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EFFECT OF REDUCING CRUDE FIBRE CONTENT ON THE NUTRITIVE VALUE OF SUNFLOWER MEAL

A.H.K. Niazi, Tasnim Kausar, F.H. Shah and Waseem Ishaque*

PCSIR Laboratories Complex, Lahore-54600, Pakistan

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Sunflower seeds contained 22.8 to 27.5% protein 31.1 to 35.5% fat, 11.5 to 14.7% crude fibre, 3.2 to 5.5% ash and 2.4 to 3.1% phytic acid. Reduction of hull fractions of seeds decreased the crude fibre but increased crude protein and phytic acid contents of sunflower meal dehulled and protein concentrate. Complete elimination of hull fractions significantly improved the net protein utilization (45.8 to 64.8%) true digestibility (70.5 to 80%) protein efficiency ratio (1.20 to 2.15) of diets incorporated with sunflower protein concentrate.

Key words: Dehulling, Protein concentrate, Nutritive value.

Introduction

The people of sub-continent have been using traditional oils such as cotton, mustard/rape and sesame oil for cooking, for times unknown. During the last 15 years, unconventional oils such as soybean oil and sunflower oil are also becoming popular because they contain more proportion of poly-un-saturated fatty acids and hence lesser prevalence of cardiac diseases with these oils as compared to animal fats.

Sunflower cultivation has a great potential as oil-seed crop because it is well adopted to the climatic conditions of Pakistan and has been successfully grown in various regions of the country. Sunflower seeds contain 40% oil which is a rich source of essential fatty acids [1-2]. The seed cake left after oil extraction contains 35-40% protein, with a well balanced amino acid profile [3]. However, the presence of undesirable compounds of the seed cake namely crude fibre, phytic acid and poly-phenols [4-6], make it unsuitable for its incorporation in poultry feed. Reduction in the non-nutritive contents of the seed cake could result in better utilization of the cake and may provide incentive to the farmers for growing more sunflower seed. The object of the present study was to determine the effect of reducing crude fibre content on the nutritive value of sunflower meal.

Materials and Methods

Seeds of one variety of sunflower plant *(Helianthus annus)* was procured from Ghee Corporation of Pakistan Ltd., whereas other five types were collected from different places of the local market. The clean and dirt free seeds were dehulled using a locally made dehuller and separator.

Processing. PCSIR - IDRC Model oil expeller was employed for extraction of oil. Sunflower seed cake/meal and sunflower protein concentrate were prepared as follows:

(i) Sunflower seed meal. Sunflower seeds (20 kg) were pre-pressed twice in the oil expeller by keeping a distance of 12 mm between the screw and cone. The cake so obtained was refluxed in a Soxhlet extractor for 20 hrs with n-hexane for reducing the oil content to a minimum of 2%. The sunflower seed meal was prepared by drying defatted cake containing all the hull fractions at 60±2° and grinding to 80 mesh size.

(ii) Sunflower meal from dehulled seeds. Sunflower seed kernels (20 kg) obtained after dehulling and hull separation were pre-pressed twice followed by defatting of cake with n-hexane as described above. The dehulled sunflower meal was dried at 60±2° and ground to 80 mesh size.

(iii) Sunflower protein concentrate. The hull fractions remaining in sunflower kernels obtained after dehulling were removed by hand picking. The pure kernels were defatted as reported above. The resulting sunflower protein concentrate was dried at 60±2° and ground to 80 mesh size.

Biological evaluation. The biological evaluation of sunflower seed meal with and without hulls, sunflower protein concentrate was performed by conducting feeding trials on 21 days old albino rats (Sprague- Dawley strain) weighing 30-32 gm each. The basal diet contained in gm/100 gm total solids: Corn starch, 78; glucose 5; corn oil, 5; vitamin, 5; minerals, 5; cellulose, 2 [7]. Experimental diets and standard casein diet were prepared by replacing corn starch in basal diet by 25.8, 19.2, 15.5 and 12.0 gm of sunflower seed meal with (diet 1) and without hulls (diet 2), sunflower protein concentrate (diet 3) and casein (diet 4) respectively. All diets contained 10% protein.

