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CHEMICAL AND NUTRITIONAL QUALITY OF WHEAT CHAPATTIS FORTIFIED WITH DEFATTED OILSEED FLOURS

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Chapattis prepared with whole wheat flour and with 10 and 20% substitution with cotton seed, mustard and sunflower seed flours were evaluated for chemical & nutritional characteristics and protein quality. It was observed that the chemical composition of chapattis prepared from whole wheat and enriched flours did not differ significantly for moisture and crude protein except for ash content. The mean values of moisture, crude protein and ash contents ranged from 32.47 to 36.34%, 7.98 to 14.30% and 1.66 to 2.56%, respectively for chapattis prepared from whole wheat and enriched flours. Chapattis prepared at 10 percent replacement level with cottonseed, mustard and sunflower seed flours were fed to albino rats for determination of PER and weight gain in rats in order to estimate protein quality for the experimental diets. It was seen from the figure that higher weight gain in rats was noted for casein diet while the lowest was found in whole wheat chapati diet. The gain in weight of rats in all the experimental diets was observed higher than the wheat flour alone. It was concluded that the enrichment of wheat flour with various oilseed flours had improved the nutritional status of protein fortified product.

Keywords: Nutritional evaluation, enriched flour, chapati quality, oilseed enrichment

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the important cereal grains because of its use for the preparation of many baked products. Chapatti, the major wheat based food product, is one of the important staple foods in the Subcontinent. Unfortunately, lysine is the first limiting amino acid in wheat flour. Tryptophan, threonine and methionine are also low in wheat when compared to the FAO standards (FAO/WHO 1973). The deficiencies of essential amino acids lead to poor utilization of proteins and thus contribute to the prevalence of malnutrition in the country. Protein deficiency also results in predisposition to parasitic and infectious diseases and general ill-health. The specific maladies such as Kwashiorkor and Marasmus are more prevalent due to protein deficiency. In adults, apart from direct ill-health, protein deficiency results in reduced capacity for physical work. The wheat products deficient in lysine further aggravate the situation due to its losses during baking, i.e. more than 10% (Saab *et al.* 1981).

The scientists have made various attempts to improve protein content and quality of wheat flour through different means. They have carried out studies on the preparation of the composite flours comprising wheat supplemented with protein rich materials of different products of oilseeds e.g. soybean, peanut, sunflower and cottonseed (Bhat and Vivian 1980). Oilseed flours significantly improve the quality of wheat flour because of its high contents of protein and essential amino acids especially lysine. This situation demands to explore the possibility of improving the wheat based foods such as chapattis, breads, noodles and crackers with protein sources such as fish flour, oilseed flour, soy, yeast or synthetically produced lysine. This approach seems to be more feasible and exhibits advantages of substantial enhancement in the protein content and at the same time it helps correcting the amino acid balance deficiencies.

Proteins from oilseeds may help in solving protein deficiency problems to combat the malnutrition prevalence in Pakistan. The use of oilseed flours for preparation of indigenous products such as chapati has not been carried out extensively. Thus there was a need to explore the possibility of using oilseed protein enriched wheat flour for the production of nutritious chapati without sacrificing its functional and sensory characteristics. Therefore, the present study was undertaken to find out the suitable proportion of oilseed flours into wheat flour for the production of oilseed protein enriched chapattis and also to find out nutritional status of enriched chapattis.

MATERIALS AND METHODS

Wheat varieties (Faisalabad 85 and Chakwal 86) were procured from the Wheat Research Institute, Ayub Agricultural Research Institute, Faisalabad. Flours were prepared by grinding the wheat varieties through Udy cyclone mills and sieving through 20 mesh sieve. Flours (12 % moisture) were packed in separate air tight containers and stored at room temperature until utilized. Oilseed flours were prepared from two varieties each of cottonseed, mustard and sunflower seeds (CIM240, NIAB78, Peela Raya, Raya Anmol, Hysun33 and Suncom110).

