phytates in plants. The phytates are considered to be the main form in which phosphates and

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inositol are stored in most plants (Erdman, 1979). The presence of phytic acid causes serious concern, since it is known to bind and decrease the bioavailability of the trace minerals such as Zn, Cu, Ca, Fe, Mn, Mo and Co (Maga, 1982).

Eklund (1975) found sunflower protein concentrate to contain between 0·689% and 0·88% phytate phosphorus, whereas Latta & Eskin (1980) found 3·66% to 3·78% phytate in sunflower protein concentrate. Saio *et al.* (1977) considered the protein bodies of the seeds to be the probable site of phytate storage.

The purpose of the present study was to investigate the distribution of the phosphorus compounds in the sunflower seed and to evaluate the phytic acid content of the seeds, meal and sunflower protein concentrate.

MATERIALS AND METHODS

FH type seeds of the 1984/85 crop were used in the present study. The seeds were completely dehulled and pressed as described by Miller *et al.* (1985, 1986). Phosphorus determination was carried out according to the methods of the AOAC (1980). Phytic acid was determined according to the techniques of Latta & Eskin (1980) and Cilliers & van Niekerk (1985). Trace minerals were determined by atomic absorption according to the methods of the AOAC (1980). Phospholipids were determined according to the method of du Plessis & Pretorius (1983).

The protein concentrate was prepared as follows. One hundred grams of pressed cake were extracted with 1 litre of acetone:water (70:30) for 2 h, followed by a 2 h extraction with 1 litre of 1% HCl. After centrifugation the precipitate was freeze-dried overnight.

RESULTS AND DISCUSSION

Table 1 shows that most of the phosphorus in the seed is located in the kernel in the form of phytic acid. This amount is relatively high compared with other oilseed meals (Tables 1 and 2). Extraction of the oil increases the phytic acid content to 4·3%. As the expressed oil is very low in phosphorus (Miller *et al.*, 1985), the phosphorus is concentrated in the pressed cake. Treatment of the meal to remove the greenish colour reduces the phytic acid content to 3·1% (25% reduction) which is similar

TABLE 1
The Distribution of Phosphorus and Phytic Acid in Sunflower Seed, Meal and Concentrate[a]

Sample	*Total phosphorus* (%)	*Phospholipid phosphorus* (%)[b]	*Phytic acid* (%)	
			Latta & Eskin (1980)[c]	*Cilliers & van Niekerk (1985)*
Whole seed	0·53	0·016 0	1·6	1·7
Kernel	0·69	0·028 7	2·2	2·2
Hull	0·04	0·001 0	0·12	0
Concentrate	1·21		3·1	3·6
Meal	1·50		4·3	4·5

[a] Average of two determinations.
[b] Coefficients of variation (CV) of individual phospholipids vary between 7% and 15%.
[c] CV, 2·5%.

to values obtained by Latta & Eskin (1980). The contribution of phospholipid phosphorus to the total phosphorus is less than 5%.

The phytic acid was determined by two different methods. Extracting with dilute HCl followed by ion-exchange chromatography and binding to Wade's reagent (Latta & Eskin, 1980) gave results which were in good agreement with TCA extraction followed by HPLC quantification (Cilliers & van Niekerk, 1985).

The relatively high ash content of the meal indicates the presence of high mineral levels. Sunflower seed is particularly high in Zn (Table 3) compared with some other oilseed meals (Table 2) and, in fact, sunflower

TABLE 2
Zinc, Calcium and Phosphorus Contents of Some Oilseed Meals (Hubbel, 1980)

Sample	*Zinc* (%)	*Calcium* (%)	*Phosphorus* (%)
Soybean meal	0·006 0	0·25	0·60
Safflower seed meal	0·004 0	0·25	0·50
Rapeseed meal	0·005 1	0·60	1·0
Cottonseed meal	0·007 8	0·15	0·30
Corn germ meal	0·01	0·30	0·50
Sunflower seed meal[a]	0·018 7	0·205	1·5

[a] Completely dehulled SF pressed cake.