(a) Net protein utilization (NPU). NPU of the experimental diets was determined after 10 days feeding trials on albino rats according to the procedure of Miller and Bender [8].

(b) True digestibility (TD). TD was calculated from the following formula:

$$\% \text{ TD} = \frac{I - (F - F_k)}{I} \times 100$$

where I = dietary intake of test group, F = faecal nitrogen of test group, F_k = faecal nitrogen of protein free group.

* Corresponding address: Govt. College of Science, Wahdat Road, Lahore, Pakistan

(c) Protein efficiency ratio (PER). PER was determined by the procedure of Campbell [9] after 28 days from weight gain and protein intake data i.e. PER = gain in weight/protein intake.

Analytical methods. The moisture, ash, fat, crude fibre, crude protein and lignin contents of the sunflower seeds, kernels and hulls, sunflower seed meal and sunflower protein concentrate were estimated according to standard AOAC methods [10], whereas phytic acid was determined by the procedure of Wheeler and Ferrel [11]. The data obtained for various observations were subjected to analysis of variance and Duncan's multiple range test [12].

Results and Discussion

The sunflower seeds collected from Ghee Corporation of Pakistan and local market contained 6.1 to 10.8% moisture, 22.8 to 27.5% crude protein, 31.1 to 35.5% fat, 11.5 to 14.7% crude fibre, 4.2 to 5.5% ash and 2.4 to 3.1% phytic acid and 5.4 to 8.2% of lignin (Table 1). The results showed that the seed variety collected from Ghee Corporation contained higher protein, fat and lower crude fibre, ash and phytic acid contents. The variation appeared to be due to the different seed varieties grown in different environmental conditions [1,13].

The proximate composition of sunflowr meal with and without hulls and sunflower protein concentrate prepared from the sunflower seed collected from Ghee Corporation of Pakistan showed that their crude protein, fat, crude fibre, ash phytic acid and nitrogen free extract (NFE) contents varied from 37.4 to 64.7%, 1.0 to 2.1%, 6.5 to 17.2%, 6.2 to 8.8%, 3.7 to 6.1% and 19.0 to 37.3% respectively (Table 2). Maximum amount of protein and phytic acid; and minimum amount of crude fibre and NFE was found in the protein concentrate. Sunflower meal containing hulls had lower amount of crude protein, and higher crude fibre, ash and phytic acid than sunflower lacking hulls. The difference in crude protein, crude fibre, ash and phytic acid contents of these fractions seemed mainly due to processing procedure and varied amounts of hulls present in these products. The results are in line with the findings of Bau *et al.* [5] and Taha *et al.* [14].

The average gain in weight of groups of albino rats fed on experimental diets 1-3 and standard casein diet-4 for 10 days, varied from 25.5 to 84.5gm (Table 3), maximum being in casein supplemented diet-4 followed by diet-3 (71.0) diet-2 (58.4) and minimum being in diet-1. The results clearly indicated that presence of higher amount of hull fractions in diet-1 lowered the availability of protein and adversely affected the growth of rats.

Moreover, the feed consumption data indicated that diet-3 containing lesser amount of hull fraction was more palatable and preferred by the rats.

The average NPU of rats fed for 10 days on various diets ranged from 45.8 to 73.2% (Table 3). The maximum NPU 73.2% was observed in case of diet-4 and minimum in diet-1. Among the experimental diets, highest NPU (64.8%) was shown by diet-3 which was significantly higher (P≤0.01) than diet-1 incorporated with sunflower meal containing all the hull fraction. The NPU value of the sunflower protein concentrate

TABLE 1. COMPOSITION* OF SUNFLOWER SEEDS.

