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Physicochemical and Functional Characteristics of Desi and Kabuli Chickpea (*Cicer arietinum* L.) Cultivars Grown in Bodity, Ethiopia and Sensory Evaluation of Boiled and Roasted Products Prepared Using Chickpea Varieties

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Abstract

Physiochemical and functional properties of two desi and one kabuli chickpea cultivars grown in Bodity, Ethiopia were evaluated and sensory quality of the boiled and roasted products were investigated. Significant differences were found among the cultivars in the parameters analyzed except in case of oil absorption and foaming capacity. Results revealed that Habru (kabuli) had the highest amount of protein, zinc, iron, and phosphorous; Mastewal (desi) had the highest amount of copper and tannin while local (desi) cultivar had highest value for ash, fiber, calcium and phytate. The results showed that all three cultivars contain bio-available zinc and calcium. Habru contain zinc higher in amount and bioavailability while the local cultivar contains calcium higher in amount and bioavailability. Of the three cultivars Habru contains bio-available iron. The overall acceptability of boiled forms of the three chickpea cultivars scored from 6.66 to 7.44 while roasted forms scored from 6.14 to 7.17. Habru cultivar is preferable to be used based on nutritional and functional characteristics.

Keywords

Anti-nutrient

Bioavailability

Chickpea

Cicer arietinum

Functional characteristics

Introduction

Legumes are one of the most important crops in the world because of their nutritional quality (Arab et al., 2010). Chickpea (*Cicer arietinum* L.), is an old world pulse and one of the seven Neolithic founder crops in the Fertile Crescent of the Near East (Lev-Yadun et al., 2000). Chickpea (*Cicer arietinum* L.) is the third most important legume in the world after dry beans and dry peas (Parthasarathy et al., 2010). Currently, chickpea is grown in over 50 countries. It is a major food legume in Southern Europe, North Africa, India and Middle East countries (Viveros et al., 2001; Iqbal et al., 2006). It is cultivated mainly in Algeria, Ethiopia, Iran, India, Mexico, Morocco, Myanmar, Pakistan, Spain, Syria, Tanzania, Tunisia and Turkey (Naghavi and Jahansouz, 2005). Based on the size, shape and color of the seeds, two types of chickpea are usually acknowledged. Kabuli chickpea is large seeded with salmon white testa, and Desi chickpea is small seeded with a light brown testa (Rincon et al., 1998). The desi type covers about 80-85% chickpea area and is predominantly grown in South and East Asia, Iran, Ethiopia and Australia, while Kabuli types are grown in the countries of Mediterranean region, West Asia, North Africa and North America (Gaur et al., 2008).

Chickpea is rich source of complex carbohydrates, proteins, vitamins and minerals (Costa et al., 2006). There is a growing demand for chickpea due to its nutritional value. In the semi-arid tropics chickpea is an important component of the diets of those individuals who cannot afford animal proteins (Chibbar, 2010). Despite its nutritional profile, chickpea has anti-nutrients like tannin and phytic acid (Siddhraju et al., 2000). Tannins inhibit the digestibility of protein and starch; whereas, phytic acid reduces the bioavailability of some essential minerals like iron, zinc etc. (Rehman and Shah, 2001). Phytate to mineral ratio, referred to as mineral molar ratio, is important for determining the potential mineral bioavailability, which in general terms indicates higher mineral bioavailability when the molar ratio is low and vice verse (Abebe et al., 2007; Gargari et al., 2007).

Globally, chickpea is mostly consumed as a seed food in several different forms and preparations are determined by ethnic and regional factors (Muehlbauer and Tullu, 1997; Ibrikci et al., 2003). In the Indian subcontinent, chickpea is split (cotyledons) as *dhal* and ground to make flour (*besan*) that is used to prepare different snacks (Chavan et al., 1986; Hulse, 1991).In other parts of the world, especially in Asia and Africa chickpea is used in stews, soups/salads and consumed in roasted, boiled, salted and fermented forms (Gecit, 1991). In Ethiopia roasted, boiled and flour forms of desi cultivar are very common.

Chickpea composition is subjected to fluctuation due to various factors like cultivar, environment and agricultural technique. In this study physicochemical and functional property of newly developed and cultivated chickpea cultivars of one Desi (Mastewal) and one Kabuli (Habru) variety grown in Bodity were compared with that of local Desi cultivar which was purchased from Bodity market. Sensory quality of the roasted and boiled forms of the new chickpea cultivars were also compared with that of the local.

Materials and methods

Sample collection

Newly released field grown Desi and Kabuli cultivars namely, Mastewal and Habru respectively were collected from Bodity, a place located in southern part of Ethiopia. The new cultivars were selected based on the preference of the farmers who grew the cultivars. The local desi cultivar which was very common to the area and used by the local community was purchased from the market and was used as control. The seed samples were ground to 1mm size using Hammer mill (Thomas Scientific Mill, Model 4, Swedesboro, NJ08085, and USA). The samples were packed in airtight polyethylene bags and transported to the laboratory where the analysis took place.

