▼ Journal of Research (Science), Bahauddin Zakariya University, Multan, Pakistan.
Vol.16, No.2, October 2005, pp. 57-63 ISSN 1021-1012

NUTRITIONAL IMPROVEMENT OF CHAPATTI USING SOY HULLS

Muhammad Issa Khan[1], Faqir Muhammad Anjum[1], Saeed Akhtar[2]
[1]Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan. [2]University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan.
email: saeedbzu@yahoo.com

Abstract: Five treatments of composite flours along with control were prepared by supplementing soy flour in wheat flour @ 1.5, 3, 4.5, 6 and 7.5% to improve nutritional quality of chapattis with respect to minerals (Ca, Mg, Fe, Zn, Mn and Cu) and phytic acid. Composite flours and chapattis were analyzed for their mineral and phytic acid content to assess the changes as a function of baking. Supplementation significantly increased mineral content of flours and this increase was also indicated in chapattis prepared from their respective flours. There was a decrease (20%) in the phytic acid content of the chapatti samples during baking. Sensory evaluation of the chapattis showed that chapattis with 4.5% replacement of wheat flour with soy hulls were accepted by the panel of judges.

Keywords: Chapatti, minerals, phytic acid, soy supplementation, wheat flour.

INTRODUCTION

Soybean has healthful nutrient profile and can be used in a variety of foods to promote desirable health effects [USDA 1986]. The bioavailability of the minerals in various soy foods is still under investigation mainly due to the presence of phytic acid in such foods which bind minerals, particularly zinc and iron and decrease their absorption. However, when soy is eaten as part of varied diet, mineral status is not likely to be a problem [USDA 1986, Heaney *et al*. 1991].

Wheat flour is a staple food of Pakistani people and an average intake is 318 g per person per day. More than fifty percent of the total energy intake is derived from wheat flour [OMNI 1996]. Wheat is principally used for the production of unleavened flat bread locally known as *Chapatti* in Pakistan. Chapattis are least expensive and utilize almost 90% of the total wheat produced in this region [Siddique 1989]. Micronutrient deficiency in Pakistani population has been widely reported. With respect to anemia, 25.5 % mothers had moderate (23.7 %) to severe (1.8 %) iron deficiency anemia while 45 % had iron deficiency and 29.4 % had anemia while zinc deficiency has been found in malnourished children and in children suffering from persistent diarrhea [Anonymous 2002]. The zinc deficiency has been reported in 54.2% preschool children [Paracha and Jamil 2000].

The phytic acid is a metal chelating agent and has the ability to bind certain dietary minerals such as Fe, Zn, Mg and Ca by forming insoluble compounds in the intestine and render them unavailable for the performance of physiological functions. Most of the mineral contents in wheat are tied up with Phytate to form complexes and ultimately make the wheat nutritionally inferior. The whole wheat meals contain 0.30% and bran contains 5% phytate [O' Dell *et al*. 1972, Lolas *et al.* 1976].

The composite flour technology plays a vital role to complement the deficiency of essential nutrients in wheat. Legumes and pulses are good sources of proteins, some essential amino acid and minerals. Soy hulls are the by-product of soybean and can be used as source of the minerals in wheat flour.

The present study was designed to explore the opportunity of supplementing wheat flour with soy bran in order to enhance the nutritional quality of chapatti with an added advantage of sufficient supply of fiber in the diet.

MATERIALS AND METHODS

PROCUREMENT AND PREPARATION OF RAW MATERIAL

The soybean purchased from Oil Seed Section Ayub Agricultural Research Institute Faisalabad, was thoroughly cleaned, steeped in water for one hour at 100 °C, de hulled and then dried in an oven at 100 °C to remove moisture. The soy hulls thus obtained were ground through cyclone mill to get soy hulls powder.

