Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 1541-1546
Received: 10-06-2020
Accepted: 08-08-2020

Saroj Dahiya
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, India

Suman
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, India

Corresponding Author:
Saroj Dahiya
Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, India

Sensory and nutritional evaluation of chapatti prepared from composite flours of coarse cereals and tulsi

Saroj Dahiya and Suman

Abstract

In the present study six types of *chapattis* were prepared from composite flours of coarse cereals with and without *tulsi* leaves powder. The c*hapatti* prepared from composite flours of blanched pearl millet: sorghum: dehusked oat: germinated chickpea in ratios of 60:10:10:20 (Type-II) and blanched pearl millet: sorghum: dehusked oat: germinated chickpea: *tulsi* leaves in ratios of 60:10:10:15:5 (Type-V) were organoleptically most acceptable and fell in the category of 'liked moderately'. Nutritional value of c*hapatti* prepared from composite flours of coarse cereals with and without *tulsi* leaves was significantly higher than control wheat *chapatti*. The crude protein content of composite flour based *chapatti* (11.25%) followed by composite flour *tulsi chapatti* (11.18%) was significantly ($P<0.05$) higher as compared to control *chapatti* (8.42%). Composite flour based *chapatti* (3.27%) and composite flour *tulsi chapatti* (3.19%) had significantly ($P<0.05$) higher crude fat content as compared to control *chapatti* (1.64%). Supplementation of tulsi at 5% level further increased the nutritional value in respect of crude fibre, ash, total dietary fibre, soluble dietary fibre and insoluble dietary fibre, total and available minerals (calcium, iron and zinc), *in vitro* protein and starch digestibility and antioxidants activity (total phenolic content and DPPH free radical scavenging activity) of coarse cereals *chapatti*.

Keywords: Coarse cereals, *tulsi*, *chapatti*, nutritional, antioxidant

Introduction

The most common ancient grains that have the potential to be used more in Indian cooking as a replacement of wheat are pearl millet, finger millet, sorghum, amaranth, oat and barley. These grains are nutritionally comparable or even superior to major cereals such as wheat and rice owing to higher levels of protein with more balanced amino acid profile, dietary energy, vitamins, several minerals (especially micronutrients such as iron and zinc), dietary fiber and can be used to make the commonly eaten *rotis* and *chapattis*. Use of these grains may also allow individuals to make healthful dietary changes that align with cultural tradition, because Indians place particularly high value on traditional diets and may feel more comfortable modifying their traditional diets rather than adopting a new, more western diet altogether (Kalra *et al*., 2004) [21].

Pearl millet (*Pennisetum glaucum* L.) is the most drought-tolerant of all the domesticated cereals and is grown in regions where no other cereals can be grown. It is one of the important crops in semi-arid areas of India and it is known to be nutritionally better than most other cereals. It's a good source of dietary protein, carbohydrates, fat, vitamins and minerals. Pearl millet is an important source of some minerals particularly iron and zinc. It has high levels of lipids, high quality and well-balanced proteins (Elyas *et al*., 2002) [10] and diverse health promoting phenolic compounds. It has health promoting properties, particularly its antioxidant activity and its use as nutraceuticals and in functional foods (Dykes and Roony, 2006) [9].

Nutritional properties of sorghum (*Sorghum bicolor* L.) are more or less limited to major entities like carbohydrates, protein, fat and fiber. Polyphenols, fiber and phytates are considered as anti-nutritional factor earlier. But, with increasing knowledge about their health promoting attributes, these can now be considered as nutraceuticals, factors such as polyphenols add promising antioxidant capacity to sorghum and coupled with fiber content of the cereal indicates it's potential as functional food.

