*HELIA*, **18**, Nr. 23, p.p. 47-52 (1995) UDC 633.854.78:664.34

# FIBRE AND IVPD OF SUNFLOWER DEFATTED MEAL

D. Theerta Prasad[1] and K.M. Channakrishnaiah[2]

*Department of Biotechnology[1], AICRP on Sunflower[2], University of Agricultural Sciences, G.K.V.K., Bangalore 560 065, India*

*Received: March 02. 1995*
*Accepted: October 26. 1995*

ABSTRACT

Sunflower defatted meal is a good source of protein of nutritional quality. The defatted meal of the whole seed contains about 24.02±2.27 % hull and 75.35±2.17 % endosperm, with an endosperm to hull ratio of 3.17±0.38. The fibre content in the defatted meal amounts to 29.83±4.03 %, out of which 17.18±2.14 % is contributed from the hull alone and the ratio of fibre content in the hull to kernel being 1.42±0.25. The results of the germination studies indicate that there is a gradual degradation of the globulins, glutelins and prolamines *in vitro*, followed by a concomitant increase in the albumins after the third day of germination. IVPD analysis shows that the fibre content has hardly any effect on the protein digestibility by pepsin + pancreatin.

**Key words: Defatted meal, fibre, IVPD, soluble proteins, sunflower**

## INTRODUCTION

In view of the increasingly large demand for protein to support the burgeoning of world population, oilseeds are being considered as nutritional and economic sources of edible proteins. Sunflower is one of the potential sources of vegetable oil and protein of nutritional quality. The chemical composition of sunflower defatted seed meal is comparable with most other oilseed meals except for its high fibre and ash content. The sunflower seed proteins are characterized by a moderately low level of albumins (17-23 %), high levels of globulins (55-60 %) followed by glutelins (11-17 %), prolamines (1-4 %) and with a combined non-protein nitrogen and insoluble residue less than 11 % of the total nitrogen of the meal (Gheyasuddin et al., 1970; Prasad, 1987, 1990; Sosulki and Bakal, 1969). The phenolic compounds have been considered as one of the major limitations in the use of sunflower meal for human consumption. Although the phenolics have not been considered as toxic compounds, they impart dark coloration to the protein concentrates due to their oxidation, and lower the nutritive value (Lusas, 1985). Many attempts have been made to develop processing methods to remove these phenolic constituents from the sunflower meal with limited success (Lusas, 1985; Sodini and Canella, 1977). Recently, we have developed a simple method to remove phenolic compounds using aqueous acetone solvent system. The results also demonstrate an improvement in IVPD with no significant variation in the aminoacid composition (Prasad, 1990). Further, the variation in the metabolisable energy is found to be affected by the residual oil content and low digestibility of hull left in the defatted meal (Erickson,

1 Corresponding Author

Table 1. Matrix of correlation coefficient among some seed characteristics of sunflower genotypes.

| Character | Range and mean±S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1. 1000 seed weight (g) | 29.29-62.02<br>44.46±8.16 | — | 0.6427* | 0.0527 | -0.2650 | 0.2520 | -0.2668 | -0.2427 |
| 2. 1000 seed volume (ml) | 23.58-75.25<br>56.52±11.19 | | | -0.6998* | -0.2311 | -0.0423 | 0.0065 | 0.0464 |
| 3. Seed density | 0.47-1.35<br>0.81±0.17 | | | | -0.0859 | 0.2604 | -0.2315 | -0.2673 |
| 4. Oil content (%) | 34.75-48.70<br>45.28±2.97 | | | | | -0.1925 | 0.1830 | 0.2317 |
| 5. Hull content@ | 22.82-25.40<br>24.02±2.27 | | | | | | -0.9876* | -0.9917* |
| 6. Kernel@ | 71.82-78.16<br>75.35±2.21 | | | | | | | 0.9796* |
| 7. Kernel/ Hull ratio | 2.58-3.37<br>3.17±0.38 | | | | | | | - |

*r= 0.3791 at 1 % level; @-percent of whole seed.

