Physico-chemical properties of pseudo-cereals (Amaranth and buckwheat)

Sangeeta and RB Grewal

Abstract
Physico-chemical properties of pseudo-cereals (amaranth and buckwheat) were studied. The pseudo-cereals were analyzed for 1000 kernel weight, bulk density, hydration capacity, hydration index, swelling capacity and swelling index. Flour samples from amaranth and buckwheat were analyzed for moisture, crude fat, crude protein, crude fibre, ash, and total carbohydrates. It was revealed that seed size of amaranth was much smaller than buckwheat. Protein and fat content of amaranth was higher than buckwheat whereas, buckwheat was found to be rich in crude fibre content.

Keywords: Physico-chemical, pseudo-cereals, amaranth, buckwheat

Introduction
The pseudo-cereals have attracted much interest in recent years. One of the reasons for this renewed interest is their excellent nutrient profile. In addition to being one of the important energy sources due to their starch content, these pseudo-cereals provide good quality protein and lipids rich in unsaturated fats. Amaranth, a major pseudo-cereal, is an ancient plant belonging to family amaranthaceae, which is believed to have originated from central and southern America. Owing to their significant starch, protein and lipid content, amaranth seeds can be considered promising raw material for the production of flour, starch and protein. Amaranth contain 62% starch, 17% protein (Silva-Sanchej et al., 2008) [36], 9-16% dietary fiber (Pederson, 1987) [27] and good source of vitamin B and minerals (Gamel et al., 2006) [15]. Buckwheat (Fagopyrum esculentum) commonly known as “kutty” is a non-glutinous pseudo-cereal belonging to the family polygonaceae. The triangular shaped seeds make it similar to a beech nut therefore, the name is may be modification of “beech wheat” (Singh and Atal, 1982) [34]. It contains 67-75% starch, 7-21% protein, 1.2-4.3% lipids, and appreciable amount of dietary fiber and minerals (Przybylski and Gruczynska, 2009) [28]. The present study was carried out to examine the physical properties and chemical composition of amaranth and buckwheat in order to identify their potential application as food ingredients.

Material and methods
The experiment was conducted at Choudhary Charan Singh Haryana Agricultural University, Hisar during 2015-2016. Amaranth seeds were procured from the Department of Plant Breeding, CCSHAU, Hisar. Buckwheat seeds were procured from Regional Research Centre, Sangla, Himachal Pradesh Krishi Visavavidyalaya, Palampur, Himachal Pradesh. Pseudo-cereals were cleaned for extraneous matter and flour was prepared by milling in Brabender Quardamat Junior Mill.

Evaluation of grains
Grains of amaranth and buckwheat were assessed for 1000 kernel weight, bulk density, hydration capacity, hydration index, swelling capacity and swelling index.

Thousand Kernel Weight
Thousand grains were counted thrice and weighed. Thousand grain weight expressed as the weight in g per thousand grains.

Bulk Density
Grains were filled in 50 ml measuring cylinder up to 25 ml. The bottom of the cylinder was
tapped gently on a laboratory bench to fill grains properly. Grains were weighed. Bulk density was calculated by dividing weight of sample to volume and expressed as g/ml.

**Hydration Capacity and hydration index**

Seeds weighing 10 g were counted and transferred to a measuring cylinder. To this 50 ml water was added and cylinder was covered with aluminum foil. Seeds were drained, superfluous water removed with filter paper and swollen seeds were reweighed. Hydration capacity and hydration index was calculated using the following formula:

\[
\text{Hydration capacity (\%)} = \frac{\text{Weight after soaking} - \text{Weight before soaking}}{\text{Weight of seeds}} \times 100
\]

Weight after soaking – Weight before soaking

\[
\text{Hydration index} = \frac{\text{Hydration capacity per seed}}{\text{Weight of one seed}}
\]

Swelling capacity and swelling index

Seeds weighing 10 gm were counted, transferred to a measuring cylinder and their volume was recorded. To this 50 ml water was added and cylinder was covered with aluminum foil and left overnight at room temperature. The seeds were drained, superfluous water was removed with filter paper and swollen seeds were reweighed. Swelling capacity and swelling index was calculated using the following formula:

\[
\text{Swelling capacity per seed} = \frac{\text{Volume after soaking} - \text{Volume before soaking}}{\text{Weight of one seed}} \times 100
\]

Volume after soaking – Volume before soaking

\[
\text{Swelling index} = \frac{\text{Swelling capacity per seed}}{\text{Seed volume (ml)}}
\]

**Chemical evaluation**

Flour samples from HQPM varieties were analyzed for moisture, crude fat, crude protein, crude fibre, ash, and total carbohydrates using standard methods of AOAC (1995) [3].