Oats (*Avena sativa* L.) another major millet crop of India is becoming more and more popular now a days as part of a functional food. While oats are suitable for human consumption as oatmeal and rolled oats, one of the most common uses as livestock feed. Oat protein is nearly equivalent in quality to soya protein which has been shown by the WHO (2003) [36] to be equal to meat, milk and egg protein. Additionally, oats are source of several natural antioxidants such as tocopherols, alkylresorcinols, and phenolic acids and their derivatives, and a unique source of avenanthramides (N-cinnamoylanthranilate alkaloids) and avenalumic acids (ethylenic homologues of cinnamic acids), which are not present in other cereal grains (Liu *et al*., 2004; Mattila *et al*., 2005) [24,26]. Moreover, β-glucans, which also exhibit an antioxidant capacity (Johansson *et al*., 2004) [18] are included in the soluble dietary fibre fractions of oats that participates in the glucoregulation and causes a decrease in serum cholesterol levels in humans.

Legumes have been considered as a major source of protein supply to the people of world. They contain 2 to 3 times more protein than cereals. Plant proteins are alternative to proteins from animal sources for human nutrition and so the legumes are recognized as the best source of vegetable protein (Molina *et al.,* 2002) [28]. They have shown numerous health benefits due to their dietary fibre content such as lower glycemic index for people with diabetes (Goni and Valentine-Gamazo, 2003) [13], increased satiation and cancer prevention as well as protection against cardiovascular diseases (Chillo *et al.,* 2008) [7].

Tulsi (*Ocimum sanctum* L.) has been used for thousands of years in Ayurveda for its diverse healing properties. The chemical composition of *Tulsi* is highly complex, containing many nutrients and other biologically active compounds. *Tulsi* also have antioxidant, anti-inflammatory, antibacterial, immune-enhancing properties and helpful for adapting to stress. *Tulsi* can be effective for diabetes treatment by reducing blood glucose levels and can also reduce significantly the total cholesterol levels, protection from radiation and cataracts, anti-hyperlipidemic and cardio-protective effects (Biswas and Biswas, 2005) [4].

Different approaches are needed to offer adults and children improved food with low-cost and locally available food formulations. To increase the consumption of millet, development of various value added products which are consumed as stable foods like chapatti serve good vehicle for carrying the added nutrient to the target population. Many functional foods are nowadays blending in composite flours and food products for improvement of the nutritive value of food and diet to avoid malnutrition and certain diseases. These products are not available in the market. Keeping this in view the present investigation was carried out to develop chapatti from coarse cereals and *tulsi* leaves powder.

Material and methods

Procurement of material

Seeds of pearl millet (HHB-272) were procured from bajra section, sorghum (HJ-513) and oat (HJ-8) from forage section, chickpea (HC-5) from pulses section and *Tulsi* leaves at optimum maturity level were procured in a single lot from Medicinal, Aromatic and Underutilized Plant Section, Department of Genetics and Plant Breeding, College of Agriculture, CCSHAU. All the seeds were cleaned and made free of dust, dirt and foreign material prior to primary processing. Raw materials were stored in clean and hygienic condition for further use.

Processing of grains

Pearl millet was blanched by the process of Chavan and Kachare (1994) [5]. The grains were subjected to boiling water (1:5 ratio of seeds to boiling water) for 30 seconds and dried at 50 °C for 60 minutes. Grains of oats were dehusked. Chickpea grains were soaked in tap water for 12 h at 37 °C. Seed to water ratio of 1:5 (W/V) was used. The unimbibed seeds were discarded. The soaked seeds were germinated in sterile petri dishes lined with wet filter paper for 48 h at 37 °C with frequent watering. The sprouts were rinsed in distilled water and dried at 50-55 °C. The *Tulsi* leaves (*Ocimum sanctum* L.) were trimmed in order to remove any dead or spoiled part. Then washed and dried at -50 °C temperature using freeze dryer. The dried unprocessed samples of sorghum, dehusked oat, germinated chickpea and blanched pearl millet were ground to fine powder in an electric grinder and then stored in plastic containers at room temperature (32 °C).

Standardization and development of *chapatti*

Six types of *chapattis* were developed using different types of composite flours of coarse cereals and *tulsi*. Three *chapattis* were prepared using composite flours of blanched pearl millet: sorghum: dehusked oat: germinated chickpea in ratios of 80:5:5:10 (Type-I), 60:10:10:20 (Type-II) and 40:15:15:30 (Type-III) (W/W) and three *chapattis* were prepared from composite flours of blanched pearl millet: sorghum: dehusked oat: germinated chickpea: *Tulsi* leaves in ratios of 80:5:5:5:5 (Type-IV), 60:10:10:15:5 (Type-V) and 40:15:15:25:5 (Type-VI) (W/W). Control *chapatti* was developed using wheat flour (100%).