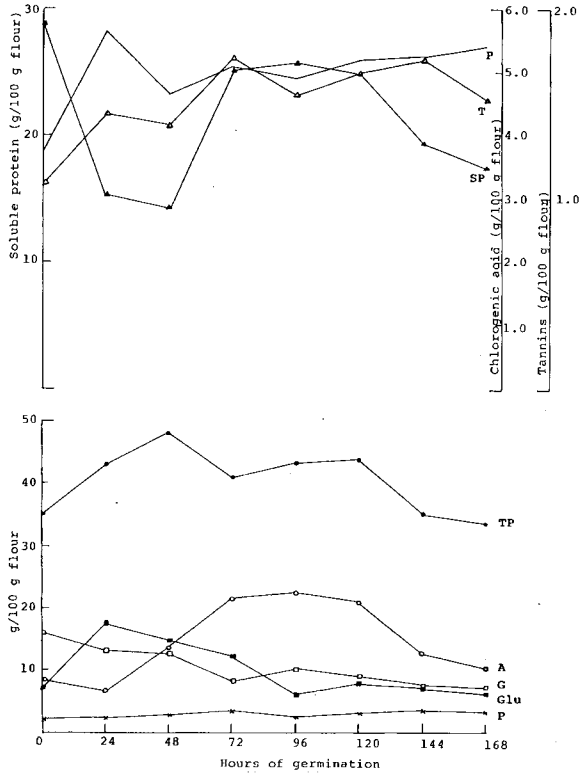


Figure1.Effect of germination on total proteins, phenolics, tannins and solubility fractions of proteins. (–): phenolics; (△): tannins; (▲): soluble proteins; (●): total proteins; (○): albumins; (❑): globulins; (■): gluteins and (x): prolamines.

Table 2. Fibre content in hull, dehulled and total defatted meal of sunflower genotypes.

| Genotypes | Hull content (%) | Kernel content (%) | Fibre content (g/100 g meal) | | | Fibre content (%) | | Kernel /hull ratio | Fibre content in hull/kernel ratio |
|---|---|---|---|---|---|---|---|---|---|
| | | | Dehulled meal | Hull | Total | Hull | Kernel | | |
| Morden | 23.76 | 74.46 | 14.08 | 18.56 | 32.80 | 78.89 | 18.92 | 3.13 | 1.32 |
| EC68414 | 22.90 | 77.16 | 16.95 | 19.84 | 37.04 | 86.64 | 21.97 | 3.37 | 1.17 |
| EC68415 | 22.82 | 76.91 | 11.73 | 16.24 | 28.21 | 71.16 | 15.25 | 3.37 | 1.38 |
| BSH-1 | 25.40 | 73.80 | 11.25 | 15.92 | 27.41 | 62.68 | 15.24 | 2.91 | 1.42 |
| KBSH-1 | 20.70 | 78.16 | 9.49 | 15.32 | 25.16 | 70.01 | 12.14 | 3.77 | 1.61 |
| MSFH-1 | 24.80 | 75.21 | 12.65 | 14.68 | 27.51 | 59.19 | 16.82 | 3.03 | 1.16 |
| MSFH-17 | 27.83 | 71.82 | 10.65 | 19.68 | 30.71 | 70.72 | 14.84 | 2.58 | 1.85 |
| Range | 22.82-25.40 | 71.82-78.16 | 9.49-16.95 | 14.68-19.84 | 25.51-37.04 | 59.19-86.64 | 12.14-21.97 | 2.58-3.37 | 1.16-1.85 |
| Mean | 24.02 | 75.35 | 12.40 | 17.18 | 29.83 | 71.33 | 16.45 | 3.17 | 1.42 |
| ±S.D. | č2.27 | ±2.21 | ±2.48 | ±2.14 | ±4.03 | ±9.27 | ±3.18 | ±0.38 | ±0.25 |

Table 3. Total fibre, phenolics, protein and IVPD of sunflower defatted meals.