TABLE 3
Mineral Composition of Sunflower Kernel and Pressed Cake (%)

Mineral	*Kernel*	*Pressed cake*
Phosphorus	0·69	1·5
Calcium	0·099	0·205
Iron	0·065	0·272
Copper	0·024	0·061
Magnesium	0·32	0·71
Manganese	0·003	0·006
Zinc	0·009	0·017 2
Potassium	0·72	1·5
Sodium	0·002	0·004
Ash	3·1	6·9

meal is more than three times richer in Zn than soybean meal. Although Maga (1982) concluded that an inverse relationship exists between the level of phytic acid and the bioavailability of Zn, the high Zn content of the sunflower meal suggests that a Zn deficiency syndrome is not likely to be induced by the sunflower meal. Jones (1979) showed, in a study of rats fed on rapeseed protein, that the Zn deficiency syndrome could be alleviated by supplementing the diet with Zn in amounts sufficient to complex the phytic acid present in the diet.

It is therefore necessary to include the phytic acid content of a sunflower presscake, meal or protein concentrate when evaluating these products for nutritional purposes.

Further studies are needed to assess the influence of the phytic acid present in sunflower products on the bioavailability of trace minerals, as well as methods to remove or inactivate the phytic acid.

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REFERENCES

AOAC (1980). *Official methods of analysis.* (13th edn), (Horwitz, W. (Ed.)), Association of Official Analytical Chemists. Washington, DC, 20044.

Cilliers, J. J. L. & van Niekerk, P. J. (1985). LC determination of phytic acid in foods by post-column colorimetric detection. *J. Agric. Food Chem.* (submitted).

Du Plessis, L. M. & Pretorius, H. E. (1983). Phospholipid composition of some plant oils at different stages of refining, measured by the Iatroscan chromarod method. *J. Am. Oil Chemists' Soc.*, **60**, 1261–5.

Eklund, A. (1975). Content of phytic acid in protein concentrate prepared from niger seed, sunflower seed, rapeseed and poppy seed. *Uppsala J. Med. Sci.*, **80**(1), 5–6.

Erdman, J. W. (1979). Oilseed phytates; Nutritional implications. *J. Am. Oil Chemists' Soc.*, **56**, 736–41.

Gassmann, B. (1983). Preparation and application of vegetable protein, especially protein from sunflower seed, for human consumption. An approach. *Die Nahrung*, **27**(4), 351–69.

Hubbel, C. H. (1980). Feedstuffs Analysis Table. *Feedstuffs*, **52**(3), 42–7.

Jones, J. D. (1979). Rapeseed protein concentrate preparation and evaluation. *J. Am. Oil Chemists' Soc.*, **56**, 716–21.

Latta, M. & Eskin, M. (1980). A simple and rapid colorimetric method for phytate determination. *J. Agric. Food Chem.*, **28**, 1313–15.

Maga, J. A. (1982). Phytate: Its chemistry, occurrence, food interactions, nutritional significance and methods of analysis. *J. Agric. Food Chem.*, **30**(1), 1–9.

Miller, N., de Villiers, J. B. M. & Pretorius, H. E. (1985). Production of low fibre sunflower cake. *Proceedings SAAFoST Congress*, 1985.

Miller, N., de Villiers, J. B. M. & Peulen, J. M. J. (1986). A process for the dehulling of high oil content sunflower seeds. *Fette, Seifen, Anstrichmittel.* (in press).

Rossi, M. & Germondari, I. (1982). Production of a food-grade protein meal from defatted sunflower. I. Effects of an industrial extraction on quality of protein. *Lebensm.-Wiss. u. Technol.*, **15**, 309–12.

Saio, K., Gallant, D. & Petit, L. (1977). Electron microscope research on sunflower protein bodies. *Cereal Chemistry*, **54**, 1171–81.

Sosulski, F. (1979). Organoleptic and nutritional effects of phenolic compounds on oilseed protein products: A review. *J. Am. Oil Chemists' Soc.*, **56**, 711–14.

Tranchino, L., Constantino, R. & Sodini, G. (1983). Food grade oilseed protein processing: Sunflower and rapeseed. *Qual. Plant Foods Hum. Nut.*, **32**, 305–34.