Source	Moisture	Crude protein	Fat	Crude fibre	Ash	Phytic acid	Lignin
	%	%	%	%	%	%	%
Ghee Corporation of Pakistan	7.5	25.4	35.5	11.5	4.2	2.6	6.4
Local market	10.8	27.5	34.8	11.6	4.8	2.4	7.1
Local market	8.6	24.8	31.1	13.3	5.3	2.7	6.5
Local market	6.5	23.2	33.8	12.2	5.1	3.1	8.2
Local market	6.1	22.8	33.3	14.7	4.6	2.7	7.2
Local market	7.5	24.6	32.7	13.8	5.5	3.0	5.4
Statistical difference	S	S	S	HS	S	HS	HS

* Dry matter basis. All values in the table represent average of triplicate readings. S = Significant (P≤0.05). HS = Highly significant (P≤0.01).

TABLE 2. COMPOSITION OF SUNFLOWER MEAL AND PROTEIN CONCENTRATE PREPARED FROM THE SEEDS OBTAINED FROM GHEE CORPORATION.

Sunflower seed fraction	Moisture	Crude protein	Fat	Crude fibre	Ash	Phytic acid	NFE**
	%	%	%	%	%	%	%
Meal (Containing hulls)	6.3	37.4	1.9	17.2	6.2	3.7	37.3
Meal (Lacking hulls)	5.8	51.5	2.1	6.7	8.1	4.3	27.3
Protein concentrate	6.5	64.7	1.0	6.5	8.8	6.1	19.0
Statistical difference	NS	HS	NS	HS	S	HS	HS

* Dry matter basis. ** NFE (%) = Nitrogen free extract. N.S. = Non-significant. S = Significant (P≤0.05). HS = Highly significant (P≤0.01).

TABLE 3. NUTRITIVE VALUE OF THE DIETS.

Dietary protein source	Weight gain*	Protein intake*	NPU*	TD*	PER**
	gm	gm	%	%	
Sunflower meal with hulls (diet 1)	22.5	20.4	45.8	70.5	1.20
Sunflower meal without hulls (diet 2)	58.4	29.5	55.7	78.8	1.80
Sunflower protein concentrate (diet 3)	71.0	31.5	64.8	80.0	2.15
Casein (diet 4)	84.5	33.4	73.2	93.0	2.40
Statistical difference	HS	HS	HS	HS	HS

* Per group of 4 rats after 10 days - average of three replicates. ** After 28 days - average of three replicates. HS =Highly significant (P≤0.01).

is at par with sunflower flour (62.7%) as reported by Sastry and Subramanian [15] but was 10.5% and 18.2% more as reported by Keith [16] and Schulz and Peterson [17] respectively. The true digestibility of sunflower meal was in agreement with that reported by Niazi *et al.* [1]. The results showed that reduction or complete elimination of hull fraction from sunflower meal significantly improved its true digestibility.

The average values of PER of the four diets after 28 days were 1.20, 1.80, 2.12 and 2.40 respectively (Table 3). Maximum PER shown by standard casein diet was because of better amino acid profile in casein. Minimum PER shown by the diet-1 was in line with the findings of Niazi *et al.* [1] and appeared to be due to unavailability of protein present in its hull fraction. The PER value of the diet-3 was 9% more than that reported by Sastry and Subramanian [15] for a similar diet. PER value of diet-3 was highly significant ($P \leq 0.01$) with respect to diet-1 and significant as compared to diet-2. The results clearly indicated that complete reduction in hull content significantly improved the nutritive value of sunflower protein concentrate.

Biological evaluation indicated that sunflower protein concentrate would give better feed efficiency when incorporated in poultry feed. The partial substitution of costly vegetable and animal protein sources from poultry rations by sunflower protein concentrate would lower the production cost of feed and give an encouraging economic impact in poultry production. Moreover, elimination of other anti-nutritive factors i.e. phytic acid and polyphenols from sunflower protein concentrate would make it fit for fortification of foodstuffs.

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