Sensory evaluation of *chapatti*

The developed *chapattis* were subjected to sensory evaluation with respect to color, appearance, aroma, texture, taste and overall acceptability by a panel of 10 judges using the Nine-point Hedonic Rating Scale.

Nutritional evaluation of *chapatti*

The organoleptically most acceptable *chapattis* were oven dried at 55-60 °C to a constant weight, ground in an electric grinder (cyclotec, M/S Tecator, Hoganas, Sweden using 0.5 mm sieve size) to a fine powder, stored in air tight polythene sheets and were analyzed for nutritional composition. The moisture, crude protein, crude fat, ash and crude fibre in the samples were estimated by using standard (AOAC, 2012) [2] method. Dietary fibre contents were assessed as per the enzymatic method of Furda (1981) [11]. For total minerals, the samples were wet acid digested using diacid mixture (HNO_3: $HClO_4$:: 5:1, v/v). The total calcium, potassium, iron and zinc in acid digested samples were determined by atomic absorption spectrophotometer as per the method of Lindsey and Norwell (1969) [23] while phosphorus in acid digested samples was determined colorimetrically (Chen *et al.*, 1956) [6]. The available calcium and zinc were extracted by the method of Kim and Zemel (1986) [22] and available iron was extracted as per the procedure of Rao and Prabhavathi (1978) [31]. The *in vitro* protein digestibility was carried out by using the modified method of Mertz *et al.* (1983) [27] and phytic acid content by the method given by Davies and Reid (1979) [8].Total phenolic content was estimated as per Singleton and Rossi (1965) [34]. DPPH free radical scavenging activity was determined by the method of Hatano *et al.* (1988) [15].

Statistical analysis

The data were statistically analyzed in a completely randomized design using analysis of variance to test the significant differences among treatments (Sheoran and Pannu, 1999) [32].

Results and Discussion

The data presented in Table 1 indicated that wheat flour based control *chapatti* rated as 'liked very much' for all the organoleptic characteristics. Type II composite flours based

Chapatti had highest mean scores for overall acceptability as compared to Type I and Type III *chapatti*. Mean scores for overall acceptability of Type I, Type II and Type III composite flours based *chapatti* were in the category of 'liked moderately'. The mean scores for colour, appearance, aroma, texture, taste and overall acceptability of Type II *chapatti* were 7.9, 7.9, 7.8, 7.7, 7.8 and 7.82, respectively, which were higher than that of Type I *and* Type III *chapatti* with mean scores of 7.6, 7.6, 7.7, 7.7, 7.7 and 7.66 and 7.2, 7.1, 7.4, 7.4, 7.2 and 7.26, respectively. Among *tulsi* leaves powder supplemented composite flours based *chapattis*, Type V *chapatti* had highest mean scores i.e. 7.6, 7.6, 7.4, 7.8, 7.6 and 7.60 for colour, appearance, aroma, texture, taste and overall acceptability, respectively, whereas, mean scores for colour, appearance, aroma, texture, taste and overall acceptability were 7.3, 7.3, 7.3, 7.6, 7.3 and 7.36, respectively in Type IV and 7.0, 7.0, 6.9, 7.2, 6.8 and 6.98, respectively for Type VI *Chapatti*. *Tulsi* leaves powder supplemented Type IV and Type V composite flours based *chapatti* fell in the category of 'liked moderately', where as Type VI *chapatti* supplemented with *tulsi* leaves powder were in the category of 'Liked slightly' on the basis of overall acceptability. Anjum *et al.* (2006) [1] and Zadeh *et al*., (2008) [37] reported composite flour based *chapatti* were found acceptable by panel of judges. The results are in agreement with the study of Kadam *et al*. (2012) [20] reported an incorporation of up to 20 per cent chickpea flour and 5 per cent *methi* leaves powder in *chapatti* was organoleptically acceptable. *Chapatti* fell in category of 'liked moderately' when prepared in 20:40:40 ratio (sorghum: chickpea: wheat) ratio (Sikandra and Boora, 2009) [33]. Johari (2013) [19] developed *chapatti* using pearl millet, rice, bengal gram flour and amaranthus leaves powder in ratio of 60:20:20:5 were found to be organoleptically acceptable and fell in the category of 'liked very much'.

