EFFECT OF SUPPLEMENTATION OF DEFATTED SOY AND MAIZE FLOUR ON NUTRITIONAL PROFILE OF WHEAT FLOUR CHAPATTI

Rajni Goyal[1]*, **Neelam** Khetarpaul[2]
Department of Foods and Nutrition, CCS HAU, Hisar
*Presently working at Department of Home Sciene, Institute of Integrated and Honors Studies, Kurukshetra University, Kurukshetra, India
Email: shubhi_rgoyal@yahoo.co.in

Abstract
Protein deficiency is one of the biggest nutritional problems in the developing countries. Soybean is the richest source of protein can be supplemented to traditional chapattis which is the staple food of majority of North Indians. Maize is now a days is well recognized for both its nutritional and health benefits, as it is a very good source of phytochemicals. Keeping this in mind, the present was conducted to study the acceptability and nutritional attributes of chapatti prepared using combination of wheat, maize and partially defatted salt treated soy dhal. Chapattis were prepared using raw unprocessed flour of wheat, maize and defatted salt treated soy flour and composite flour. The developed chapattis were analyzed for consumer acceptability. Nutritional analysis of unprocessed flours and developed chapattis was done for proximate composition, sugar, antinutrients and in-vitro protein and starch digestibility. The organoleptic evaluation of the developed chapattis revealed that they were acceptable in term of sensory parameters. The protein content of the developed chapatti was found to be 24%higher than the control whereas sugar content was similar to that of the control. The phytic acid and polyphenol contents of chapatti decreased significantly by 34 and 66% respectively, over the unprocessed composite flour (control), which in turn significantly improved the in vitro protein (4.4%) and starch digestibility (27.7%).

Keywords: Partially defatted soy dhal, unleavened bread, wheat, maize

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1. INTRODUCTION

Cereals are one of the key components of the diet in India, providing on an average about 10-12% of proteins and 90% of calories. Due to economic and social reasons, the availability of animal protein is less as majority of Indian population is vegetarian. According to FAO (Food and Agriculture Organization) cereals and cereal products are an important source of energy, carbohydrate, protein and fibres, as well as containing a range of micronutrients such as vitamin E, some of the B vitamins, magnesium and zinc. Wheat is the major staple cereal consumed by majority of large segment of population in India. Maize is third important cereal after wheat and rice and is a staple food in Asian and African countries. It is generally consumed as snacks in the form of pop corn, as thickening agent in the form of corn starch and as chapatti in the form of flour. However, wheat and maize are limiting in essential amino acid especially lysine.

To overcome the deficiency of essential amino acids, soybean has a great potential as it is the most economical source of dietary protein and contains most of the essential amino acids except methionine (FAO 1970), which is abundant in cereals. The supplementation of wheat and maize based diets with soybean can help in overcoming the problem of protein-energy malnutrition which is quite prevalent in the developing countries. To fulfill the requirement of protein and energy, the fortification of wheat flour should be done with soy and corn flour in some food product which is most commonly used under household conditions and *chapatti* is one such form. In Indian households, *chapattis* are prepared fresh and eaten daily in each meal. Hence, fortification of wheat flour with soy and maize was done in the present study to prepare *chapattis* which were evaluated organoleptically by a panel of semi-trained judges followed by their nutritional evaluation.

2. MATERIALS AND METHODS

Preparation of flours for making chapattis

Maize was procured from local market and ground to fine powder. Whole wheat flour was procured from the local market. Soybean(PK 416 variety) was obtained from Plant Breeding Department of CCSHAU, Hisar and processed using following method:

Blanching and dehulling of soybean

Soybean was blanched for 10 minutes in boiling water, husk was removed manually and obtained soydhal was dried in oven at 60°C ± 2°C till constant weight was attained.

Partial defatting of soy dhal

Soydhal was then soaked in hexane for 24 hours followed by 4 hours shaking which resulted in 9.6 per cent reduction in total fat content of soy *dhal* (Khetarpaul *et al.*, 2004c).

Presoaking treatments of soy dhal

Four salt treatments viz. sodium carbonate, sodium bicarbonate, sodium chloride and sodium tripolyphosphate (0.75% for 6 hours) were given to soy *dhal* to reduce its cooking time (Khetarpaul et. al., 2004a, 2004b & 2005). This *dhal* was further used in combination with wheat and maize flour for the development of nutritious *chapatti*.