Table 1. Composition of experimental diets

Diets	Specifications*	Proportion	Ingredients							Total (g)	Crude protein (%)
			Flour (g)	Corn starch (g)	Corn oil (g)	Glucose (g)	Mineral mixture (g)	Vit. mixture (g)	Casein (g)		
A	CSF_1+F_1	10+90	58.99	21.01	5.00	5.00	5.00	5.00	-	100.00	10
B	CSF_2F_1	10+90	63.09	16.91	5.00	5.00	5.00	5.00	-	100.00	10
C	MSF_1+F_1	10+90	63.17	16.83	5.00	5.00	5.00	5.00	-	100.00	10
D	MSF_2F_1	10+90	61.31	18.69	5.00	5.00	5.00	5.00	-	100.00	10
E	SSF_1+F_1	10+90	65.48	14.52	5.00	5.00	5.00	5.00	-	100.00	10
F	SSF_2+F_1	10+90	65.01	14.99	5.00	5.00	5.00	5.00	-	100.00	10
G	CSF_1+F_2	10+90	60.49	19.51	5.00	5.00	5.00	5.00	-	100.00	10
H	CSF_2+F_2	10+90	61.69	18.31	5.00	5.00	5.00	5.00	-	100.00	10
I	MSF_1+F_2	10+90	59.88	20.12	5.00	5.00	5.00	5.00	-	100.00	10
J	MSF_2+F_2	10+90	60.42	19.58	5.00	5.00	5.00	5.00	-	100.00	10
K	SSF1+F_2	10+90	64.43	15.5	5.00	5.00	5.00	5.00	-	100.00	10
L	SSF_2+F_2	10+90	63.89	16.11	5.00	5.00	5.00	5.00	-	100.00	10
M	F_1	100	78.55	01.45	5.00	5.00	5.00	5.00	-	100.00	10
N	F_2	100	80.38	00.62	5.00	5.00	5.00	5.00	-	100.00	10
O	Casein	--	-	67.52	5.00	5.00	5.00	5.00	12.50	100.00	10
P	Protein free	--	-	80.00	5.00	5.00	5.00	5.00	-	100.00	0.04

*CSF_1+F_1 = CIM240+Faisalabad85, CSF_2F_1 = NIAB78+Faisalabad85, MSF_1+F_1= Peela Raya+Faisalabad85, MSF_2+F_1= Raya Anmol+Faisalabad85,

SSF_1+F_1= Hysun33+Faisalabad85, SSF_2+F_1= Suncom110+Faisalabad85, CSF_1+F_2=CIM240+Chakwal86, CSF_2+F_2=NIAB78+Chakwal86,

MSF_1+F_2= Peela Raya+Chakwal86, MSF_2+F_2= Raya Anmol+Chakwal86, SSF_1+F_2=Hysun33+Chakwal86, SSF_2+F_2=Suncom110+Chakwal86,

F_1= Wheat flour (Faisalabad85), F_2=Wheat flour (Chakwal86).

The oilseeds were procured from Oilseed Section, Ayub Agricultural Research Institute, Faisalabad for the crop years 2001-02 and processed in such a way to get defatted, detoxified and low fiber oilseed flours. The oilseed flours were blended with 10 and 20% levels with whole wheat flours for chapatti preparation.
Whole wheat and oilseed enriched chapattis were analyzed for moisture, crude protein and ash contents by the methods of AOAC. (1990).
Biological studies of different oilseed enriched wheat chapattis were conducted according to the methods described by Miller and Bender (1955) using albino rats. Experimental diets for rats were prepared as mentioned in Table 1. Protein efficiency ratio (PER) and weight gain in rats was measured through biological assays as described below:

Sixty four weanling albino rats (21 days) were used for the biological assay of experimental diets. The rats were fed to a stock diet for one week so that they weighed 50-60 g prior to experiment and then randomly divided into sixteen groups of four rats each. Each group was weighed (173±2.5g) and housed separately in metabolic cages. The diets were randomly assigned to experimental groups and were fed *ad libitum* for a period of ten days. The temperature of the animal room was maintained at 30±2°C. Each group of four rats was separately kept in wire screen mesh bottom; underneath each cage meal tray covered with a sheet of filter paper was placed. Composite weight of each group of the rats was recorded daily with electronic top loading balance. At the end of 10 days, the faecal material was collected and brought to a constant weight by drying at 100°C and stored in polyethylene bags for estimation of nitrogen. The spilt food collected from each cage was dried and weighed.
At the end of the experiment, rats were killed by chloroform anesthesia. The skull and abdominal cavities were opened and whole body was dried in an oven at 100°C till to a constant weight. The dried carcass was run through electric grinder and stored for nitrogen determination.
The data thus collected were subjected to statistical analysis employing completely, randomized design (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The results regarding analysis of variance for moisture content of chapattis prepared from different oilseed enriched wheat flours have been presented in Table 2.

Table 2. Analysis of variance for chemical proximate of different oilseed enriched wheat flour chapattis.