Table 1: Mean scores of organoleptic acceptability of *chapatti* based on composite flours

Level of supplementation	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Control (100% wheat flour)	8.2±0.15	8.1±0.18	8.1±0.09	8.3±0.22	8.1±0.17	8.16±0.16
Type I P:S:O:C::80:5:5:10	7.6±0.26	7.6±0.11	7.7±0.18	7.7±0.25	7.7±0.04	7.66±0.22
Type II P:S:O:C::60:10:10:20	7.9±0.13	7.9±0.08	7.8±0.16	7.7±0.15	7.8±0.11	7.82±0.11
Type III P:S:O:C::40:15:15:30	7.2±0.18	7.1±0.10	7.4±0.22	7.4±0.06	7.2±0.25	7.26±0.24
Type IV P:S:O:C:T::80:5:5:5:5	7.3±0.16	7.3±0.28	7.3±0.29	7.6±0.12	7.3±0.21	7.36±0.12
Type V P:S:O:C:T::60:10:10:15:5	7.6±0.21	7.6±0.12	7.4±0.22	7.8±0.10	7.6±0.24	7.60±0.18
Type VI P:S:O:C:T::40:15:15:25:5	7.0±0.29	7.0±0.15	6.9±0.25	7.2±0.11	6.8±0.23	6.98±0.26
CD ($P \leq 0.05$)	0.38	0.41	0.44	0.52	0.54	0.42

Values are mean ± SE of ten independent determinations
P: Pearl millet S: sorghum O: Oat
C: Chickpea T: Tulsi leaves powder

Data regarding the proximate composition of *chapatti* based on composite flours are given in Table 2. The moisture content of both types of composite flours based *chapatti* was higher than that of control *chapatti*. In control *chapatti*, it was 25.36 per cent, whereas, it was 27.41 per cent in composite flour based *chapatti* and 29.53 per cent in composite flour based *chapatti* supplemented with *tulsi*. The crude protein content of composite flour based *chapatti* (11.25%) followed by composite flour *tulsi chapatti* (11.18%) was significantly ($P<0.05$) higher as compared to control *chapatti* (8.42%). Composite flour based *chapatti* (3.27%) and composite flour *tulsi chapatti* (3.19%) had significantly ($P<0.05$) higher crude fat content as compared to control *chapatti* (1.64%). The ash content of composite flour based *chapatti* (3.21%) was significantly ($P<0.05$) higher as compared to control *chapatti* (1.13%). Supplementation of *tulsi* leaves powder further increased the ash content of composite flour based *chapatti* (3.58%). The control *chapatti* exhibited 1.25 per cent crude fibre which increased significantly ($P<0.05$) in both types of composite flours based *chapattis*. The crude fibre content of composite flour based *chapatti* was 1.85 per cent. Significantly ($P<0.05$) maximum amount of crude fibre was observed in composite flour based *chapatti* supplemented with *tulsi* leaves powder (2.26%). These results are in agreement with those reported by earlier workers in legume flour supplemented *chapatti* (Inam *et al*., 2010; Mundra *et al*., 2010 and Mamata *et al*., 2012) [17, 29, 25]. It was found that incorporation of *methi* leaves powder in composite flour (wheat flour, chickpea flour and soy flour) *chapatti* increased the crude fiber and ash content as reported by Kadam *et al.* (2012) [20].