Method of preparing chapatti

Chapattis were prepared incorporating soy and maize with wheat flour in the following two proportions using conventional method (Rawat, 1990).

Type of *chapatti* Type I/Type II/Type III/Type IV

Ingredients	**A**	**B**
Wheat flour	75	85
Soy flour	15	10
Maize flour	10	5

Type I: Sodium carbonate treated soydhal + wheat + maize
Type II: Sodium bicarbonate treated soydhal + wheat + maize
Type III: Sodium chloride treated soydhal + wheat + maize
Type IV: Sodium tripolyphosphate treated soydhal + wheat + maize

Sensory evaluation of chapattis

Organoleptic evaluation of control and developed *chapattis* was done by a panel of 10 semi trained judges using 9 point hedonic scale. The scores between 1 and 9 were given by the judges. The ranking of the scores is as given below:

9 Very desirable
8 Desirable
7 Moderately desirable
6 Slightly desirable
5 Neither desirable nor undesirable
4 Slightly undesirable
3 Moderatly undesirable
2 Undesirable
1 Very undesirable

Nutritional evaluation of the best accepted *chapatti* with the highest score was done. The selected developed *chapatti* as well as control *chapatti* were dried in oven at 60°C ± 2°C till constant weight was achieved. After drying, the samples were ground to fine powder and analyzed for following parameters:

Nutritional Evaluation of chapattis

a) Proximate nutrients

Moisture, crude protein, fat, ash and crude fibre contents of raw flour as well as *chapatti* were estimated using the standard method of analysis (AOAC, 1990).

***b)* Carbohydrate profile**

Total soluble sugars, reducing sugar and non-reducing sugar contents were determined by the method of Hulme and Narain (1931).

***c)* Antinutrients**

Phytic acid and polyphenol contents was determined using the method of Davies and Reid (1979) and Singh and Jambunathan (1981), respectively.

***d)* In vitro protein and starch digestibility**

In vitro protein and starch digestibility were estimated by the modified method of Mertz *et al.* (1983) and Singh *et al.* (1982), respectively.

Statistical analysis

The data were subjected to statistical analysis for calculation of mean and standard error. The data were analyzed in completely randomized design for analysis of variance (Panse and Sukhatme, 1961).

3. RESULTS AND DISCUSSION

Sensory evaluation

The sensory scores of Type I (A and B *chapatti*) revealed that these were 'liked moderately' except taste of B *chapatti* which was 'liked slightly'.

In case of Type II (A and B) *chapatti*, colour and appearance was 'liked moderately' by the judges. Flavour and texture of Type II A and B *chapatti* were found to fall in 'like slightly' category except flavour of B *chapatti* which fell in 'like moderately' category. Taste and overall acceptability of Type II (A and B) *chapatti* fell in 'like slightly' category except the taste of B *chapatti* which was 'neither desirable nor undesirable'.

The sensory scores of Type III (A and B) *chapatti* fell in 'like moderately' category except taste which was 'liked slightly'.

The colour and appearance of Type IV (A and B) *chapatti* was 'liked moderately' by the judges, except appearance of B *chapatti* which fell in 'like slightly' category. Flavour, texture and overall acceptability of Type IV A and B *chapatti* were found to fall in 'like slightly' category. However, taste of A and B *chapatti* fell in 'neither desirable nor undesirable' and 'slightly undesirable' category, respectively.

Overall, the score of overall acceptability was the highest for Type I-A *chapatti* prepared from wheat: soy: maize (75:15:10) so this type of *chapatti* was further selected for nutritional evaluation.

The results are also consistent and similar to those of Deshpande (2001) who evaluated *chapatti* prepared from wheat flour blended with full fat soyflour (90:10). Raza et. at. (2014) observed that chapatti prepared using 80:20 blend of wheat and maize flour had maximum acceptability. Katiyar and Katiyar (2018) reported that the quality and taste of chapattis were desirable and fairly acceptable prepared from blended flour of wheat, soy, bajra, maize and chickpea.