Physical properties determination

A reported procedure (Khattak et al., 2006) was followed for making physical measurements. Three random samples of 100 seeds from each cultivar per replication were weighed and the values converted to grams per seed. Seed volume was determined by transferring 100 seeds into a 100 ml measuring cylinder, and 50 ml of distilled water were added. The gain in volume divided by100 was taken as the seed volume. Seed density was calculated by dividing seed weight by seed volume. Hydration capacity was recorded as gain in weight after overnight soaking in distilled water. The swelling capacity was determined as gain in volume after overnight soaking in water, and swelling index was calculated as swelling capacity divided by original seed volume.

Functional properties analysis

Water absorption capacity was determined using the method of Sathe and Salunkhe (1981) with slight modifications. 10 ml of distilled water was added to 1.0 g of the sample in a beaker. The suspension was stirred using a magnetic stirrer for 5 min. The suspension obtained was thereafter centrifuged at 3555 rpm for 30 min and the supernatant measured in a 10 ml graduated cylinder. Water absorbed was calculated as the difference between the initial volume of water added to the sample and the volume of the supernatant. The same procedure was repeated for oil absorption except that oil was used instead of water.

Foaming capacity was determined by the method of Coffman and Garcia (1977) with slight modification. A known weight of the chickpea sample was dispersed in 100 ml distilled water. The resulting solution was homogenized for 5 min at high speed. The volume of foam separated was noted and expressed as percentage of volume before homogenization to determine foaming capacity.

Nutrient analysis

Moisture, ash, crude fiber, fat and protein were analyzed according to AOAC (2000). Total calcium, iron, zinc and copper contents in the chickpea samples were determined according to the method of Osborne and Voogt (1978) while phosphorous content was determined using AOAC (1984). All the estimations were done in triplicate and reported on dry weight basis.

Anti-nutritional and molar ratio analysis

Phytate was determined by the method of Latta and Eskin (1980) as modified by Vaintraub and Lapteva (1988).Tannin was determined by the method of Burns (1971) as modified by Maxson and Rooney (1972).Themole of phytate and minerals were determined by dividing the weight of phytate and minerals with their respective atomic weight (phytate: 660 g/mol; Fe: 55.8 g/mol; Zn: 65.4 g/mol; Ca: 40.1 g/mol; copper: 63.5 g/mol). The molar ratio between phytate and mineral was obtained after dividing the mole of phytate with the mole of minerals.

Sensory evaluation of boiled and roasted chickpea

Sensory evaluation of boiled and roasted forms of the three chickpea cultivars was performed at laboratory level by fifteen panelists who were randomly selected from students and staff of School of Nutrition Food Science and Technology. The age of the panelist range between 20 and 30. The products were ranked using nine point hedonic scales where 1, 2, 3, 4, 5, 6, 7, 8 and 9 represent dislike extremely, dislike very much, dislike moderately, dislike slightly, neither like nor dislike, like slightly like moderately, like very much and like extremely (Amerine et al. , 1965). The trial was conducted on the same time for three consecutive days. Prior to starting the work, the Ethical Review Committee of the Hawassa University approved the study proposal Written informed consent was obtained from the subjects before they were included in the study.

Statistical analysis

Results were expressed as mean ± standard deviation. Data was statistically analyzed using SAS software, version 9.00. The significant differences between means were calculated by one-way analysis of variance (ANOVA) using Fishers multiple range test at $p<0.05$.

Results

In case of physical properties, significant difference ($p<0.05$) was found in all the parameters analyzed. Mastewal has highest value for seed weight (0.32± 1.72), swelling capacity (0.15±0.00) and hydration capacity (0.3043±0.01). Habru on the other hand ranked second in these three parameters followed by Local cultivar (Table 1).

Functional properties analysis results revealed that water absorption capacity, oil absorption capacity, and foaming capacity content ranged from 3.15 to 3.68 ml, 3.70 to 3.88 ml, and 1.42 to 3.85% respectively. Significant difference ($p<0.05$) was obtained among the cultivars in water absorption capacity only. Habru and Mastewal were found to have higher water absorption capacity (Table 2). Habru scored 3.68 ± 0.07 while Mastewal scored 3.73 ± 0.2 for water absorption capacity.