Table 2: Proximate composition of *chapatti* based on composite flours (%, dry weight basis)

Types	Moisture	Crude protein	Crude fat	Ash	Crude fibre
Control (100% wheat flour)	25.36±0.02	8.42±0.14	1.64±0.11	1.13±0.02	1.25±0.04
Coarse cereals *chapatti* P:S:O:C::60:10:10:20	27.41±0.07	11.25±0.25	3.27±0.08	3.21±0.11	1.85±0.07
Coarse cereals tulsi *chapatti* P:S:O:C:T::60:10:10:15:5	29.53±0.05	11.18±0.08	3.19±0.04	3.58±0.05	2.26±0.03
CD ($P \leq 0.05$)	0.88	0.75	0.06	0.26	0.11

Values are mean ± SE of three independent determinations
P: Pearl millet S: sorghum O: Oat
C: Chickpea T: Tulsi leaves powder

The results regarding total dietary fibre, soluble dietary fibre and insoluble dietary fibre content of composite flours based *chapatti* are presented in Table 3. A significant difference was observed in total, soluble and insoluble dietary fibre content among all types of *chapatti*. Maximum amount of total dietary fibre was observed in *chapatti* supplemented with *tulsi* leaves powder (13.97 g/100g) and lowest amount in control *chapatti* (11.12 g/100g). Soluble dietary fibre content of composite flour based *chapatti* was 3.35 g/100g which further increased with the supplementation of *tulsi* leaves powder (3.67 g/100g). The insoluble dietary fibre content of composite flour based *chapatti* supplemented with *tulsi* leaves powder (10.30 g/100 g) was significantly ($P<0.05$) higher as compared to composite flour based *chapatti* (9.07g/100g and control (8.26 g/100g). Mundra *et al*. (2010) [29] reported also 12 per cent increase in total dietary fibre contents of whole bengal gram flour supplemented *chapatti*. Similar results were also observed by Hung and Nithianandan (1993) [16] and Goni and Valentin-Gamazo (2003) [13] who reported that total dietary fibre content in food products increased by three to five times when supplemented with chickpea flour.

Table 3: Dietary fibres content of *chapatti* based on composite flours (g/100g, dry matter basis)

Types	Total dietary fibre	Soluble dietary fibre	Insoluble dietary fibre
Control (100% wheat flour)	11.12±0.15	2.86±0.03	8.26±0.11
Coarse cereals *chapatti* P:S:O:C::60:10:10:20	12.42±0.21	3.35±0.13	9.07±0.09
Coarse cereals tulsi *chapatti* P:S:O:C:T::60:10:10:15:5	13.97±0.08	3.67±0.09	10.30±0.04
CD (*P*≤0.05)	0.76	0.23	0.74

Values are mean ± SE of three independent determinations
P: Pearl millet S: sorghum O: Oat
C: Chickpea T: Tulsi leaves powder

The results of total and available mineral content of composite flours based *chapatti* are presented in Table 4. The total calcium, iron and zinc content in control *chapatti* were 46.74, 3.63 and 1.48 mg/100g, respectively. Composite flour based *chapatti* had significantly (*P*<0.05) higher total calcium (82.47 mg/100g), iron (4.38 mg/100g) and zinc (2.64 mg/100g) content as compared to control *chapatti*. Supplementation of *tulsi* leaves powder further significantly (*P*<0.05) increased the total calcium (139.58 mg/100g), iron (7.11 mg/100g) and zinc (3.06 mg/100g) content of composite flour based *chapatti*. *Tulsi* leaves powder supplemented composite flour based *chapatti* had maximum amount of available calcium (58.86%), iron (27.81%) and zinc (52.86%) content as compared to control and composite flour based *chapatti.* The available calcium, iron and zinc content in composite flour based *chapatti* was 43.54, 26.12 and 46.62 per cent, respectively which was significantly higher as compared to control *chapatti* i.e. 57.32, 27.27 and 50.32 per cent, respectively.