Source of variation	Degree of freedom	Moisture	Crude protein	Ash
Year (Y)	1	0.851^{NS}	6.546^{NS}	0.0003^{NS}
Rep(year)	4	294.059	34.075	1.6434
Flour (F)	1	4.227^{**}	0.735^{NS}	0.0229^{NS}
Y × F	1	0.024^{NS}	0.004^{NS}	0.5509^{**}
Combination (C)	12	24.742^{**}	37.035^{**}	0.9011^{**}
Wheat Flour	1	5.094^{**}	183.955^{**}	1.7301^{**}
Oilseed flour (SF)	5	51.873^{**}	28.629^{**}	0.6508^{**}
Level (L)	1	13.746^{**}	111.980^{**}	5.1189^{**}
SF × L	5	3.741^{**}	1.067^{NS}	0.1420^{**}
Y × C	12	0.109^{NS}	0.451^{NS}	0.0332^{NS}
F × C	12	0.495^{NS}	2.716^{NS}	0.0375^{NS}
Y × F × C	12	0.135^{NS}	0.165^{NS}	0.0206^{NS}
Error	100	0.679	2.533	0.0296

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)

It is obvious from the results that the moisture content of chapattis among oilseed flour combinations differed significantly. The average moisture content of chapattis prepared from different oilseed enriched wheat flours is shown in Table 3. The data showed that the moisture content in chapattis was found to be significantly the highest in wheat flours enriched with 20% of Peela Raya, Hysun 33 and Suncom 110. The wheat flours enriched with 10 and 20% CIM 240 and 10% and 20% NIAB 78 were found to be statistically at par with respect to moisture content. The chapattis prepared from wheat flour enriched with oilseed flours significantly contained higher moisture content than the chapattis prepared from unenriched wheat flour. The studies conducted by Bhat and Vivian (1980) who had indicated that the moisture contents in chapattis were 32.6 to 36.0% when supplemented with soy, peanut and cottonseed flours while moisture contents in whole wheat chapati was 35.5%.

Table 3. Moisture (%) of chapattis prepared from different oil seed enriched flours.

Wheat flour	Control	Cotton seed flour				Mustard seed flour				Sunflower seed flour			
		CIM 240		NIAB 78		Peela Raya		Raya Anmol		Hysun 33		Suncom 110	
		10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80
	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
F1	35.20	33.27	33.20	32.89	32.52	34.93	36.16	35.10	36.13	35.84	36.58	35.74	36.49
F2	35.58	32.88	32.44	33.01	32.42	34.33	36.05	35.08	35.96	34.73	36.08	35.01	36.20
Mean	35.39bc	33.07e	32.82e	32.95e	32.47e	34.63d	36.10a	35.09cd	36.05ab	35.28cd	36.33a	35.37bc	36.34a

F1 = Wheat flour (Faisalabad-85); F2 = Wheat flour (Chakwal-86)
Means, in a row or a column, sharing the same alphabet are statistically non-significant (P>0.05).

Table 4. Crude protein (%) of chapattis prepared from different oil seed enriched flours.

Wheat flour	Control	Cotton seed flour				Mustard seed flour				Sunflower seed flour			
		CIM 240		NIAB 78		Peela Raya		Raya Anmol		Hysun 33		Suncom 110	
		10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80
	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
F1	7.86	11.52	13.60	10.73	12.98	11.86	15.06	12.16	15.36	9.47	10.92	10.41	11.61
F2	8.10	11.43	13.62	11.31	12.30	12.35	13.55	12.08	12.99	10.62	11.75	10.14	11.51
Mean	7.98g	11.48c-f	13.61ab	11.02def	12.64bc	12.10cd	14.30a	12.12cd	14.18a	10.04f	11.33c-f	10.28ef	11.56cde

F1 = Wheat flour (Faisalabad-85); F2 = Wheat flour (Chakwal-86)
Means, in a row or a column, sharing the same alphabet are statistically non-significant (P>0.05).

Table 5. Ash (%) of chapattis prepared from different oil seed enriched wheat flours.

Wheat flour	Control	Cotton seed flour				Mustard seed flour				Sunflower seed flour			
		CIM 240		NIAB 78		Peela Raya		Raya Anmol		Hysun 33		Suncom 110	
		10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80	10+90	20+80
	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
F1	1.67	1.77	1.92	1.84	2.10	2.02	2.52	1.96	2.40	1.84	2.19	1.82	2.12
F2	1.65	1.76	2.06	1.82	2.23	2.00	2.52	1.94	2.72	1.86	2.08	1.81	2.04
Mean	1.66h	1.76gh	1.99cde	1.82fg	2.16b	2.00cd	2.52a	1.95def	2.56a	1.85efg	2.14bc	1.81fg	2.08bcd

F1 = Wheat flour (Faisalabad-85); F2 = Wheat flour (Chakwal-86)
Means, in a row or a column, sharing the same alphabet are statistically non-significant (P>0.05).