Proximate composition varied significantly ($p<0.05$) among the chickpea cultivars (Table 3). Significant difference was obtained in all proximate parameters analyzed. Protein, fat, ash, fiber, carbohydrate and energy contents ranged from 19.57 to 20.92%, 3.77 to 7.01%, 2.97 to 3.43%, 5.09 to 16.91%, 52.61% to 56.30%and 322.58 to 371.91% respectively. Habru (Kabuli) was found to have highest value for protein (20.92 ± 0.2), fat (7.01 ± 0.4) and energy (371.91 ± 4.50) while Local (desi) was found to have highest value for ash (3.43 ± 0.1) and crude fiber (16.91 ± 0.1). Zinc, iron calcium and phosphorus contents ranged from 2.05 to 3.69 mg/100 g, 4.04 to 6.47 mg/100 g, 146.48 to 400.78 mg/100 g and 216.35 to 375.24 mg/100 g respectively. Habru (Kabuli cultivar) had highest value for zinc (3.69±0.1), iron (6.47±0.03) and phosphorus (375±3.8). Local (Desi cultivar) on the other hand had highest value for calcium (400.78±113.5) (Table 3).

Table 1. Physical properties of chickpea cultivars.

Cultivar	Seed weight (g)	Seed volume (ml/seed)	Seed density (g/ml)	Swelling capacity (ml/seed)	Swelling index (g/seed)	Hydration capacity
Habru	0.27 ± 0.50[b]	0.11 ± 0.01[a]	2.50 ± 0.21[a]	0.11 ± 0.02[b]	1.03 ± 0.05[b]	0.2527 ± 0.01[b]
Mastewal	0.32 ± 1.72[a]	0.12 ± 0.03[a]	2.82 ± 0.71[a]	0.15 ± 0.00[a]	1.33 ± 0.29[ab]	0.3043 ± 0.01[a]
Local	0.12 ± 0.19[c]	0.05 ± 0.00[b]	2.37 ± 0.04[a]	0.07 ± 0.00[c]	1.40 ± 0.00[a]	0.1127 ± 0.00[c]

Mean ± SD values of three chickpea cultivars; different letters (a-c) denote significant differences ($p<0.05$) within columns.

Table 2. Functional characteristics of chickpea cultivars.

Cultivar	Water absorption (ml/g)	Oil absorption (ml/g)	Foaming Capacity (%)
Habru	3.68 ± 0.07[a]	3.75 ± 0.4[a]	1.42 ± 0.7[a]
Mastewal	3.73 ± 0.2[a]	3.88 ± 0.07[a]	3.85 ± 0.01[a]
Local	3.15 ± 0.4[b]	3.70 ± 0.3[a]	2.85 ± 1.3[a]

Mean ± SD values of three chickpea cultivars; different letters (a-c) denote significant differences ($p<0.05$) within columns.

Table 3. Nutritional composition of chickpea cultivars in wet weight bases.

Cultivar	Moisture (%)	Protein (%)	Fat (%)	Energy (Kcal/100 g)	Carbohydrate (%)	Fiber (%)	Ash (%)	Iron (mg/100 g)	Calcium (mg/100 g)	Phosphorous (mg/100 g)	Zinc (mg/100 g)
Habru	7.52 ± 0.40[a]	20.92 ± 0.2[a]	7.01 ± 0.40[a]	371.91 ± 4.50[a]	56.30 ± 0.46[a]	5.09 ± 0.2[c]	3.16 ± 0.04[b]	6.47 ± 0.03[a]	147.47 ± 4.10[b]	375.24 ± 3.8[a]	3.69 ± 0.1[a]
Mastewal	7.27 ± 0.04[a]	19.88 ± 0.1[b]	6.02 ± 0.03[b]	356.38 ± 1.44[b]	55.67 ± 0.17[a]	8.19 ± 0.3[b]	2.97 ± 0.02[b]	4.04 ± 0.06[c]	146.48 ± 12.0[b]	228.24 ± 16.3[b]	2.05 ± 0.1[c]
Local	3.73 ± 0.01[b]	19.57 ± 0.2[b]	3.77 ± 0.30[c]	322.58 ± 1.20[c]	52.61 ± 0.15[b]	16.91 ± 0.1[a]	3.43 ± 0.10[a]	4.99 ± 0.06[b]	400.78 ± 113.5[a]	216.35 ± 13.2[b]	3.04 ± 0.2[b]

Mean ± SD values of three chickpea cultivars; different letters (a-c) denote significant differences ($p<0.05$) within columns.

In case of anti-nutrients (Table 4), phytate content ranged from 56.99 to 63.28 mg/100 g while tannin content ranged from 29.56 to 103.41 mg/ 100 g. There was a significant difference (P<0.05) in phyate and tannin contents among the cultivars. Local (desi) had highest value for phytate (63.28 ± 0.01) while Mastewal (Desi) had the lowest (60.20 ± 0.91). On the other hand, Mastewal was found to have the highest value for tannin (103.41 ± 0.00) while Habru (29.56 ± 6.3) was found to have the lowest. In this study phytate to iron, phytate to zinc and phytate to calcium molar ratios ranged from 0.79 to 1.19, 1.62 to 2.76 and 0.01 to 0.02 respectively. Phytate to iron molar ratio is less than the critical point1 for Habru (0.79 ± 0.01) cultivar only.