Table 4: Total (mg/100g) and available mineral (%) content of *chapatti* based on composite flours (dry matter basis)

Types	Total Calcium	Available calcium	Total Iron	Available iron	Total Zinc	Available zinc
Control (100% wheat flour)	46.74.±1.21	43.54±0.56	3.63±0.06	26.12±0.08	1.48±0.03	46.62±0.34
Coarse cereals *chapatti* P:S:O:C::60:10:10:20	82.47±0.74	57.32±0.26	4.38±0.15	27.27±0.24	2.64±0.07	50.32±0.12
Coarse cereals tulsi *chapatti* P:S:O:C:T::60:10:10:15:5	139.58±1.05	58.86±0.52	7.11±0.14	27.81±0.16	3.06±0.02	52.86±0.33
CD (*P*≤0.05)	2.47	1.28	0.16	0.52	0.08	0.93

Values are mean ± SE of three independent determinations
P: Pearl millet S: sorghum O: Oat
C: Chickpea T: Tulsi leaves powder

The results of *in-vitro* protein, starch digestibility and phytic acid of composite flours based *chapatti* are presented in Table 5. Composite flour *chapatti* supplemented with *tulsi* leaves powder had significantly (*P*<0.05) higher *in vitro* protein digestibility (79.89%) as compared to control (76.24%) and composite flour *chapatti* (77.23%). The *In vitro* starch digestibility of composite flours based *chapatti* supplemented with *tulsi* leaves powder (36.46 mg maltose released/g) was significantly (*P*<0.05) higher as compared to control (34.43 mg maltose released/g) and composite flour *chapatti* (35.06 mg maltose released/g). The phytic acid content of control *chapatti* was 186.65 mg/100g which increased significantly (*P*<0.05) in composite flours *chapatti.* This may be due to the fact that pearl millet, sorghum and mung bean had higher content of phytic acid. However, blanching of pearl millet and germination of chickpea cause the significant reduction in phytic acid but wheat flour contained lowest amount of phytic acid and polyphenol as reported by Archana *et al*. (2000) [3] and Grewal and Jood (2006) [14]. A significantly lower amount of phytic acid content was observed in *tulsi* leaves powder supplemented *chapatti* (233.42 mg/100g) as compared to composite flour based *chapatti* (246.25 mg/100g). Drumstic leaves supplemented products had lower level of phytates as reported by Pant *et al.* (2012) [30].

Table 5: *In vitro* digestibility and anti-nutrient content of *chapatti* based on composite flours (dry matter basis)

Types	In *vitro* digestibility		Antinutrient
	Protein (%)	Starch (mg maltose released/g)	Phytic acid (mg/100g)
Control (100% wheat flour)	76.24±0.31	34.43±0.11	186.65±4.62
Coarse cereals *chapatti* P:S:O:C::60:10:10:20	77.23±0.09	35.06±0.24	246.25±2.53
Coarse cereals tulsi *chapatti* P:S:O:C:T::60:10:10:15:5	79.89±0.16	36.46±0.19	233.42±2.67
CD (P≤0.05)	1.87	0.74	13.56

Values are mean ± SE of three independent determinations
P: Pearl millet S: sorghum O: Oat
C: Chickpea T: Tulsi leaves powder

Data regarding antioxidant activity of composite flours based *chapatti* are depicted in Table 6. The composite flours based *chapattis* exhibited higher antioxidant activity as compared to control *chapatti*. Composite flour based *chapatti* had significantly ($P<0.05$) higher total phenolic content (10.66 mg GAE/g) and DPPH free radical scavenging activity (42.82%) as compared to those of control *chapatti* (1.83 mg GAE/g and 12.53%). Supplementation of *tulsi* leaves powder significantly ($P<0.05$) increased the total phenolic content (16.41 mg GAE/g) and DPPH free radical scavenging activity (47.14%) of composite flour based *chapatti*. This increase in antioxidant activity might be due to the high antioxidant activity of pearl millet, sorghum, oat, germinated chickpea and *tulsi* leaves powder. Control products contained lowest amount of total phenolic content and DPPH free radical scavenging activity. Gallegos-Infante *et al.* (2012) [12] also reported an improvement in antioxidant activity of semolina spaghetti after incorporation of bean flour. Enrichment of traditional food staple with natural food ingredients has enhanced the antioxidant content in food products Sridevi *et al.* (2010) [35].