| Genotypes | % protein | | % fibre | | % phenolics | | *In vitro* protein digestibility (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Pepsin | | Pepsin+pancreatin | |
| | With hull | Without hull | With hull | Without hull | With hull | Without hull | With hull | Without hull | With hull | Without hull |
| Morden | 28.61 | 41.23 | 32.80 | 18.92 | 5.54 | 2.62 | 55.24 | 70.43 | 73.28 | 74.42 |
| EC68414 | 32.34 | 43.42 | 37.04 | 21.97 | 4.16 | 3.08 | 57.32 | 71.21 | 74.56 | 72.32 |
| EC68415 | 34.12 | 44.15 | 28.21 | 15.25 | 4.32 | 3.68 | 54.20 | 71.22 | 70.23 | 74.61 |
| BSH-1 | 39.21 | 41.91 | 27.41 | 15.24 | 4.51 | 2.82 | 53.91 | 71.53 | 64.12 | 68.42 |
| KBSH-1 | 33.70 | 42.82 | 25.16 | 12.14 | 4.50 | 3.68 | 53.21 | 72.30 | 69.62 | 72.41 |
| MSFH-1 | 37.20 | 46.84 | 27.51 | 16.82 | 3.81 | 2.94 | 51.24 | 69.14 | 66.13 | 70.17 |
| MSFH-17 | 33.61 | 44.13 | 30.71 | 14.84 | 3.72 | 2.90 | 56.31 | 69.02 | 70.41 | 74.20 |
| Range | 28.81-39.21 | 41.23-46.84 | 25.16-37.04 | 12.14-21.97 | 3.72-5.54 | 2.62-3.68 | 51.24-57.32 | 69.02-72.30 | 64.12-74.56 | 68.42-74.61 |
| Mean | 34.10 | 43.50 | 29.83 | 16.23 | 4.36 | 3.10 | 54.49 | 70.69 | 69.76 | 72.36 |
| ±S.D. | č3.38 | ±1.83 | ±4.02 | ±2.76 | ±0.60 | ±0.42 | ±2.02 | ±1.23 | ±3.68 | ±2.35 |

1994). Incidentally, fibre is one of the most variable components in seed meal which ranges from 15-20 % in the oil type and 22-28 % in the confectionary type of sunflower and has positive correlation with the hull content (Dorrell, 1978). Therefore, the present study is undertaken with an objective to examine the correlation between the seed meal components especially hull and fibre and protein digestibility.

## MATERIALS AND METHODS

Sunflower genotypes grown in *kharif* season of 1992-93 at University of Agricultural Sciences were used for this analysis. The seed density of the sunflower genotypes was determined by measuring the ratio of the weight and volume of 1000 seeds. The total nitrogen content was determined by the micro-Kjeldhal's method and the value was multiplied by 6.25 to get an estimate of crude protein content (AOAC, 1980). The fibre content was detemined by the acid detergent method described by Baker (1977). The IVPD of the samples using pepsin and pepsin-pancreatin was carried out as per the method described earlier (Prasad, 1990). The oil content in the samples was determined by the Soxhlet method using petroleum ether (40-60°C).

The seeds were soaked overnight in running water and spread on moist filter paper for germination in dark at room temperature. The kernels were removed at an interval of 24 hours and dried in oven at 50°C. The ground samples were defatted using petroleum ether (40-60°C) by the Soxhlet method. The proteins from sunflower defatted meals were fractionated by the method described by Gheyasuddin et al., (1970).

## RESULTS AND DISCUSSION

A significant variation in the levels of tannins, phenolics, total and soluble proteins and protein solubility fractionation was observed in the sunflower kernel upon germination (Fig. 1A and B). An increase in the total and soluble proteins was recorded after 3rd day of germination till 6th day followed by albumin content. In general, a gradual reduction in the globulins, glutelins and prolamines was observed upon germination. The kernels maintained a considerably high levels of tannins and phenolics even on 7th day of germination. The results of the study indicate that the reserve proteins are degraded during germination with a concomitant increase in the albumin type of proteins, possibly these may be the enzymes involved in the degradation and the mobilization of cotyledonary carbon reserves.