The analysis of variance for crude protein content of chapattis prepared from different oilseed enriched wheat flours (Table 2) indicated that crude protein content of chapattis did not differ significantly due to the wheat flours.The chapattis prepared from different combination of oilseed flour possessed significant differences in protein content. The protein content was found to be the highest in chapattis prepared from wheat flour enriched with 20% Peela Raya and 20% Raya Anmol (Table 4). The lowest crude protein content was recorded in chapattis prepared from whole wheat flours followed by the chapattis prepared from wheat flour enriched with 10% Hysun33.

There was a significant increase in the crude protein content of chapattis when prepared from oilseed enriched wheat flours. The crude protein content of chapattis increased progressively with the increase in the level of oilseed flour supplementation. Jan *et al.*. (2000) have reported an increase in the crude protein content of chapattis enriched with oilseed flours. Rawat *et al.* (1994) also reported an increase in protein level of soy flour fortified chapattis. Ghandi *et al.* (2000) observed increase in protein contents from 11.9 to 19.8% at 20% blending level of defatted soy enriched chapattis. The protein content of chapattis prepared from wheat flour enriched with soy, peanut and cottonseed flour was higher in chapattis prepared from whole wheat flour (Bhat and Vivian, 1980).The higher protein in the wheat flour enriched with oilseed flours has resulted corresponding increase in the protein content of resultant chapattis.

The mean ash content of chapattis prepared from different oilseed enriched wheat flours has been shown in Table 5. The data revealed that the ash content was found to be significantly higher in chapattis prepared from wheat flour enriched with 20% Peela Raya and 20% Raya Anmol. The chapattis prepared from wheat flour enriched with 20% NIAB 78, Hysun 33 and Suncom 110 were found to be statistically at par with respect to ash content. The ash content of chapattis prepared from wheat flour enriched with 10% NIAB 78 and 10% Suncom 110 also did not differ significantly for this chemical constituent. The lowest ash content was found in the chapattis prepared from nonenriched wheat flour followed by enriched with 10% CIM 240. The variation in ash content between chapattis prepared from wheat flour enriched with 10% Raya Anmol and 10% Hysun 33 was found to be non significant.

The mean values for PER of different oilseed enriched wheat flours are given in (Table 6). The PER ranged 1.42-2.51 among different experimental diets. The PER of wheat flour enriched with oilseed flours ranged between 1.50-1.97 while in whole wheat flour diets it was 1.42 and 1.45 for wheat variety Faisalabad-85 (M) and Chakwal-86 (N) respectively.

A significant difference was observed among the experimental diets prepared with flour of different wheat varieties enriched with different oilseed flours. The PER was higher in experimental diets containing oilseed enriched flours in wheat flours than the wheat flours having no enrichment. The differences in protein efficiency ratio between the unsupplemented diets containing wheat flour of wheat variety Faisalabad-85 (M) and Chakwal-86 (N) was also found to be significant ($P<0.01$).The results revealed that there was a significant increase in the PER of the wheat flours when enriched with any oilseed flour.

The enrichment of whole wheat flour with different oilseed flours was found to be significant effect on the PER. In a former study, Faridi *et al.* (1983) reported a PER of 1.61 for bread and 1.99 for whole wheat flour, respectively. Effect of soy-fortification on nutritional quality of chapati was evaluated by Rawat *et al.* (1994) who reported an increase in PER of soy-meal fortified chapattis from 1.3 to 1.7. Similarly, Siddique *et al.* (1996) observed significant improvement in PER of chickpea flour supplemented chapati. The differences in PER observed during this study may be due to the difference in baking, variety and agronomic factors. Improvement in PER of whole wheat flour due to oilseed flour enrichment is also in agreement with these findings.

The weight gain(WG) revealed that the rats consumed significantly the lowest feed per unit gain in weight (Fig.1). The highest values were observed in casein wheat flour diet while the poorest WG was observed when rats fed on diet containing no oilseed flour because the WG of rats was proportional to the quantity of feed consumed. The WG of whole wheat flour was improved by addition of oilseed flour by achieving a relatively high weight gain. However, enrichment of wheat flours with oilseed flours significantly improved the nutritional quality of wheat flours. It has been report by Siddique (1989) that the enrichment of whole wheat chapati with legumes flour improved the gain in weight of rats. The findings of the present study are in agreement with the results obtained by Rawat *et al.* (1994) and Siddique *et al.* (1996) for feed efficiency (FE) who observed improvement in the weight gain of the rats due to consumption of oilseed and chickpea supplemented flour diets.