PREPARATION OF COMPOSITE FLOURS

The composite flours were prepared by blending wheat flour with soy bran as given below:

Treatments	T_0	T_1	T_2	T_3	T_4	T_5
Wheat flour %	100	98.5	97.0	95.5	94.0	92.5
Soy hulls %	----	1.50	3.00	4.50	6.00	7.50

PRODUCTION OF CHAPATTIS FROM THE COMPOSITE FLOUR

The flours were kneaded by hand for 30 minutes before the chapatti preparation. The chapattis were baked on griddle at 210°C for 1-2 minutes as described by Haridas *et al*. [1986].

MINERAL CONTENT OF COMPOSITE FLOURS AND CHAPATTIS

The mineral content (Ca, Mg, Fe, Zn, Mn and Cu) in composite flour and chapatti samples was estimated by using Atomic Absorption Spectrophotometer (Perkin Elmer-100) as described in AOAC [2000]. The samples were wet digested according to the method reported by Richard [1969]. A sample weighing 0.5g of the flour was digested in 100 mL conical flask adding 10 mL HNO_3 at 60-70 °C for 20 minutes and then digested with 5 mL $HClO_4$ at 60-70 °C for 20 minutes and subsequently temperature was raised to 195 °C till the sample was transparent and reduced to 1-2 mL. The digested samples were diluted in a volumetric flask with deionized water. The chapatti samples were digested in the similar way. These samples were then loaded to Atomic Absorption

Spectrophotometer and concentration of elements was estimated. The difference in content of Ca, Mg, Fe, Zn, Mn and Cu in soy supplemented flours and chapattis prepared from their respective flours was estimated to assess the impact of heat treatment on these minerals.

PHYTIC ACID CONTENT OF COMPOSITE FLOURS AND CHAPATTIS

The phytic acid content in soy supplemented wheat flours and their chapatti samples were determined by the method described by Haug and Lantzsch [1983]. Phytate reference solution, ferric solution and 2-2 bipyridine solutions were prepared as required in the procedure. The extract measuring 0.5 mL of was taken through pipette in the stopperd test tube. One mL of ferric solution was added and stoppered properly for heating in the water bath for 30 minutes. After cooling in the ice water for 15 minutes, it was brought to room temperature. Transferred 1 mL of the supernatant in another test tube and added 1.5 mL of 2-2 bipyridine solutions. Absorbance was measured at 519 nm against distilled water (CECIL-7200) and phytic acid content was calculated accordingly through phytic acid standard curve.

SENSORY EVALUATION OF CHAPATTIS

The chapattis prepared from soy supplemented flours were presented to a panel of judges and sensory evaluation was carried out for colour, flavour, taste, texture, chewability, foldability and appearance according to methods described by Land and Shepherd [1988].

STATISTICAL ANALYSIS

The data for each parameter were statistically analyzed as described by Steel *et al*. [1997].

RESULTS AND DISCUSSION

The statistical results regarding the mineral content of composite flours (Table 1) indicated a pronounced increase with increasing concentration of soy hulls in the flours. The concentration of these minerals in supplemented flours correlated with the quantity of the soy hulls added to these flours, as the soy hulls are a significantly rich source of these minerals.

Table 1: Mineral content (mg per 100g) of composite flours.

Treatments	Ca	Mg	Fe	Zn	Mn	Cu
T_0	46.50^f	153.00^f	4.40^e	3.40^f	3.53^f	0.63^f
T_1	58.22^e	177.44^e	$4.68d^e$	3.57^e	3.62^e	0.80^e
T_2	69.93^d	201.89^d	$4.95c^d$	3.75^d	3.72^d	0.97^d
T_3	81.65^c	226.33^c	5.23^{bc}	3.92^c	3.82^c	1.15^c
T_4	93.36^b	250.77^b	5.50^{ab}	4.09^b	3.91^b	1.32^b
T_5	105.08^a	275.21^a	5.78^a	4.26^a	4.01^a	1.49^a
Overall Mean	75.79	214.10	5.09	3.83	3.77	1.06

T_0 WF 100 %, T_1 WF 98.50 % + S.F 1.50 %, T_2 WF 97.0 % + S.F 3.00%
T_3 WF 95.5 % + S.F 4.50% T_4 WF 94.0 % + S.F 6.00% T_5 WF 92.5 % + S.F 7.50%
WF = Wheat Flour SF =Soy Flour
Means sharing similar letter are statistically non significant.