**Results and Discussion**

**Table 1: Physical properties of pseudo-cereals**

<table>
<thead>
<tr>
<th>Sample</th>
<th>1000 kernel weight (g)</th>
<th>Bulk density (g/ml)</th>
<th>Hydration index</th>
<th>Swelling index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudo-cereals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amaranth</td>
<td>0.51±0.003</td>
<td>0.64±0.00</td>
<td>0.80±0.003</td>
<td>0.63±0.003</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>23.73±0.11</td>
<td>0.69±0.00</td>
<td>0.57±0.003</td>
<td>0.96±0.003</td>
</tr>
</tbody>
</table>

Thousand kernel weight of amaranth (0.51 g) recorded in the present study was within the range of weight (0.46 – 0.70 g/1000grains) observed for 11 lines of *amaranthus caudatus* by Kaur et al., (2010) [19] and lower than the value (0.55 – 1.04 g) reported by Gimlinger et al., (2007) [14]. Thousand kernel weight of buckwheat grains was 23.73 g (Table 1) was comparable with the weight/1000grains (23.92 g) observed by Pandey et al., (2015) [26] and higher than the range (1.60-2.19 g/100 seeds) reported by Kumari and Raghuwanshi (2015) [23]. Variation in 1000 kernel weight of different grains of pseudo-cereals may be attributed to varietal characteristic which is influenced by the size of the grains (Cheik et al., 2006) [11] and moisture content of grains (Balasubramanian et al., 2010) [5]. Bulk density of amaranth seeds (0.66 g/ml) observed in present study was lower than the values (720–840 kg/m³) reported by Abalone et al., (2004) [1]. Bulk density of buckwheat was recorded as 0.69 g/ml and was in the range of values (0.48-0.73 g/ml) reported by Kumari and Raghuwanshi (2015) [23] and lower than the value (768 kg/m³) observed by Pandey et al., (2015) [26]. Variation in bulk density of amaranth and buckwheat may be attributed to the variety, moisture content, seed size and contamination level. Hydration index and swelling index of amaranth (0.80 and 0.63, respectively) and of buckwheat (0.57 and 0.96, respectively) depicted in Table 1 was higher than the value recorded for amaranth (Shyam and Raghuvanshi, 2015) [30] and for buckwheat (Kumari and Raghuwanshi, 2015) [23]. The difference observed for hydration index and swelling index of amaranth and buckwheat may be due to difference in variety, seed size, seed coat permeability, hydrophilic constituent and genetic endowment (Kumar, 2012) [22].

**Chemical composition**

**Table 2: Chemical composition of pseudo-cereals**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture (%)</th>
<th>Crude protein (%)</th>
<th>Crude fat (%)</th>
<th>Crude fibre (%)</th>
<th>Ash (%)</th>
<th>Total carbohydrates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudo-cereals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amaranth</td>
<td>9.32±0.05</td>
<td>15.96±0.27</td>
<td>5.75±0.17</td>
<td>3.72±0.03</td>
<td>2.42±0.01</td>
<td>72.14±0.43</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>11.31±0.14</td>
<td>10.66±0.00</td>
<td>2.47±0.14</td>
<td>12.86±0.14</td>
<td>1.99±0.00</td>
<td>72.00±0.24</td>
</tr>
</tbody>
</table>

 Moisture content of amaranth (9.32%) was comparable with the value (9.75%) reported by Sindhu and Khatkar, (2016) [32] and higher than the value reported by Tanimola et al. (2016) [39]. Mendoza and Bressani (1987) [25] reported higher moisture content of amaranth varieties (10.3-10.6%) than the value reported in present study. Moisture content of buckwheat grain was 11.31%. Baljeet et al., (2010) [6] and Demin et al., (2013) [12] also found 11.60 and 10.59% moisture in buckwheat, respectively which was comparable with the value of moisture percent observed in present study.

However, Pandey et al., (2015) [26] reported lower moisture content of buckwheat.