Table 1. Sensory evaluation of *chapati* prepared from wheat flour (control) and composite flour containing wheat, maize and soy flour

Salt treatment of soy dhal	Type of *chapati*	Colour	Appearance	Flavour	Texture	Taste	Overall accepta-bility
Sodium carbonate (Type I)	Control	7.8 ±0.31	7.8±26	7.8 ± 0.25	7.8 ± 0.36	7.9 ± 0.31	7.82 ± 0.42
	A	7.6 ±0.16	7.6±0.16	7.2 ± 0.13	7.6 ± 0.16	7.3 ± 0.15	7.46 ± 0.08
	B	7.6 ±0.16	7.3 ±.15	7.1± 0.10	7.2 ± 0.13	6.6 ± 0.16	7.16 ± 0.08
	CD (P<0.05)	NS	NS	0.36	0.42	0.41	0.28
Sodium bicarbonate (Type II)	Control	7.8± 0.31	7.8 ±0.26	7.8 0.25	7.8 ± 0.36	7.9 ± 0.31	7.82 ± 0.42
	A	7.1± 0.18	7.1± 0.18	6.9 ± 0.18	6.4 ± 0.21	6.5 ± 0.27	6.92 ± 0.18
	B	7.2 ±0.13	7.2 ± 0.20	7.0 ± 0.15	6.6 ± 0.20	5.5 ± 0.40	6.82 ± 0.16
	CD (P<0.05)	0.44	0.50	0.45	0.54	0.83	0.47
Sodium chloride (Type III)	Control	7.8 ±0.31	7.8± 0.26	7.8 ± 0.25	7.8 ± 0.36	7.9 ± 0.31	7.82 ± 0.42
	A	7.6 ±16	7.6 ±0.16	7.2± 0.13	7.3 ± 0.21	6.9 ± 0.10	7.32 ± 0.11
	B	7.6±0.60	7.3 ±0.15	7.1± 0.10	7.0 ± 0.15	6.4 ± 0.22	7.08 ± 0.08
	CD (P<0.05)	NS	NS	0.36	0.49	0.44	0.31
Sodium tripolyphospahte (Type IV)	Control	7.8± 0.31	7.8 ± 0.26	7.8 ± 0.25	7.8 ± 0.36	7.9 ± 0.31	7.82 ± 0.42
	A	7.1± 0.10	7.0± 0.01	6.9 ± 0.10	6.9 ± 0.10	5.9 ± 0.23	6.76 ± 0.07
	B	7.0± 0.15	6.9 ± 0.10	6.7 ± 0.15	6.8 ± 0.13	4.9 ± 0.35	6.46 ± 0.11
	CD (P<0.05)	0.38	0.28	0.38	0.36	0.73	0.30
Overall CD (P<0.05)		0.41	0.41	0.37	0.45	0.60	0.33

Values are mean ± Se of 10 independent determinations Control = *Chapati* prepared from wheat flour

A = *Chapati* of wheat : soy : maize flour 85 : 10 : 5 B = *Chapati* of wheat : soy : maize flour 75 : 15 : 10

Table 2. Proximate composition of unprocessed flour and *chapatis* (g/100 g, dry matter basis)

	Moisture	Protein	Fat	Ash	Crude fibre
Controls					
Unprocessed wheat	12.11 ± 0.61	12.31 ± 0.44	1.08 ± 0.05	1.90 ± 0.20	1.89 ± 0.07
Unprocessed soy	9.8 ± 0.63	33.8 ± 1.32	23.4 ± 0.98	5.1 ± 0.18	3.9 ± 0.29
Unprocessed maize	13.63 ± 0.22	11.01 ± 0.24	3.6 ± 0.29	1.45 ± 0.09	2.15 ± 0.08
Unprocessed composite flour	11.91 ± 1.07	15.40 ± 0.29	4.68 ± 0.03	2.33 ± 0.13	2.00 ± 0.05
Chapati					
Wheat	29.67 ± 0.83	12.06 ± 0.03	1.17 ± 0.06	2.63 ± 0.13	1.87 ± 0.05
Wheat+soy+maize	33.54 ± 1.19	15.49 ± 0.42	5.01 ± 0.06	3.03 ± 0.28	2.76 ± 0.07
't' value	10.64	4.79	4.42	1.21	1.71
CD (P<0.05)	2.59	2.38	1.47	0.59	0.48

Control = Wheat flour *chapati*
Unprocessed composite flour: Wheat : Soy : Maize
75 : 15 : 10
t tab at 5% level 4.303

Nutritional evaluation

Proximate constituents of flours and chapattis

The results presented in Table 2 depict the proximate composition of flours and *chapatti*. The moisture content of the maize (13.63%) was higher when compared to that of wheat (12.11%) and soy flour (9.8%).