Table 6. Nutritional parameter of different experimental diets

Diets	Specifications	Proportion	Protein efficiency ratio	Feed efficiency
	CSF1+F1	10+90	1.57ef	5.62f
B	CSF2+F1	10+90	1.54f	6.28cd
C	MSF1+F1	10+90	1.94b	5.53f
D	MSF2+F1	10+90	1.83c	5.97e
E	SSF1+F1	10+90	1.49fg	6.96b
F	SSF2+F1	10+90	1.51fg	6.50c
G	CSF1+F1	10+90	1.71d	6.40c
H	CSF2+F1	10+90	1.62e	6.49c
I	MSF1+F1	10+90	1.97b	5.98e
J	MSF2+F1	10+90	1.85c	5.65f
K	SSF1+F1	10+90	1.50fg	5.96e
L	SSF2+F1	10+90	1.52f	6.13de
M	Wheat flour F1	0+100	1.42h	7.16ab
N	Wheat flour F2	0+100	1.45gh	7.39a
O	Casein	-	2.51a	3.89g
P	Non-protein	-	-	2.96h

Means is a column sharing same letters are statistically non-significant (P>0.01)

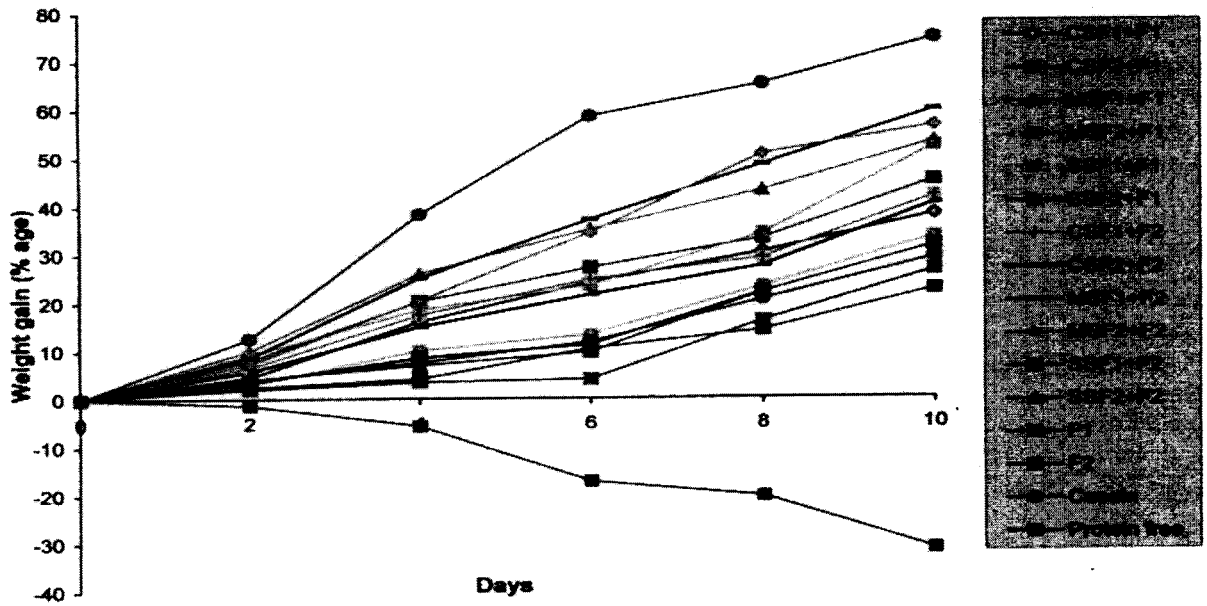

Fig.1. Weight gain in rats by experimental diets.

CONCLUSION

The results of the present study indicated that there was a significant increase in moisture, crude protein and ash contents in chapattis prepared from wheat flour enriched with oilseed flours. The enrichment of wheat flour with oilseed flours not only increased the protein content and ash content of the enriched flours but also increased the level of these constituents in the chapattis as well. This further showed that wheat flours enrichment with oilseed flours may help to improve the nutritional status of masses whose staple diet is chapatti.

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