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NUTRITIONAL AND ORGANOLEPTIC EVALUATION OF WHEAT ROTIS SUPPLEMENTED WITH SOYBEAN FLOUR

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Proximate and mineral composition, sensory characteristics and biological value of wheat rotis (unleavened Pakistani bread) supplemented with soybean flour at (0, 5, 10, 15, 20 % levels) were studied. Protein, fat, ash, calcium, phosphorus, iron and phytic acid contents of wheat rotis were increased with supplementation. The carbohydrate content of rotis significantly decreased with the incorporation of soybean flour, but the crude fibre content remained unchanged. Protein efficiency ratio, net protein utilization and biological value of supplemented rotis were higher than those of control samples; however, there was no significant effect of supplementation on the true digestibility of wheat rotis. Addition of soybean flour upto 20 % level did not cause any adverse effect on the sensory acceptability of rotis.

Key words: Proximate composition; Mineral and phytic acid content; Biological value.

INTRODUCTION

In all developing countries, cereals and pulses which are consumed primarily as a source of carbohydrates and proteins also supply ample quantities of minerals. In Pakistan wheat constitutes 84 % of total cereal intake and provides 51 % and 60 % of total calories and protein consumed respectively [1]. Wheat contains sufficient amount of protein, but its quality is poor because it is deficient in certain essential amino acids like lysine, threonine and valine [2].

Soybean has been known to be an inexpensive source of both protein and fat as compared to costly foods of animal origin. It is however deficient in sulphur containing amino acids [3] and has poor baking quality due to lack of gluten. These two problems can be effectively overcome by its supplementation with wheat which has a good baking quality and is relatively a good source of methionine. In this communication the nutritional and organoleptic evaluation of wheat rotis prepared from different combination of wheat and soybean flours has been reported.

MATERIALS AND METHODS

Certified seeds of wheat variety Pak-81 and soybean variety Bragg were colleccted from the Mutation Breeding Division, Nuclear Institute for Food And Agriculture, (NIFA), Peshawar. Samples were thoroughly cleaned, ground in a microgrinder and passed through 30 mesh. Soybean flour was subjected to moist heat treatment (100^{o} for 15 min) in order to inactivate heat labile antinutrients [4] and to remove beany flavour and bitter taste [5]. Soybean flour at 5, 10, 15 and 20 % level was mixed with wheat flour for further processing. Percent water absorption of these flours was determined by the Cereal Laboratory Methods [6].

Preparation of rotis. Control wheat flour and that supplemented with different levels of soybean flour were made into homogenous doughs with water by constant kneading. The rotis were baked by traditional method in an earthen oven and used for further analysis. The weight of dough per each roti was 205 g. Each roti was rolled to a dia. of 22 cm.

Proximate composition. Moisture, protein, fat, ash, crude fibre and carbohydrate contents were determined by the Cereal Laboratory Methods [6].

Mineral analysis. Wet digestion of different samples was carried out according to the method of O'Dell *et al.* [7]. Calcium was determined in the digested samples by the method of Reitemeier [8] using oxalate precipitation. Total phosphorus was determined colorimetrically using the vanadate molybdate method of Hanson as described by Egan *et al.* [9]. The iron was also determined colorimetrically using the thiocyanate method of Wong as described by Ranganna [10].

Phytate phosphorus was determined by Fe (III) substitution method of Haug and Lantzsch [11]. The decrease in iron determined colorimetrically was a measure of

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phytate-phosphorus. Phytic acid was calculated from phytate-phosphorus assuming the formula of phytic acid as:

$$C_6P_6O_{24}H_{18}$$

Biological evaluation. Rotis prepared from different combinations of wheat and soybean flours were oven dried to a constant weight at 105°C and ground for the preparation of experimental diets. The diets with respect to different nutrients were manipulated in such a way that they contained 7.5 % protein, 4 % mineral mixture and 1 % vitamin mixture [12], and provided 4.3 kcal per g. of diet. Starch was used for dietary adjustments. Casein (Merck) was used as a standard.

Protein efficiency ratio (PER). PER was determined by the method of Osborne and Mendel [13]. Young rats weaned at 21 days of age were fed on stock diet for one week. 28-day old rats were uniformly divided into six groups of 4 each and housed in separate cages. Four groups of rats were fed test diets; one group was given the control diet, while the 6th group received the standard casein diet. The diet and water was provided ad-libitum for a period of 28 days. The PER was calculated from the food consumed and weight gained by each group.