Table 6: Antioxidant activity of *chapatti* based on composite flours (dry matter basis)

Types	Total phenolic content (mg GAE/g)	DPPH free radical scavenging activity (%)
Control (100% wheat flour)	1.83±0.04	12.53±0.11
Coarse cereals *chapatti* P:S:O:C::60:10:10:20	10.66±0.14	42.82±0.06
Coarse cereals tulsi *chapatti* P:S:O:C:T::60:10:10:15:5	16.41±0.22	47.14±0.16
CD (P≤0.05)	0.47	0.83

Values are mean ± SE of three independent determinations
P: Pearl millet S: sorghum O: Oat
C: Chickpea T: Tulsi leaves powder

Summary and Conclusion

It may be concluded from the present study that *chapatti* prepared from composite flours of coarse cereals were superior in terms of nutritional value. Supplementation of *tulsi* leaves powder at 5 per cent level further enhanced the nutritive value of coarse cereals *chapatti*. Thus, consumption of such foods in daily diet not only offers unique nutritional value but may also have therapeutic properties.

Acknowledgement

Authors highly acknowledge Indian Council of Agricultural Research for providing financial support under Emeritus Scientist Scheme for this research work.

References

1. Anjum FM, Khan MI, Butt MS, Hussain S, Abrar M. Functional properties of soy hulls supplemented wheat flour. Nutrition & Food Science. 2006; 36(2):82-89.
2. AOAC. Official Methods of Analysis, 19th edition. Association of the Official Analytical Chemists, Washington D.C, USA, 2012.
3. Archana, Sehgal S, Kawatra A. *In vitro* protein and starch digestibility of pearl millet (*Pennisetum glacum* L.) as affected by processing techniques. Diet Nahrung. 2010; 45(1):25-27.
4. Biswas NP, Biswas AK. Evaluation of some leaf dusts as grain protectant against rice weevil *Sitophilus oryzae* (Linn.). Environment & Ecology. 2005; 23:485-488.
5. Chavan JK, Kachare DP. Effect of seed treatment on lipolytic deterioration of pearl millet flour during storage. Journal of Food Science and Technology. 1994; 31(1):80-81.
6. Chen PS, Tosibara TY, Warner H. Micro determination of phosphorus. Annals of Chemistry. 1956; 28:1756-1759.
7. Chillo S, Laverse J, Falcone PM, Protopapa A, Del N. Influence of the addition of buckwheat flour and durum wheat bran on spaghetti quality. Journal of Cereal Science. 2008; 47(2):144-152.
8. Davies NT, Reid H. An evaluation of phytates, zinc, copper, iron and magnesium content and availability of soya based textured vegetable, protein meat substitute or meat extruders. British Journal of Nutrition. 1979; 41:579-589.
9. Dykes L, Rooney LW. Sorghum and millet phenols and antioxidants. Journal of Cereal Science. 2006; 44:236-251.
10. Elyas SHA, Tinay E, Yousif AH, Elsheikh EAE. Effect of natural fermentation on nutritive value and *in vitro* protein digestibility of pearl millet. Food Chemistry. 2002; 78(1):75-79.
11. Furda I. Simultaneous analysis of soluble and insoluble dietary fibre. The Analysis of Dietary Fibre in Food (Eds. WPT. James and O. Theander), Marcel Dekker, New York. 1981, 163-172.
12. Gallegos-Infante JA, Rivas MG, Chang S, Manthey F, Yao RF, Reynoso-Camacho R *et al*. Effect of the addition of common bean flour on the cooking quality and antioxidant characteristics of spaghetti. Journal of Microbiology, Biotechnology & Food Science. 2012; 2(2):730-744.
13. Goni I, Valentin-Gamazo C. Chickpea flour ingredient slows glycemic response to pasta in healthy volunteers. Food Chemistry. 2003; 81(4):511-515.
14. Grewal A, Jood S. Chemical composition and digestibility (*in vitro*) of green gram as affected by processing and cooking methods. British Food Journal 2009; 3:235-242.
15. Hatano T, Kagawa H, Yasuhara T, Okuda T. Two new flavonoids and other constitutes in licorice root; their relative astringency and radical scavenging effects. Chemical Pharma Bulletin. 1988; 36:2090-2097.
16. Hung T, Nithianandan V. Preparation and evaluation of noodles supplemented with chickpea and lupin flours. Asian Food Journal. 1993; 8:26-31.
17. Inam AKMS, Haque MA, Shams-Ud-Din M, Easdani M. Effects of chickpea husk on the baking properties of chapattis. Journal Bangladesh Agricultural University. 2010; 8(2):297-304.

