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STUDIES ON THE EFFECT OF REDUCTION OF FIBRE AND ANTINUTRITIVE FACTOR ON THE QUALITY OF SUNFLOWER MEAL

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Three varieties (suncross-843, NK-265, NK-212) of sunflower seeds were analysed for their proximate composition. Cultivar NK-212 was selected for further treatments, in view of its desirable nutritive and other physico-chemical characteristics. Application of different methods/treatments resulted in reduction of fibre from 24.41 to 18.34% and chlorogenic acid from 3.34 to 1.02%. Biological evaluation studies on the processed meal indicated considerable improvements in the nutritional qualities.

Key words: Fibre content, Chlorogenic acid, Nutritional quality, Sunflower.

Introduction

It has been recognised world over that sunflower appears to have a tremendous potential for meeting the ever increasing demands for edible oil and protein by virtue of its high oil content, high yield per acre and relatively high protein content of its meal [1]. It has been reported that in terms of world production, sunflower is the fourth major oil-seed producer, the third most important source of edible oil and the fourth largest resource of food and feed protein [2].

The principal oil seed crops grown in Pakistan have been cotton, mustard and rape seeds. However, recently the trend has been shifted towards the introduction of other high yielding crops. Most important one amongst the newly introduced oil crops has been reckoned to be the sunflower [3]. The area under cultivation of this crop has increased from 22,662 (1982-83) to 43,112 (1991-92) hectares, while the production has gone up from 18,811 to 42,531 tonnes respectively [4]. The area under cultivation and production of sunflower seeds is anticipated to further increase to make up the shortage of edible oils in the country [5].

Sunflower meal contains 30-35% good quality protein [6], while amino acid profile of this protein is comparable to that of protein from soya bean, which has been considered to be the best amongst vegetable proteins [7].

Sunflower contains several antinutritive components which limits its utilization as a source of poultry feed and dietary meal. Efforts have been made to produce sunflower protein concentrate and isolate low in antinutrient factors [1] and deleterious effects of these compounds on the quality of sunflower proteins [9]. Moreover, its seeds contain a substantial quantity of hulls (20%), which results in high fibre in the meal and also imparts dark colour to it [8].

In view of the above reported informations, a project was planned to produce sunflower meal low in fibre and chlorogenic acid content and to evaluate the processed meal for its proximate composition and nutritional characteristics.

Materials and Methods

Suncross-843, NK-265 and NK-212 cultivars of sunflower are recommended for general cultivation by the Punjab Agriculture Department. Therefore, these cultivars were acquired from the Seed Division of Ghee Corporation of Pakistan. Sunflower seeds were dehulled by applying Pomenta and Burns method [10]. The seeds were heated in air oven at 40° for 2.5 hrs. coarsely ground in a hand operated stone-mill just to crack the hulls; and hulls and kernels were separated in an air stream. Hulls still remaining on the seeds were manually removed. Partial dehulling and mechanical oil extraction was carried out at the PCSIR Oil Processing Unit. Hexane was used for solvent oil extraction. Sunflower seeds, kernels, hulls and oil extracted meal were analysed for proximate composition [11]. The meal was treated with the following chemicals to reduce the chlorogenic acid; 95% ethyl alcohol, 0.2% sodium chloride, 0.2% citric acid and 0.2% sodium bisulphite. Chlorogenic acid was estimated by following Eskin and Ernst method [12]. Biological evaluation of the treated meal was carried out on 20 male weanling (21 days old) albino rats (average weight : 30 g). The rats were weighed individually and housed separately in standard screen bottom stainless steel cages (25 x 18 x 18 cm). The rats were fed on basal diet upto stabilizing period and then they were randomly divided into 5 groups having 4 rats in each and assigned to them formulated experimental diets in individual cages. The rats were provided diets and clean water *ad Libitum*. The environmental temperature was maintained at 22°. The animals were weighed at alternate days. The feed consumption record was also maintained.

TABLE 1. PROXIMATE COMPOSITION OF DIFFERENT VARIETIES OF SUNFLOWER.

Proximate composition (%)	Suncross-843			NK-265			NK-212		
	whole seeds	kernels	Hulls	Whole seeds	Kernels	Hulls	Whole seeds	Kernels	Hulls
Moisture	7.84	3.64	8.62	5.65	4.00	7.68	5.76	4.56	8.21
Protein	25.41	35.12	3.32	27.43	36.42	3.51	28.14	36.86	3.34
Fat	49.86	62.04	4.47	50.44	62.14	5.89	49.02	61.11	4.85
Fibre	28.41	3.48	53.41	27.64	3.14	52.00	27.24	3.00	51.88
Ash	3.46	3.04	5.26	3.94	3.18	5.32	3.60	2.86	4.65

Results and Discussion

Selection of cultivars. Three commercially grown sunflower varieties were acquired from the seed division of Ghee Corporation of Pakistan and analysed for their proximate composition (Table 1). Highest amount of fat was found (50.76%) in seeds of variety NK-265, while NK-212 contained the highest amount of protein (28.14%). The lowest fibre contents (3.00%) were found in the kernel fraction of cultivar NK-212. Therefore, variety NK-212 was selected for further studies due to having the highest amount of protein and the lowest quantity of fibre.

Effect of methods of oil extraction on the proximate composition. Dehulled solvent treated meal contained the highest amount of protein (41.19%) followed by dehulled mechanically extracted sample (Table 2). Maximum amount of fibre was found in mechanically extracted whole meal and the minimum in solvent extracted dehulled sample. However, commercial production of hull free meal is economically not feasible, therefore partially dehulled solvent extracted meal was taken for further experiments. This meal was almost oil free (Table 2) and could be stored for a longer period even at high temperatures without the chance of quality deterioration due to the development of rancidity.