The protein, fat and ash contents of soy flour were found to be significantly (P<0.05) higher as compared to that of wheat and maize flour. The results are in accordance to those reported by Gopalan *et al.* (1995) and Aminigo and Oguntudne (2000). Crude fibre content of soy flour was significantly (P<0.05) higher than that of wheat and maize flour. Non-significant differences were found in the values of crude fibre content of maize and wheat.

There was a significant increase in moisture, protein and fat contents of the developed *chapatti* when compared to those of wheat flour *chapatti* (Table 2). The increase in the nutrient contents of the developed *chapatti* is attributed to supplementation of soy and maize flour to wheat flour.

The nutritional evaluation of unprocessed composite flour and composite flour *chapattis* revealed a significant increase in moisture content of the developed *chapatti* which is due to addition of water for preparing dough (Table 2). The protein content of the developed *chapatti* increased significantly (20.1%) over the unprocessed composite flour. However, non-significant differences were found in fat, ash and crude fibre content of the developed *chapatti* and unprocessed composite flour. The results obtained in the present study were in accordance with those earlier reported by Duhan (1994) who found 11.64 per cent protein in wheat and soy flour supplemented *chapatti*. Khetarpaul and Goyal (2009) and Turab (2017) observed higher protein, fat and ash content in partially defatted soy fortified composite flour *chapattis*.

Carbohydrate profile of flours and chapattis

Reducing sugar content of wheat, soy and maize was 0.61, 0.60 and 0.50 per cent which were not significantly different. Non-reducing sugar content of soy flour (5.79%) was significantly higher (P<0.05) than that of wheat (3.56%) and maize flour (3.78%) but the difference was not significant (Table 3).

Table 3. Carbohydrate profile of unprocessed flours and *chapati*

Flours	Total soluble sugars	Reducing sugar	Non-reducing sugar
Flour			
Unprocessed wheat	4.17 ± 0.22	0.61 ± 0.03	3.56 ± 0.20
Unprocessed soy	6.39 ± 0.14	0.60 ± 0.05	5.79 ± 0.08
Unprocessed maize	4.28 ± 0.22	0.50 ± 0.04	3.78 ± 0.27
Unprocessed composite flour	4.52 ± 0.08	0.54 ± 0.02	3.98 ± 0.10
Chapati			
Wheat flour *chapatti*	4.29 ± 0.05	0.62 ± 0.06	3.67 ± 0.11
Wheat+soy+ maize *chapati* *75 : 15 : 10*	4.64 ± 0.22	0.70 ± 0.07	3.94 ± 0.15
't' value	0.29	0.46	0.34
CD (P<0.05)	0.59	NS	0.70

Control = Wheat flour *chapatti* t tab at 5% level 4.303
Unprocessed composite flour: Wheat : Soy : Maize
75 : 15 : 10

Total, reducing and non-reducing sugar contents of developed *chapatti* increased when compared to wheat flour *chapatti* but the differences were not significant.
The nutritional evaluation of unprocessed composite flour and developed *chapattis* revealed that total soluble sugar content were 4.52 and 4.64 per cent, respectively. However, this slight increase over the control was not statistically significant. Similar trend was found in non-reducing sugar contents of unprocessed composite flour and developed *chapatti*. The reducing sugar content of control and developed *chapattis* varied non-significantly. Similar results have been reported by Khetarpaul and Goyal (2008), however, Dogra *et al.* (2001) had earlier reported increase in total soluble sugar and non-reducing sugar contents of *chapatti* on heating due to the activities of α and β amylase enzymes. The increase in sugar contents might be attributed to processing treatment like roasting, leading to hydrolysis of starch to monosaccharides.