Net protein utilization (NPU). The method of Miller and Bender [14] was followed for the determination of NPU. The 28-day old rats were divided into seven groups. Six groups received the same diets mentioned under PER while the 7th group was fed the basal protein free diet for a period of 10 days. The animals were killed with chloroform, fresh weights were recorded, incisions through the body and skull were made and then oven dried at 105°. From the loss in weight and nitrogen intake by the group, the NPU was calculated.

The feces collected at the end of the experiment were dried and fecal nitrogen was determined. True digestibility (TD) and biological value (BV) were calculated according to the formulae of Miller and Bender [14].

Organoleptic evaluation. Wheat rotis prepared from different levels of soybean supplementation were presented to a taste panel of 10 judges for sensory evaluation. The rotis were scored for colour. flavour (odour + taste), feel to touch (texture), chewability and overall accetability. A scale of 0 to 10 was used where 0 was disliked extremely and 10 was liked extremely [15].

Statistical analysis. All data were analysed statistically by the analysis of variance with least significant difference (LSD) between different supplementation levels means determined [16].

RESULTS AND DISCUSSION

Water absorption capacity of flours. Water absorption capacity (%) of control wheat flour and those supplemented with soybean flour at different levels was determined (Fig. 1). Supplementation with soybean flour significantly ($P < 0.01$) increased the water absorption capacity of wheat flour. Water holding capacity of control wheat flour was 77.00 % while that supplemented at 5, 10, 15 and 20 % levels were 80.21, 84.00, 88.70 and 93.75 %, respectively.

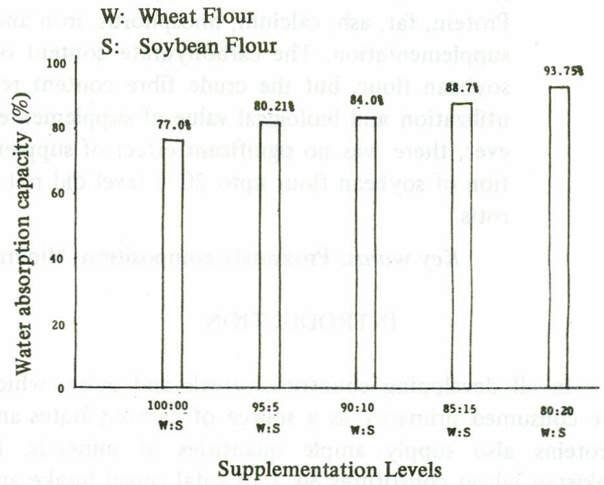

Fig. 1. Water absorption capacity of wheat flour supplemented with soybean flour.

Proximate composition of rotis. Proximate composition of wheat rotis supplemented with soybean flour is given in Table 1. Protein, fat and ash content of soybean flour were higher and the carbohydrate content was lower than that of wheat flour. Crude fibre contents of both flours were almost equal. Supplementation of wheat rotis with soybean flour, therefore, resulted in a significant ($P < 0.01$) increase in protein, fat and ash contents and significant ($P < 0.01$) decrease in carbohydrates. Crude fibre contents of both unsupplemented and supplemented rotis were comparable.

The moisture content of soybean flour supplemented rotis (15.37 to 15.85 %) was significantly ($P < 0.01$) higher than that of control wheat roties (14.80 %). As reported earlier, supplementation with soybean flour increased the water absorption capacity of wheat flour, which resulted in a higher moisture content of rotis. Increased water absorption has been reported in cakes in which high proteins soyflour was substituted for non-fat dry milk solids [12]. An increase in the moisture content of rice-based breakfast cereals has also been reported with increasing percentage of soybean substitution [19]. More absorption of water and its retention in the finished product might be due to the hydrophilic nature of proteins.

Important mineral composition of rotis. Results on the important mineral contents of wheat rotis supplemented with soybean flour are given in Table 2. Calcium, phosphorus and iron content of soybean flour were higher than those of wheat flour. Hence, substitution of the latter with the former flour significantly ($P < 0.01$) increased the mineral contents in the resultant wheat rotis. Phytic acid contents of wheat and soyflour were 425.61 and 648.80 mg/100 g, respectively. The phytic acid content of control rotis was 275.94 mg/100 g, and that of supplemented one ranged from 305.02 to 393.09 mg/100 g indicating that the baking of unleavened rotis had a destructive effect on this antinutrient which is in agreement with earlier reports [19].