The minimum iron content was observed in control (T_0) while the maximum iron was observed in T_5 as given in Table 1. The addition of 1.50 % (T_1) did not exert any significant effect on iron content of the flours. Likewise, increasing soy hulls concentration from 6.00 % (T_4) to 7.50 % (T_5) indicated a non significant change in iron content of the composite flours. Thirty one %t more iron was available in the flours on adding 7.5 percent soy hulls (Table 1). Similar changes were observed for the concentration of Ca, Mg, Zn, Mn and Cu content of different composite flours. The statistical results revealed that iron content of chapatti increased as a function of baking (Table 2). There was an increase of 7.47 % in iron content of chapatti as a result of heat treatment calculated as difference in conc. of iron in flours and their respective chapatti samples (Table 3). Similarly, there was an overall increase in Ca, Mg, Zn, Mn and Cu as indicated in Table 3. The mineral analysis of soy hulls and wheat flour revealed that soy hulls contain higher amount of mineral (Fe, Zn, Mn, Cu, Ca and Mg) than wheat flour. The mineral contents of wheat flour were increased by the supplementation. Rawat *et al.* [1994] stated that soy supplemented chapattis have higher level of Ca and Fe than prepared from whole wheat flour. Maqbool *et al*. [1987] reported that Ca, P and Fe, content of wheat *rotis* was increased with supplementation, which is in line with the present study. The results showed that the mineral content of chapattis increased slightly. The analysis of variance results showed a non significant difference in the phytate content of flours and chapattis as indicated in Table 4. However, the treatment effect was found to be significant both in supplemented flours and chapattis prepared from these flours. The lowest values (1.39 and 1.07 %) for phytic acid content were observed in flours and chapattis respectively (control) while the highest concentration (1.77 and 1.36 %) (T_5) of phytic acid was noted in flours and chapattis respectively. There was a decrease of 22.78 % in phytic acid content of chapattis when compared to composite flours (Table 4). Phytate was reduced during bread making process to a substantial extent as a result of degradation in which P6 (Hexainositol phosphate) and P5 (Pentainositol phosphate) were converted into their lower product that are P4 and P3 (Inositol with 4 and 3 phosphates respectively). P4 and P3 have lower ability to bind minerals as compare to P6 and P5. Dagher *et al.* [1987] stated that 32% of original phytic acid was lost during Arabic bread preparation containing different levels of bran.

The phytic acid content of a composite flour increased with an increase in soy hulls supplementations as shown in Table 4. The increase in phytic acid content was because of the fact that it is concentrated in the hulls (bran) as compared to the endosperm. Maqbool *et al*. [1987] found that supplementation increased the phytic acid contents of wheat *rotis*. Mameesh and Mamta [1993] stated that Arabic flat bread prepared from whole wheat flour has 72% higher phytic acid than from white flour due to high proportion of bran in the whole wheat flour.

Table 2: Mineral content (mg per 100g) of chapattis prepared from composite flours.

Treatments	Ca	Mg	Fe	Zn	Mn	Cu
T_0	48.13^f	158.36^f	4.73^f	3.66^f	3.79^e	0.67^d
T_1	60.25^e	183.65^e	5.03^e	3.84^e	3.88^{de}	0.86^c
T_2	72.38^d	208.95^d	5.32^d	4.03^d	3.99^{cd}	1.04^c
T_3	84.50^c	234.25^c	5.62^c	4.21^c	4.09^{bc}	1.23^b
T_4	96.63^b	259.55^b	5.92^b	4.40^b	4.20^{ab}	1.41^b
T_5	108.75^a	284.84^a	6.21^a	4.58^a	4.30^a	1.60^a
Overall Mean	78.44	221.60	5.47	4.12	4.04	1.14

Means sharing similar letter are statistically non significant.