Antinutrient content of flours and chapatti

Phytic acid and polphenol contents of unprocessed flours revealed that soy flour had highest amount of these antinutrients. Phytic acid content was lowest in maize flour followed by wheat flour and composite flour. However wheat flour had lowest amount of polyphenol content.
When comparison of wheat flour chapatti was done with composite flour chapatti, it was observed that developed wheat, soy and maize *chapatti* had 13% higher phytic acid content as compared to wheat flour *chapatti* which might be due supplementation of soy and maize flour having higher amount of phytic acid.
The unprocessed composite flour (control) contained 755.07 mg phytic acid per 100 g, whereas chapatti made from this flour had only 498.19 mg phytic acid/100 g (Table 4). A significant (P<0.05) decrease (34%) in phytic acid content of developed *chapatti* over the unprocessed composite flour was noticed. The roasting of chapattis might have resulted in significant reduction in phytic acid content. Similar effect of roasting of soybean and baking of *chapatti* on antinutritional content has been reported earlier (Rawat *et al.*, 1994; Dogra *et al.*, 2001; Khetarpaul and Goyal, 2008).

Table 4. Phytic acid and polyphenol contents of unprocessed flours and *chapatis*

	Phytic acid (mg/100 g)	Polyphenol (mg/100 g)
Flours		
Unprocessed wheat	625.19 ± 7.12	455.12 ± 4.65
Unprocessed soy	1494.72 ± 45.63	615.61 ± 3.86
Unprocessed maize	619.87 ±8.45	580.23 ± 12.47
Unprocessed composite flour	755.07 ± 3.74	491.70 ± 3.49
Chapati		
Wheat flour *chapatti*	440.40 ± 0.36	169.27 ± 0.47
Wheat+soy+ maize *chapati* 75:15:10	498.19 ± 6.16	167.07 ± 1.06
't' value	7.04	0.26
CD (P<0.05)	67.81	20.46

Control = Wheat flour *chapati* t tab at 5% level 4.303
Unprocessed composite flour: Wheat : Soy : Maize
75 : 15 : 10

The polyphenol (mg/100 g) contents of the raw and unprocessed composite flour and developed *chapattis* were found to be 491.70 and 167.07, respectively (Table 4). This significant (66%) decrease in polyphenols after giving the processing treatment i.e. roasting to the composite flour was due to binding of polyphenols with other organic substances and proteins, or from alterations in the chemical structure of polyphenols that cannot be determined by available chemical methods (Reddy *et al.*, 1985). Omoikhoje et. al., *(2009) reported that trypsin inhibitor, hemaggl*utinin and tannin were completely eliminated in bambaragroundnut seeds cooked for 60 min or longer.

Protein and starch digestibility (in vitro)

The protein digestibility was the highest in case of maize flour followed by wheat flour, but the differences between the two were non-significant. However, among all the flours maize flour had significantly (P<0.05) higher protein digestibility. The similar results for protein digestibility of wheat and maize were earlier reported by Jood and Kapoor (1992).

The nutritional evaluation of unprocessed composite flour and developed *chapatti* revealed that protein digestibility of developed *chapatti* was significantly higher which might be attributed to higher content of phytic acid and polyphenols content in the unprocessed composite flour (Table 4) that adversely affect the protein digestibility. The digestibility of legume protein has been found to improve significantly during processing due to destruction of antinutrients (Kadam *et al.*, 1986) or by opening the protein structure through denaturation (El Faki *et al.*, 1984) and also by denaturing globulins, highly resistant to proteases in the native state (Walker and Kochhar, 1982).

Table 5. Protein digestibility (*in vitro*, g/100 g) and starch digestibility (*in vitro*, mg maltose released/g) of unprocessed flours and *chapati*

	Protein digestibility	Starch digestibility
Flours		
Unprocessed wheat	71.17 ± 0.78	33.29 ± 0.53
Unprocessed soy	60.42 ± 0.65	24.33 ± 0.44
Unprocessed maize	72.11 ± 0.28	33.42 ± 0.55
Unprocessed composite flour	69.65 ± 1.24	31.96 ± 1.22
Chapati		
Wheat flour *chapatti*	73.19 ± 0.37	43.78 ± 0.25
Wheat+Soy+Maize *chapati*	72.68 ± 0.38	40.81 ±0 0.24
't' value	0.68	2.57
CD (P<0.05)	2.38	2.18

Control = Wheat flour *chapati*
Unprocessed composite flour: Wheat : Soy : Maize
75 : 15 : 10
t tab at 5% level 4.303

