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

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Abstract
In the present study six types of chapattis were prepared from composite flours of coarse cereals with and without tulsi leaves powder. The chapatti prepared from composite flours of 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 chapatti 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) [22].

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) [19] 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) [4]. 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 its 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) [38] 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 participate 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 (Biswa and Biswa, 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 processing. Raw materials were stored in clean and hygienic condition free of dust, dirt and foreign material prior to primary processing. Raw materials were stored in clean and hygienic condition for further use.

**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, CCS HAU. 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 Tectar, 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 (HNO₃: HClO₄:: 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 and 6.66 and 7.2, 7.1, 7.4, 7.4, 7.2 and 7.26, respectively. Among tulsi leaves powder supplemented composite flours based chapatti, Type V chapatti had highest mean scores i.e. 7.6, 7.6, 7.4, 7.8 and 7.60 for colour, appearance, aroma, texture and 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 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’, whereas 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) (11) 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

<table>
<thead>
<tr>
<th>Level of supplementation</th>
<th>Colour</th>
<th>Appearance</th>
<th>Aroma</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (100% wheat flour)</td>
<td>8.2±0.15</td>
<td>8.1±0.18</td>
<td>8.1±0.09</td>
<td>8.3±0.22</td>
<td>8.1±0.17</td>
<td>8.1±0.20</td>
</tr>
<tr>
<td>Type I P:S:O:C:T::40:15:15:25:5</td>
<td>7.6±0.26</td>
<td>7.6±0.11</td>
<td>7.7±0.20</td>
<td>7.7±0.25</td>
<td>7.5±0.07</td>
<td>7.6±0.22</td>
</tr>
<tr>
<td>Type II P:S:O:C:T::60:10:10:15:5</td>
<td>7.9±0.13</td>
<td>7.9±0.08</td>
<td>7.8±0.16</td>
<td>7.7±0.15</td>
<td>7.8±0.11</td>
<td>7.8±0.11</td>
</tr>
<tr>
<td>Type III P:S:O:C:T::40:15:15:30</td>
<td>7.2±0.18</td>
<td>7.1±0.10</td>
<td>7.4±0.22</td>
<td>7.4±0.06</td>
<td>7.2±0.25</td>
<td>7.2±0.24</td>
</tr>
<tr>
<td>Type IV P:S:O:C:T::80:5:5:5:5</td>
<td>7.3±0.16</td>
<td>7.3±0.28</td>
<td>7.3±0.29</td>
<td>7.6±0.12</td>
<td>7.3±0.21</td>
<td>7.3±0.12</td>
</tr>
<tr>
<td>Type V P:S:O:C:T::60:10:10:15:5</td>
<td>7.6±0.21</td>
<td>7.6±0.12</td>
<td>7.4±0.22</td>
<td>7.8±0.10</td>
<td>7.6±0.24</td>
<td>7.6±0.18</td>
</tr>
<tr>
<td>Type VI P:S:O:C:T::40:15:15:25:5</td>
<td>7.0±0.29</td>
<td>7.0±0.15</td>
<td>6.9±0.25</td>
<td>7.2±0.11</td>
<td>6.8±0.23</td>
<td>6.9±0.26</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>0.38</td>
<td>0.41</td>
<td>0.44</td>
<td>0.52</td>
<td>0.54</td>
<td>0.42</td>
</tr>
</tbody>
</table>

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, 20, 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)

<table>
<thead>
<tr>
<th>Types</th>
<th>Moisture</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Ash</th>
<th>Crude fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (100% wheat flour)</td>
<td>25.36±0.02</td>
<td>8.42±0.14</td>
<td>1.64±0.11</td>
<td>1.13±0.02</td>
<td>1.25±0.04</td>
</tr>
<tr>
<td>Coarse cereals chapatti P:S:O:C:T::60:10:10:20</td>
<td>27.4±0.07</td>
<td>11.25±0.05</td>
<td>3.27±0.08</td>
<td>3.21±0.11</td>
<td>1.85±0.07</td>
</tr>
<tr>
<td>Coarse cereals tulsi chapatti P:S:O:C:T::60:10:10:15:5</td>
<td>29.5±0.05</td>
<td>11.18±0.08</td>
<td>3.19±0.04</td>
<td>3.58±0.05</td>
<td>2.26±0.03</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>0.88</td>
<td>0.75</td>
<td>0.06</td>
<td>0.26</td>
<td>0.11</td>
</tr>
</tbody>
</table>

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) 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) and Goni and Valentin-Gamazo (2003) 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)