Table 3: Effect of baking on mineral content (mg per 100g) of composite flours

Mineral	Composite Flour	Chapatti	Difference (mg per 100g)	% Increase
Ca	75.79	78.44	2.65	3.50
Mg	214.10	221.60	7.5	3.50
Fe	5.09	5.47	0.38	7.47
Zn	3.83	4.12	0.29	7.75
Mn	3.77	4.04	0.27	7.16
Cu	1.06	1.14	0.08	7.55

Table 4: Table of mean for phytic acid (%) content of composite flours and chapattis

Treatments	Flour	Chapattis
T_0	1.39^e	1.07^e
T_1	1.47^{de}	1.13^{de}
T_2	1.54^{cd}	1.19^{cd}
T_3	1.62^{bc}	1.25^{bc}
T_4	1.69^{ab}	1.30^{ab}
T_5	1.77^a	1.36^a
Overall Mean	1.58	1.22

Means sharing similar letter are statistically non significant.

Tangkongchitr *et al.* [1981] reported that in whole wheat pup, the cumulative loss of phytates phosphorous after fermentation, proofing and baking were 16, 19 and 22.5% respectively. The findings of Anjum *et al*. [2001] reported reduced phytic acid during baking of bread and chapattis.
There was a non significant difference in T_0 and T_1 for most of the sensory characteristics of the chapattis prepared from soy-supplemented flours. However, an addition of 3% of soy hulls significantly affected these sensory characteristics of chapattis. The scores assigned to colour, flavour, taste, texture, chewability, foldability and appearance of chapattis made from different flour samples have been presented in Table 5. These sensory characteristics of chapattis were affected by treatments. There was a significant difference for scores assigned to chapattis prepared from supplemented and non-supplemented flours (T_0 and T_5) pertaining to these sensory characteristics. Increasing concentration of soy hulls decreased the scores for these sensory parameters. The colour of the chapattis was particularly affected as a function of soy hull supplementation. It was the colour of the hull that was indicated in the chapattis through flours. However, the overall scores for these

parameters indicated that the chapatti assigned the lowest score were not even rejected by the panel of judges. The supplemented chapattis up to 4.5% were acceptable for all characteristics except for slight darkening in colour (Table 5).

Table 5: Scores for sensory characteristics of chapattis prepared from composite flours.

Treatments	Colour	Flavour	Taste	Texture	Chewability	Foldability	Appearance
T_0	7.0^a	8.0^a	7.5^a	8.0^a	7.5^a	7.5^a	7.0^a
T_1	7.0^a	7.5^{ab}	7.5^a	7.5^b	7.0^{ab}	7.0^{ab}	7.0^a
T_2	6.5^{ab}	7.0^b	7.0^{bc}	7.0^c	7.0^{ab}	7.0^{ab}	6.5^{ab}
T_3	6.0^b	7.0^b	6.5^c	6.0^d	6.5^b	6.5^b	6.0^b
T_4	4.5^c	5.5^c	5.0^d	5.0^e	5.5^c	5.0^c	4.5^c
T_5	4.0^c	5.5^c	5.0^d	4.5^f	5.0^c	4.5^c	4.0^c
Overall Mean	5.83	6.75	6.42	6.33	6.42	6.25	6.00

CONCLUSION

The present study revealed that micronutrients and phytic acid increased by supplementing wheat flour with soy hulls. The mineral content increased considerably during baking while phytic acid showed a reduction in flour samples. This decrease in phytic acid is suggestive of partial reduction of phytic acid during baking of chapattis.