The role of proteases and amylases and their *de novo* synthesis during germination is well-known, breaking down the storage proteins and carbohydrates as well as the turnover of cellular protein in the growing seedlings (Basha and Cherry, 1976; Shutov and Vaintraub, 1987).

The correlation of coefficients between some of the seed characteristics are tabulated in Table 1. A significant positive correlation exists between the seed weight, volume and densities. Whereas the hull and endosperm content followed by endosperm to hull ratio show a significant negative correlation among them. The fibre content in the defatted hull, dehulled seed meal and whole seed meal was determined to be 51.19-86.64 (71.33±9.27), 12.14-21.97 (16.45±3.15) and 25.51-37.04 (29.83±4.03) per cent, respec-

tively (Table 2). The ratio of fibre content in hull to kernel varies from 1.16 to 1.85 (1.42±0.25). Although the sunflower hull contains about 26 per cent of reducing sugars (14 % xylose, 7 % arabinose and 2% galactose), the earlier reports suggest that these carbohydrates are not readily available. Whereas, the dehulled defatted sunflower meal is reported to have 8.3 per cent of reducing sugars (0.6 % glucose, 2.3% sucrose, 3.2% raffinose and 0.8 % trehalose) indicating that the level of the available total carbohydrates among the genotypes depends on their hull content (Concalon, 1971; Celga and Bell, 1977; Dorrell, 1978).

Most often, the defatted cake of sunflower which is commercially available, is associated with hull and in turn will have higher fibre content. Assuming this as on of the limiting factors in using the sunflower defatted meal as a protein-rich source for food formulations, *in vitro* digestibility experiments were initiated to examine the relation between fibre content and protein digestibility. The protein content in the samples was 28.91-39.21 (34.10±3.38) and 41.23-46.84 (43.50±1.83) per cent for the sunflower defatted meal with and without hull, respectively, whereas the phenolic content was found to be 3.72-5.54 (4.36±0.60) and 2.62-3.68 (3.10±0.42) per cent, respectively (Table 3). The IVPD results indicate that the fibre content has a more significant effect on the protein digestibility using pepsin than pepsin + pancreatin. The IVPD analysis shows that the efficiency of protein hydrolysis using pepsin + pancreatin seems to be better than pepsin alone for the samples having high fibre content.

The results clearly indicate that the major contribution towards the fibre content in the defatted whole seed meal of sunflower comes from its hull content which varies from one genotype to the other. At present, the dehulled and partially dehulled sunflower has found its way in successfully substituting the soybean meal as the poultry and ruminant feed (Kinard, 1975; Rad and Keshavarz, 1976). Considering the nutritional quality of the protein and digestibility data, sunflower meal seems to be adequate as sole source of supplementary proteins for dairy cattle. Realising the importance of dietary fibres in health care like (a) lowering of blood sugar and fat levels, (b) providing nourishment to the mucosal membrane of the intestine by fibre and its metabolic products, etc., fibre in take through food and food formulations has been given top priority in dietary and nutritional recommendations (Dorrell, 1978; Erickson, 1994; Kinard, 1975; Lusas, 1985; Robertson, 1975). IVPD analysis shows that the fibre content hardly affect the protein hydrolysis by pepsin + pancreatin. This clearly indicates the possibility that sunflower defatted meal is a promising source of protein of nutritional quality. Since methods for the removal of phenolic constituents in the defatted meal are already available (Lawhon et al., 1982. Prasad, 1990), the sunflower protein isolates can find their way in protein-rich food formulations for human consumption.

## REFERENCES

AOAC, 1980. Official Methods of Analysis of the Association of Analytical Chemists, 13th Edition, Washington, D.C.

Baker, D., 1977. Determining fibre in cereals. Cereal Chem., 54, 360-365.

Concalon, P., 1971. Chemical composition of sunflower hulls. J. Am. Oil Chem. Soc., 48, 629-632.