Reduction of fibre contents. Fibre content of solvent extracted, partially dehulled and dehulled meal were reduced from 24.41% to 18.34 and 14.85% respectively, while in

TABLE 2. EFFECT OF METHOD OF OIL EXTRACTION ON THE PROXIMATE COMPOSITION OF SUNFLOWER NK-212 MEAL.

Proximate Composition (%)	Solvent extraction			Mechanical extraction	
	With Hulls	Partially Dehulled	Dehulled	With Hulls	Dehulled
Moisture	10.00	8.81	4.12	5.04	4.09
Protein	28.14	34.05	41.4	28.24	37.18
Fat	1.54	0.83	0.54	9.06	9.17
Fibre	24.41	18.34	14.85	26.82	15.78
Ash	6.41	5.88	5.54	6.54	6.02

TABLE 3. EFFECT OF VARIOUS CHEMICAL TREATMENTS ON PROXIMATE COMPOSITION AND REDUCTION OF CHLOROGENIC ACID IN PARTIALLY DEHULLED SOLVENT EXTRACT MEAL

Treatment	Moisture (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	Chlorogenic Acid (%)
Untreated (Control)	10.0	34.0	0.80	21.0	5.9	3.34
0.2% NaCl	7.8	29.0	0.81	20.8	6.0	2.68
95% Ethyl Alcohol	7.9	29.4	0.82	21.1	6.2	1.33
0.2% Citric Acid	7.8	30.3	0.80	20.9	6.1	1.24
0.2% Sodium Bisulphite	7.5	32.8	0.84	21.0	6.7	1.02

TABLE 4. COMPOSITION OF EXPERIMENTAL DIETS

Constituents	Diets			
	A	B	C	D
Dried milk powder	35.00	-	-	1
Untreated sunflower meal	-	27.00	-	-
0.2% Citric acid treated meal	-	-	25.00	-
0.2% Sodium bisulphite treated meal	-	-	-	24.00
Starch	45.00	53.00	55.00	56.00
Glucose	5.00	5.00	5.00	5.00
Fibre	5.00	5.00	5.00	5.00
Vitamin	5.00	5.00	5.00	5.00
Minerals	5.00	5.00	5.00	5.00
Total	100.00	100.00	100.00	100.00

TABLE 5. GROWTH RATE AND FEED EFFICIENCY OF WEANING RATS FED ON DIETS CONTAINING SUNFLOWER MEAT TREATED BY DIFFERENT TECHNIQUES.

Description	Diets*			
	A	B	C	D
Number of rats	4	4	4	4
Duration of experiment (days)	10	10	10	10
Initial weight of rats (g)	30.0	30.0	30.0	30.0
Final weight of rats (g)	55.0	51.0	50.0	58.0
Feed consumption per rat (g)	125	125	95.0	105
Feed efficiency ratio	5.0	5.9	4.75	3.75

*Composition of diets is reported in Table-IV.

mechanically extracted meal fibre contents were reduced from 26.82% to 15.76% (Table 2) thereby improving the nutritional quantity of meal.

Chlorogenic acid reduction. Partially dehulled solvent extracted meal contained 3.34% chlorogenic acid. This was reduced to acceptable level by applying various chemical treatments (Table 3). These results indicate that 0.2% sodium bisulphite treatment reduced this antinutrient factor to acceptable level (1.02%). These findings are in agreement with the observations of Bau *et al.* [6], who treated the sunflower kernels prior to fat extraction for reducing phenolic compounds. In this process loss of 2.2% protein was observed, which is the minimum as compared to the loss incurred by other methods. However, application of sodium chloride and alcohol did not show significant effect on the chlorogenic acid reduction, (Table 3). Amount of fat and fibre was observed to be almost similar in all the methods employed, however, comparatively higher amount of mineral contents were noticed in sodium bisulphite treated meal, which may be due to the addition of this chemical in the processed meal.

Biological evaluation of processed meal: Preparation of experimental diets. Four diets (A,B,C & D) were prepared one containing dried milk powder (control) while in rest of the three, milk powder was replaced by (i) untreated sunflower meal (ii) citric acid treated meal and (iii) sodium bisulphite treated meal (Table 4).

Weight gain. Rats fed on diet containing untreated meal and meal treated with citric acid showed comparatively lesser body growth than the meal treated with sodium bisulphite (Table 5). This might be due to the reduction of chlorogenic acid without impairing the protein quality of meal treated with sodium bisulphite (Table 3). However, lesser weight gain by the rats fed on diet containing citric acid treated meal may be due to adverse effect of this treatment on the protein quality, consequently reducing the protein availability of the diet. Hence, it may be concluded that sodium bisulphite treatment successfully reduced the antinutritive factor without adversely affecting quality of the meal.

Feed consumption. Feed containing citric acid treated meal was consumed comparatively in lesser quantity than the meal given sodium bisulphite treatment. However, maximum feed was consumed in case of control and the diet containing untreated meal (Table 5). This might be due to the occurrence of physico-chemical changes, in the course of detoxification process, on the palatability of the meal.

Feed efficiency ratio (FER). Sodium bisulphite treated meal showed comparatively better FER as compared to the feed containing citric acid treated meal (Table 5). However, feed containing untreated sunflower meal as protein source showed poor results. This clearly indicates that, if the antinutritive factor is reduced, sunflower meal protein can replace dried milk protein even with better efficiency.

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