References

Anjum, F.M., Butt, M.S., Ahmad, N. and Ahmad, I. (**2001**) "Phytate and mineral content in different milling fractions of some Pakistani spring wheats", *Intern J. Food Sci. and Tech*., 37, 13-17.

Anonymous (**2002**) National Nutritional Survey (2001-02). Planning Commission, Government of Pakistan, Islamabad.

AOAC (**2000**) "Official Methods of Analysis", The Association of Official Analytical Chemists, 17th ed., Arlington Virginia USA.

Dagher, S.M., Shadarevian, S. and Birbari, W. (**1987**) "Preparation of high bran Arabic bread with low phytic acid content", *J. Food Science*, 52 (6), 1600–1603.

Haridas, R.P., Leelavathi, K. and Shurpalekar, S.R. (**1986**) "Test baking of chapatti development method", *J. Cereal Chem*., 63, 297-303.

Haug, W. and Lantzsch, H.J. (**1983**) "Sensitive method for the rapid determination of phytate in cereal and cereal products", *J. Sci. Food Agric.*, 34, 1423-26.

Heaney, R.P., Weaver, C.M. and Fitzsimmons, M.L. (**1991**) "Soybean phytates content: Effect on calcium absorption", *Amer. J. Clin. Nutr*., 53, 745-747.

Land, D.G., and Shepherd, R. (**1988**) "Scaling and Ranking Methods", In: J.R. Piggott (Ed.), *Sensory Analysis of Foods*, Elsevier Applied Science, London, pp. 155-185.

Lolas, G.M., Palamidis, N. and Markakis, P. (**1976**) "The phytic acid, total phosphorus relationship in Barley, Oat, Soybean and Wheat", *J. Cereal Chem*., 53, 867.

Mameesh, M.S. and Mamta, T. (**1993**) "Phytate content of some popular Kuwaiti foods", *J. Cereal Chem*., 70 (5), 502-503.

Maqbool, A., Aurangzeb, R.A., Habib, N.B. and Khan, I. (**1987**) "Nutritional and organoleptic evaluation of wheat rotis supplemented with soybean flour", *Pak. J. Sci. and Indus Res*., 30(8), 615-618.

O'Dell, B.L., de Boland, A. and Koirtyohann, R. (**1972**) "Distribution of phytate and nutritionally important elements among the morphological component of cereal grain", *J. Agric. Food Chem*., 20, 718.

OMNI (**1996**) "Mandatory Food Enrichment" *Nutriview Supplement*, the Roche/USAID Fortification Basics series, and OMNI/ USAID Publication.

Paracha, P.I. and Jamil, A. (**2000**) "Assessment of micronutrient (Iron, Vitamin A and Zinc) status in preschool children of NWFP, Pakistan", Deptt. Human Nutrition, NWFP Agric. University, Peshawar, Pakistan.

Rawat, A., Singh, G. and Mital, B.K. (**1994**) "Effect of soy fortification on quality characteristics of chapattis", *J. Food Sci. Tech*. (India), 31(2), 114-116.

Richard, L.A. (**1969**) "Diagnosis and Improvements of Saline and Alkali Soils", US Department of Agriculture, Washington, DC.

Siddique, M.I. (**1989**) "Physicochemical properties of composite flour for chapatti production", PhD Thesis, Department of Food Technology, University of Agriculture, Faisalabad.

Steel, R., Torrie, J. and Dickey, D. (**1997**) "Principles and Procedures of Statistics: A Biometrical Approach", 3rd ed., McGraw Hill Book Co., New York, USA.

Tangkongchitr, .U., Seib, P.A. and Hoseney, R.C. (**1981**) "Phytic Acid. II. Its Fate during bread making", *J. Cereal Chem*., 58(3), 229-234.

United States Department of Agriculture (USDA) (**1986**) Composition of Foods: Legumes and Legumes Products, Washington, DC, USA.