The *in vitro* starch digestibility (mg maltose released/g) was found to be higher in maize flour as compared to wheat and soy flour. Non-significant differences were observed in the starch digestibility of wheat flour *chapatti* and developed *chapatti*. However, comparison of unprocessed composite flour and developed *chapatti* reveals a significant improvement (28%) in starch digestibility of developed *chapatti*. This might be due to the fact that starch granules are gelatinized and partially solubilized, thus becoming available to digestive enzymes. Also during cooking various heat labile antinutrients like phytates and tannins are inactivated or destroyed leading to improved starch digestibility, as reported in the present study (Table 4).
The enhancement in starch digestibility due to heat treatment has also been reported by other workers in red gram, bengal gram and black gram (Kelkar *et al.*, 1996); moth bean (Bravo *et al.*, 1998) and composite flour chapatti (Khetarpaul and Goyal, 2009).

4. CONCLUSION

The results of the present study thus, reveal that the *chapatti* prepared by using combination of salt treated defatted soy, wheat and maize flour was organoleptically acceptable. Nutritionally, this composite flour *chapatti* contained significantly higher protein than the wheat *chapatti* sample. Processing treatment i.e. roasting decreased the amount of phytic acid and polyphenols and improved the protein and starch digestibility considerably of the composite flour *chapatti*. Hence, blending of wheat flour with maize and soy flour is better to improve the nutritional profile of unleavened bread. These types of chapattis can help to overcome the problem of malnutrition to some extent.

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5. REFERENCES

[1]. Aminigo, E.R. and Oguntunde, A.O. (2000). Functional properties and nutritive composition of maize (Zea mays) as affected by heat treatments. Journal of Food Science and Technology, 37(1): 11-15.

[2]. AOAC. (1990), Official Methods of Analysis of the Association of Official Analytical Chemists. Arlington, Virginia, USA, 2:15.

[3]. Bravo, L., Siddhuraju, P. and Calixto, F.S. (1998). Effect of various processing methods on the in vitro starch digestibility and resistant starch content of Indian pulses. Journal of Agricultural Food Chemistry, 46: 4667-4674.

[4]. Davies, N.T. and Reid, H. (1979). An evaluation of phytate, zinc, copper, iron and manganese contents and zinc availability from soy-based textured vegetable protein meat substitutes or meat extenders. British Journal of Nutrition, 41: 579.

[5]. Deshpande, S.S., Mishra, A. and Mishra, M. (2001). Preparation and organoleptic evaluation of soy-blended food products. Journal of Food Science and Technology, 38(3):291-293.

[6]. Dogra, J., Dhaliwal, Y.S. and Kalia, M. (2001). Effect of soaking, germination, heating and roasting on the chemical composition and nutritional quality of soybean and its utilization in various Indian leavened products. Journal of Food Science and Technology, 38(5): 453-457.

[7]. Duhan, R. (1994). Nutritional and sensory evaluation of some traditional food products developed from soybean. M.Sc. Thesis. CCSHAU, Hisar, India.

[8]. El-Faki, H.A., Venkataraman, L.U. and Desikacher, H.S.R. (1984). Effect of processing on the in vitro digestibility of protein and carbohydrates in some Indian legumes. Plant Foods for Human Nutrition, 34: 127-133.

[9]. [9] FAO. (1970), Amino acid content of foods and Biological data on protein: Nutritional studies, 24. Food and Agriculture Organization of the United Nations, Rome.

[10]. Gopalan, C., Ramasastri, B.V. and Balasubramanian, S.C. (1995). Nutritive Value of Indian Foods. NIN, Indian Council of Medical Research, Hyderabad. 47-58.

[11]. Hulme, A.C. and Narain, R. (193)1. The ferricyanide method for determination of reducing sugars. A modification Hagedom Jensen Hones technique. Biochemical Journal, 25: 1051-1061.

[12]. Jood, S. and Kapoor, A.C. (1992). Effect of storage and insect infestation on protein and starch digestibility of cereal grains. Food Chemistry, 44: 209-219.

[13]. Kadam, S.S., Ghorpade, V.M., Adsule, R.N. and Salunkhe, D.K. (1986). Trypsin inhibitor in moth beans; thermal stability and changes during germination and cooking. Plant Foods for Human Nutrition, 36: 43-46.