Amaranth and buckwheat contained 15.96 and 10.66% protein, respectively. Protein content observed in present study was in the range of the values (15.33-18.19%, 6.6-19.8% and 15.22-18.55%) observed by Becker et al.,(1981) [8]; Kaur et al., (2010) [19] and Gimlinger et al., (2007) [14], respectively for different amaranth varieties of amaranth and the values (6.51-11.47%) observed by Ikeda et al., (2004) [16] for buckwheat species. Values for protein content in amaranth...
(Babor et al., 1994 and Souci et al., 2000) [4, 35] and buckwheat (Souci et al., 2000) [33] were similar to the values found in the present study. Lower protein content in amaranth (Menegassi et al., 2011; Chauhan and Singh, 2013; Shevkani et al., 2014; Sindhu and Khatak, 2016 and Tanimola et al., 2016) [24, 10, 29, 32, 39] and in buckwheat (Baljeet et al., 2010 and Batham et al., 2013) [6, 7] have been reported. Alvarez-Jubete et al., (2009) [2] observed higher value of protein in amaranth and Wronkowska and Smietana (2008) [38]; Inglett et al., (2009) [17]; Demin et al., (2013) [12]; Khan et al., (2013) [20]; Vojtiskova et al., (2014) [37]; Pandey et al., (2015) [26]; and Deng et al., (2015) [13] and Sindhu and Khatak (2016) [31] observed higher protein content in buckwheat than the value of protein observed in present study.


Amaranth and buckwheat contained 3.72 and 12.86% crude fibre, respectively (Table 2). Comparable range of crude fibre (3.23-5.84 and 3.54-4.22%) in amaranth (Becker et al., 1981 and Gimplinger et al., 2007, respectively) [8, 14] and (10.9 and 14.24%) in buckwheat (Inglett et al., 2009 and Pandey et al., 2015, respectively) [17, 26] has been reported. Chauhan and Singh (2013) [10] and Sindhu and Khatak (2016) [12] observed higher (4.40 and 5.37%), respectively whereas, Kaur et al., (2010) [19] observed lower (0.30-1.5%) value for crude fibre in Amaranthus hypochondriacus lines than the value of crude fibre content observed in present study. Sindhu and Khatak, (2016) [10, 33], Demin et al., (2013) [12]; Khan et al., (2013) [20] and Baljeet et al., (2010) [6] also reported lower crude fibre content in buckwheat than found in buckwheat.

Ash content of amaranth and buckwheat was 2.42 and 1.99%, respectively, which was comparable with the values of ash content in amaranth (Kaur et al., 2010) [19] and buckwheat (Alvarez-Jubete et al., 2010 [3]; Inglett et al., 2009 [17] and Sindhu and Khatak, 2016) [33]. Babor et al.,(1994) [4]; Gimplinger et al., (2007) [14]; Alvarez-Jubete et al., (2010) [2]; Shevkani et al., (2014) [29] and Kachiguma et al., (2015) [18] observed higher (2.96, 2.71-3.23, 2.80, 3.0-3.5 and 4.41-8.73%), respectively ash content in amaranth whereas, Wronkowska and Smietana (2008) [38]; Demin et al., (2013) [12]; Deng et al. (2015) [13]; Pandey et al., (2015) [20] and Sindhu and Khatak (2016) [31] reported higher (2.42, 2.12, 2.53, 2.18 and 2.81%, respectively) ash content in buckwheat than the ash content observed for amaranth and buckwheat in present study. Tanimola et al., (2016) [39] observed lower (1.87%) ash content in amaranth and Souci et al., (2000) [38]; Baljeet et al., (2010) [6]; Batham et al., (2013) [10] and Khan et al., (2013) [20] observed lower (1.59, 1.42, 1.56 and 1.14-1.62%, respectively) ash content in buckwheat than the value found in the present study.

Amaranth and buckwheat contained 72.14 and 72.00% carbohydrates, respectively (Table 2). Similar values were reported by Gimplinger et al., (2007) [14] for three genotypes of amaranth. Tanimola et al., (2016) [39] also reported similar value for carbohydrates content. Koziol (1992) [21] reported lower (70.3%) whereas, Shevkani et al., (2014) [20] reported higher (73.7-76.4%) value of carbohydrates in amaranth as compared to observed in present study. Baljeet et al., (2010) [6] and Inglett et al., (2009) [17] reported 75.74% and 73.3% carbohydrates, respectively in buckwheat which were higher than the value of carbohydrate content observed in the present study.

Slight variation in the value of carbohydrates, proteins, lipids, fibre and ash in present study may be due to differences in the varieties of grains of pseudo-cereals analyzed and also due to difference in the climatic conditions and cultural practices (Koziol, 1992 and Bressani, 1994) [21, 9].

**Conclusion**

The present investigation, it was revealed that seed size of amaranth was much smaller than buckwheat. Protein and fat content of amaranth was higher than buckwheat whereas, buckwheat was found to be rich in crude fibre content.

**Acknowledgement**

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**References**

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