<table>
<thead>
<tr>
<th>Types</th>
<th>Total dietary fibre</th>
<th>Soluble dietary fibre</th>
<th>Insoluble dietary fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (100% wheat flour)</td>
<td>11.12±0.15</td>
<td>2.86±0.03</td>
<td>8.26±0.11</td>
</tr>
<tr>
<td>Coarse cereals chapatti P:S:O:C::60:10:10:20</td>
<td>12.42±0.21</td>
<td>3.35±0.13</td>
<td>9.07±0.09</td>
</tr>
<tr>
<td>Coarse cereals tulsi chapatti P:S:O:C:T::60:10:10:15:5</td>
<td>13.97±0.08</td>
<td>3.67±0.09</td>
<td>10.30±0.04</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>0.76</td>
<td>0.23</td>
<td>0.74</td>
</tr>
</tbody>
</table>

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 were 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)

<table>
<thead>
<tr>
<th>Types</th>
<th>Total Calcium</th>
<th>Available calcium</th>
<th>Total Iron</th>
<th>Available iron</th>
<th>Total Zinc</th>
<th>Available zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (100% wheat flour)</td>
<td>46.74±1.21</td>
<td>43.5±0.56</td>
<td>3.63±0.06</td>
<td>26.12±0.08</td>
<td>1.48±0.03</td>
<td>46.62±0.34</td>
</tr>
<tr>
<td>Coarse cereals chapatti P:S:O:C::60:10:10:20</td>
<td>82.47±0.74</td>
<td>57.3±0.26</td>
<td>4.38±0.15</td>
<td>27.27±0.24</td>
<td>2.64±0.07</td>
<td>50.32±0.12</td>
</tr>
<tr>
<td>Coarse cereals tulsi chapatti P:S:O:C:T::60:10:10:15:5</td>
<td>139.58±1.05</td>
<td>58.86±0.52</td>
<td>7.11±0.14</td>
<td>27.81±0.16</td>
<td>3.06±0.02</td>
<td>52.86±0.33</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>2.47</td>
<td>1.28</td>
<td>0.16</td>
<td>0.52</td>
<td>0.08</td>
<td>0.93</td>
</tr>
</tbody>
</table>

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) and Grewal and Jood (2006). 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).

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

<table>
<thead>
<tr>
<th>Types</th>
<th>In vitro digestibility</th>
<th>Antinutrient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protein (%)</td>
<td>Starch (mg maltose released/g)</td>
</tr>
<tr>
<td>Control (100% wheat flour)</td>
<td>76.24±0.31</td>
<td>34.43±0.11</td>
</tr>
<tr>
<td>Coarse cereals chapatti P:S:O:C::60:10:10:20</td>
<td>77.23±0.09</td>
<td>35.06±0.24</td>
</tr>
<tr>
<td>Coarse cereals tulsi chapatti P:S:O:C:T::60:10:10:15:5</td>
<td>79.89±0.16</td>
<td>36.46±0.19</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>1.87</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Values are mean ± SE of three independent determinations

P: Pearl millet  S: sorghum  O: Oat  C: Chickpea  T: Tulsi leaves powder

“1544”
Data regarding antioxidant activity of composite flours based on chickpea are depicted in Table 6. The composite flours based on chickpea exhibited higher antioxidant activity as compared to control. Composite flour based on chickpea had significantly higher total phenolic content (10.66 mg GAE/g) and DPPH free radical scavenging activity (4.82%) as compared to those of control (1.83 mg GAE/g and 12.53%). Supplementation of tulsi leaves powder significantly increased the total phenolic content (16.41 mg GAE/g) and DPPH free radical scavenging activity (47.14%) of composite flour based on chickpea. 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) 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).

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

<table>
<thead>
<tr>
<th>Types</th>
<th>Total phenolic content (mg GAE/g)</th>
<th>DPPH free radical scavenging activity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (100% wheat flour)</td>
<td>1.83±0.04</td>
<td>12.53±0.11</td>
</tr>
<tr>
<td>Coarse cereals chickpea</td>
<td>10.66±0.14</td>
<td>42.82±0.06</td>
</tr>
<tr>
<td>P:S:O:C::60:10:10:20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse cereals tulsi chickpea</td>
<td>16.41±0.22</td>
<td>47.14±0.16</td>
</tr>
<tr>
<td>P:S:O:C:T::60:10:10:15:5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>0.47</td>
<td>0.83</td>
</tr>
</tbody>
</table>

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 chickpea prepared from composite flours of coarse cereals were superior in terms of nutritional value. Supplementation of tulsi leaves powder at 5% level further enhanced the nutritive value of coarse cereals on chickpea. Thus, consumption of such foods in daily diet not only offers unique nutritional value but may also have therapeutic properties.

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**References**