18. Johansson L, Tuomainene P, Ylinen M, Ekholm P, Virkki L. Structural analysis of water-soluble and -insoluble β-glucans of whole-grain oats and barley. Carbohydrate Polymers. 2004; 58:267-274.
19. Johari A. Development of pearl millet and rice based gluten free food products. M. Sc. Thesis. CCS Haryana Agricultural University, Hisar, India, 2013.
20. Kadam ML, Salve RV, Mehrajfatema ZM, More SG. Development and evaluation of composite flour for *missi roti /chapatti*. Journal of Food Processing & Technology. 2012; 3:134.
21. Kalra P, Srinivasan S, Ivey S, Greenlund K. Knowledge and practice: the risk of cardiovascular disease among Asian Indians. Results from focus groups conducted in Asian Indian communities in Northern California. Ethnicity & Disease. 2004; 14(4):497-504.
22. Kim H, Zemel MB. *In vitro* estimation of potential bioavailability of calcium for sea mustard, milk and spinach under stimulate normal and reduce gastric condition. Journal of Food Science. 1986; 51:957-963.
23. Lindsey WL, Norwell MA. A new DPTA-TEA Soil test for zinc and iron. Agronomy Abstract. 1969; 61:84-89.
24. Liu L, Zubik L, Collins W, Marko M, Meydani M. The anti-atherogenic potential of oat phenolic compounds. Atherosclerosis. 2004; 175:39-49.
25. Mamata M, Kamal GN, Chandru R, Vijayalakshmi KG. Processing and utilization of legume seed coat fibre for functional food formulations. International Journal of Food Science Technology & Nutrition. 2012; 6(1):78-98.
26. Mattila P, Pihlava JM, Hellstrom J. Contents of phenolic acids, alkyl and alkenylresorcinols, and avenanthramides in commercial grain products. Journal of Agricultural and Food Chemistry. 2005; 53:8290-8295.
27. Mertz ET, Kirleis AW, Aretell JD. *In vitro* digestibility of protein in major food cereals. Federation proceedings. 1983; 42(5):6026-6028.
28. Molina E, Defaye AB, Ledward DA. Soy protein pressure-induced gels. Food Hydrocolloids. 2002; 16:625-632.
29. Mundra A, Nirmala BY, Kasturiba B. Designing of low glycaemic *chapati* of dicoccum wheat for the effective management of diabetes. Karnataka Journal of Agricultural Science. 2010; 23(3):476-479.
30. Pant R, Chawla P, Sadana B, Kushwaha S. Development and nutritional evaluation of cereal pulse based snacks using drumstick leaves. Journal Research Punjab Agricultural University. 2012; 49(2):99-103.
31. Rao BSN, Prabhavathi T. An *in vitro* method of predicting the bioavailability of iron from Food. American Journal of Clinical Nutrition. 1978; 31:169.
32. Sheoran OP, Pannu RS. Statistical software package for agricultural research workers in recent advances in information theory, Statistics and Computer application. (Eds. DS. Hooda and RC. Hasija), 1999, 139-143.
33. Sikandra, Boora P. Nutritional evaluation of sorghum and chickpea incorporated value added products. Journal of Dairying, Foods & Home Science 2009; 28(3, 4):181-185
34. Singleton VL, Rossi JA. Calorimetry of total phenols with phosphomolybdic phasphotungstic acid reagents. American Journal of Ecology Viticulture. 1965; 16:144-158.
35. Sridevi N, Yenagi B, Basavaraj RR, Basarkar PW. Studies on antioxidants content of cooked and enriched foods of North Karnataka. Journal of Dairying, Foods & Home Science. 2010; 29(3):204-209.
36. WHO. Diet nutrition and the prevention of chronic disease. WHO Technical Report Series. 2003; 2(4):206-212.
37. Zadeh SS, Jabeen IT, Khyrunnisa B. Incorporation of fibre from plant waste material in traditional preparations. Proceedings IFCON, 2008.