Biological evaluation. Results regarding the PER, NPU, TD and BV of control and supplemented wheat rotis and casein are given in Table 3. Different supplementation levels caused a gradual and significant ($P < 0.01$) increase in PER, NPU and BV of wheat rotis. However, supplementation had no significant effect on the digestibility of wheat protein and TD values varied from 97.58 to 98.92 % in all diets. As a percent to casein, PER, NPU and BV of control rotis were 47.38, 41.70 and 69.02, respectively. These values increased to 71.84, 84.52 and 85.69, respectively when rotis were supplemented at 20 % level with soybean flour. Results on the improvement of the nutritive value of cereal proteins by supplementing with that of grain legumes have been extensively reported [20,21,22]. Supplementation of maize with soy residue

Table 1. Proximate composition of wheat rotis supplemented with soybean flour.

Supplementation levels (%)	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
0	14.80	10.46	1.76	1.48	1.84	69.66
5	15.37	10.83	1.90	1.88	1.74	68.28
10	15.52	12.12	2.96	2.12	1.81	65.47
15	15.47	14.05	5.44	2.27	1.83	60.57
20	15.85	14.59	6.69	2.52	1.87	58.48
L.S.D. (1 %)	0.19	0.32	0.12	0.28	N.S.	1.44
Wheat flour	7.65	10.41	2.93	1.69	1.90	75.42
Soybean flour	5.16	30.64	22.20	5.87	1.95	34.18

Table 2. Important minerals and phytic acid content of wheat rotis supplemented with soybean flour.

Supplementation levels (%)	Calcium (mg/100 g)	Iron(mg/100 g)	Total phosphorus (mg/100 g)	Phytic acid (mg/100 g)
0	61.99	3.40	255.15	275.94
5	62.24	4.24	280.75	305.02
10	63.01	5.59	319.40	330.65
15	63.63	5.15	331.10	353.19
20	63.97	5.94	352.20	393.09
L.S.D. (1 %)	1.11	0.18	17.33	20.17
Wheat flour	59.81	3.75	234.85	425.61
Soybean flour	71.97	8.53	676.65	648.80

Table 3. Biological value of wheat rotis supplemented with soybean flour.

Supplementation levels (%)	PER	NPU	TD	BV
0	1.36	41.70	98.82	42.20
5	1.48	43.02	98.60	43.63
10	1.60	47.50	98.85	48.05
15	1.79	49.02	98.65	49.69
20	1.99	51.12	97.58	52.39
Casein	2.79	60.48	98.92	61.14
L.S.D. (%)	0.24	1.46	N.S	2.06

Table 4. Organoleptic characteristics of wheat rotis supplemented with soybean flour.

Supplementation levels (%)	Colour (0-10)	Flavour (0-10)	Feel to touch (0.10)	Chewability (0-10)	Overall acceptability (0-10)
0	8.25	7.90	7.80	8.50	7.96
5	8.17	7.98	7.59	8.74	8.03
10	7.98	7.86	7.79	8.59	7.99
15	7.62	7.53	7.85	8.88	7.98
20	7.25	7.75	7.39	8.24	7.76
L.S.D. (%)	N.S	N.S	N.S	N.S	N.S

All values are average of 10 judgements.
0=Disliked extremely; 10=Liked extremely; N.S = Non-significant

[23], fortification of corn with soybean flour [24] or peanut and chickpea [25] improved its nutritive value significantly. Considerable improvement in the nutritive value of wheat bread has been reported by enrichment with soybean flour [26], peanut flour [27] and chickpea flour [28].

Organoleptic characteristics. Control as well as supplemented wheat rotis were evaluated organoleptically by a trained panel of judges for different sensory characteristics. Different supplementation levels did not cause any adverse effect in any of the sensory characters investigated and colour, flavour (odour + taste) feel-to-touch (texture), chewability and overall acceptability scores of all the rotis were comparable (Table 4).

It can be concluded from these results that wheat rotis can be supplemented (without adverse effect) with soybean flour upto 20 % level. These rotis would be more nutritious than ordinary wheat rotis and would be acceptable to the common man.

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