Celga, G.F., Bell, K.R., 1977. High press ureliquid chromatography for the analysis of soluble carbohydrates on defatted oilseed flours. J. Am. Oil Chem. Soc., 54, 150-152.

Dorrell, D.G., 1978. Processing and utilization of oilseed sunflower. In: Sunflower Science and Technology (Ed. Carter, J.F.), Madison, USA, pp. 407-440.
Erickson, O., 1994. Fibre according to Asp. In: Focus, 18, 14-15.
Gheyasuddin, N., Cater, C.M., Mattil, K.F., 1970. Effect of several variables on the extractability of sunflower seed proteins. J. Food Sci., 35, 453-456.
Kinard, D.H., 1975. Feeding values of sunflower meal and hulls. Feedstuffs, 47, 26-31.
Lawhon, J.T., Glass, R.W., Manak, T.J., Lusas, E.W., 1982. Food Technol, 36, 76-80.
Lusas, E.W., 1985. New Protein Foods, Volume 5, Academic Press, New York.
Prasad, D.T., 1987. Characterization of sunflower albumins. Lebensm Wiss u Technol., 20, 22-25.
Prasad, D.T., 1990. Proteins of phenolic extracted sunflower meal: 1. Simple method for removal of polyphenolic components and characteristics of salt soluble proteins. Lebensm Wiss u Technol., 23, 229-235.
Rad, F.H., Keshavarz, K., 1976. Evaluation of nutritional value of sunflower meal and the possibility of substitution of sunflower meal for soybean meal in poultry diets. Poultry Sci., 55, 1757-1765.
Robertson, J.A., 1975. Use of sunflower seed in food products. Crit. Rev. Food Sci. Nutr., 6, 201-240.
Sodini, G., Canella, M ., 1977. Acidic butanol removal of color forming phenols from sunflower meal. J. Agric. Food Chem., 25, 822-825.
Sosulki, F.W., Bakal, A., 1969. Isolated proteins from rapeseed flax and sunflower meals. Can Inst. Food Technol. J., 2, 28-32.

**FIBRA Y IVPD EN LA TORTA DESENGRASADA EN GIRASOL**

RESUMEN

La torta desengrasada del girasol es una buena fuente de proteína de calidad nutricional. La torta desengrasada de la semilla entera contiene alrededor de 24.02±2.27% de cáscara y 75.35±2.17% de endospermo con una proporción endospermo/cáscara de 3.17±0.38. El contenido de fibra de la torta desengrasada fue de 29.83±4.03% de la cual 17.18±2.14 procedía solo de la cáscara y la relación contenido de fibra en la cáscara a endospermo fue 1.42±0.25. Los resultados de los estudios de germinación indican que hay una degradación gradual de las globulinas, glutelinas y prolaminas. A la germinación in vitro siguió un incremento concomitante en las albúminas después del tercer día de germinación. Los análisis IVPD muestra que el contenido de fibra no tiene casi efecto en la digestibilidad de la proteína por persieva + pancreatina.

**TENEUR EN FIBRE ET IVPD DANS LES TOURTEAUX DE TOURNESOL DÉSHUILÉS**

RÉSUMÉ

Le tourteau déshuilé de tournesol est une bonne source de protéines de qualité nutritionnelle. Le tourteau déshuilé issu de la graine entière contient 24.02+-2.27% de coque et 75.35 = 2.17% d'endosperme, avec un ration endosperme / coque de 3.17 +- 0.38. La teneur en fibre de la farine déshuilée est de 29.83 +- 4.03%, la coque seule représentant 17.18 +- 2.14% de cette teneur. Le ratio de la teneur en fibre de la coque à celle de l'endosperme est de 1.42+-0.25. Les résultats des études de germination indiquent qu'il y a une dégradation graduelle des globulines, glutenines et prolamines *in vitro*, accompagnée d'une augmentation concomitante des albumines après le troisième jour de germination. L'analyse IVPD montre que la teneur en fibre a un effet relativement marqué sur la digestibilité des protéines par la pepsine + la pancréatine.