[14]. Katiyar, S. and Katiyar, R. (2018). Quality characteristics of blended wheat flour with bajra, chickpea, soybean and maize flours. Food Science Research Journal, 9 (1): 156-162.

[15]. Kelkar, M., Shastri, P. and Tao, B.Y. (1996). Effect of processing on in vitro carbohydrates digestibility of cereals and legumes. Journal of Food Science and Technology, 33(6): 493-497.

[16]. Khetarpaul, N., Garg, R. and Goyal, R. (2004a). Improvement in cooking quality of soybean (Glycine max) by presoaking treatment with enzyme (lipase) solution. Nutrition and Food Science, 34 (1): 8-12.

[17]. Khetarpaul, N., Grewal, R., Goyal, R. and Garg, R. (2004b). Influence of amylase enzyme soaking on cooking time and organoleptic scores of soy dhal. Forage Research, 29(4): 219-221.

[18]. Khetarpaul, N., Grewal, R.B., Goyal, R. and Garg, R. (2004c). Development of partially defattd soyflour and dhal. Food Chemistry, 87 (3): 355-359.

[19]. Khetarpaul, N., Goyal, R. and Garg, R. (2005). Effect of salt solution pretreatment on the cooking quality and consumer acceptability of soy dhal. British Food Journal, 107(5): 344-352.

[20]. Khetarpaul, N. and Goyal, R. (2008). Development, nutritional and sensory attributes of nutritious bread prepared using combination of wheat, soy and rice. Acta Alimentaria, 37(2): 147-57.

[21]. Khetarpaul, N. and Goyal, R. (2009). Effect of composite flour fortification to wheat flour on quality characteristics of unleavened bread. British Food Journal, 111(6): 554- 564.

[22]. Mertz, E.T., Kirleiz, A.W. and Axtell, J.D. (1983). In vitro protein digestibility of proteins in major food cereals. Fedreation Proceedings, 42: 6026-6031.

[23]. Omoikhoje,S.O., Aruna,M.B. and Bamgbose, A.M. (2009). Effect of cooking time on some nutrient and antinutrients components of bambaragroundnut seeds. Animal Science Journal, 80(1): 52-56.

[24]. Panse, V.G. and Sukhatme, P.V. (1961). Statistical Methods of Agricultural Workers. 2nd Edn. Indian Council of Agricultural Research, New Delhi. 12:87.

[25]. Rawat, A. (1990). Nutritional and microbiological quality of soy fortified chapatis. M. Sc. (Food Techn.) Thesis. G.B. Pant University of Agriculture and Technology, Pantnagar, India.

[26]. Rawat, A., Singh, G., Mittal, B.K. and Mittal, S.K. (1994). Effect of soy fortification on quality characteristics of chapatis. Journal of Food Science and Technology, 31(2):114-116.

[27]. Raza, S., Kanwal, S., Naseem, K. and Bibi, A. (2014). Effect of substitution of wheat with maize on technological and organoleptic properties of chapattis. Asian Journal of Agriculture and Rural Development. 4(4): 292-296.

[28]. Reddy, N.R., Pierson, M.D., Sathe, S.K. and Salunkhe, D.K. (1985). Dry bean tannins: A review of nutritional implications. Journal of American Oil Chemical Society, 62:541-548.

[29]. Singh, U. and Jambunathan, R. (1981). Studies on desi and kabuli chickpea (Cicer arietinum) cultivars. Level of protease inhibitors, level of polyphenolic compounds and in vitro protein digestibility. Journal of Food Science, 46:1364-1367.

[30]. Singh, U., Khedekar, M.S. and Jambunathan, R. (1982). Studies on desi and kabuli chickpea cultivars. The level of amylase inhibitors, levels of oligosaccharides and in vitro starch digestibility. Journal of Food Science, 47:510.

[31]. Turab S.Z.S. (2017). Studies on production of partially defatted soybean flour and its utilization in Chapatti. M.Tech.Dissertation, Vasantrao Naik Marathwada Krishi Vidyapeeth, Prabhani, India.

[32]. Walker, A.F. and Kochhar, N. (1982). Effect of processing including domestic cooking on nutritional quality of legumes. Proceedings Nutrition Society, 41:41.