Phytate to zinc and phytate to calcium molar ratios of the three cultivars are less than the critical points 15 and 0.24 respectively. Habru and local scored lower value, 1.62 ± 0.07and 2.07± 0.1, respectively for phytate to zinc molar ratio compared to Mastewal cultivar (Table 4).

In terms of overall acceptability (Table 5 and Table 6), boiled forms of the three chickpea scored from 6.60 to 7.44 (like moderately) while roasted forms scored from 6.14 to 7.17 (like moderately). Significant difference ($p<0.005$) was obtained in overall acceptability. Boiled and roasted Habru and Local cultivars scored the highest value which is like moderately for the overall acceptability. Habru scored 7.44 ± 1.1 (like moderately) and 6.81± 1.7 (like moderately) for boiled and roasted forms respectively while local scored 7.08 ± 1.1 (like moderately) and 7.17 ± 1.4 (like moderately) for boiled and roasted respectively.

Table 4. Anti-nutrient contents and molar ratio.

Cultivar	Phytate (mg/100 g)	Tannin (mg/100 g)	Phytate: Iron	Phytate: Zinc	Phytate: Calcium	Phytate: Copper
Habru	60.20 ± 0.91 ^{b}	29.56 ± 6.30 ^{c}	0.79 ± 0.01 ^{c}	1.62 ± 0.07 ^{b}	0.02 ± 0.01 ^{a}	30.45 ± 1.70 ^{a}
Mastewal	56.99 ± 1.40 ^{c}	103.41 ± 0.00 ^{a}	1.19 ± 0.05 ^{a}	2.76 ± 0.20 ^{a}	0.02 ± 0.01 ^{a}	8.78 ± 0.40 ^{b}
Local	63.28 ± 0.01 ^{a}	68.32 ± 6.20 ^{b}	1.07 ± 0.01 ^{b}	2.07± 0.10 ^{b}	0.01 ± 0.01 ^{b}	27.21 ± 1.20 ^{a}

Mean± SD values of three chickpea cultivars; different letters (a-c) denote significant differences (p<0.05) within columns; Critical molar ratio for Phytate: Iron is 1, phytate: Zinc is 15 and Phytate: Calcium is 0.24.

Table 5. Sensory evaluation of boiled forms of chickpea cultivars.

Sample	Appearance	Flavor	Taste	Texture	Overall acceptability
Boiled Habru	7.60 ± 1.5^{a}	7.04 ± 1.5 ^{a}	7.08 ± 1.4 ^{a}	7.00 ± 1.5 ^{a}	7.44 ± 1.1 ^{a}
Boiled Mastewal	5.77 ± 2.0^{c}	6.39 ± 1.8 ^{b}	6.65 ± 1.6 ^{a}	6.62 ± 1.2 ^{a}	6.60 ± 1.5 ^{b}
Boiled Local	6.66 ± 1.5 ^{b}	6.83 ± 1.4^{ab}	6.89 ± 1.4 ^{a}	6.81 ± 1.5 ^{a}	7.08 ± 1.1^{ab}

Mean ± SD values of three chickpea cultivars; different letters (a-c) denote significant differences (p<0.05) within columns.

Table 6. Sensory evaluation of roasted forms of chickpea cultivars.

Sample	Appearance	Flavor	Taste	Texture	Overall acceptability
Roasted Habru	6.98 ± 1.7^{a}	6.67 ± 1.5 ^{a}	6.65 ± 1.7^{ab}	6.23 ± 2.1 ^{b}	6.81 ± 1.7^{ab}
Roasted Mastewal	6.16 ± 1.7 ^{b}	6.52 ± 1.7 ^{a}	5.96 ± 2.0 ^{b}	6.23 ± 2.1 ^{b}	6.14 ± 2.1 ^{b}
Roasted Local	6.79 ± 1.6^{ab}	6.81 ± 1.5 ^{a}	6.83 ± 1.3 ^{a}	7.21 ± 1.5 ^{a}	7.17 ± 1.4 ^{a}

Mean ± SD values of three chickpea cultivars; different letters (a-c) denote significant differences (p<0.05) within columns.

Discussion

According to Khan et al. (1995), seed size is an important parameter for the selection of genetic material, processing operations and in general the larger seed is considered of better quality and preferred for consumption and export. Rate of penetration of water to the inner part of the seed is affected by seed size, seed hardness and permeability of the seed coat to water. Khan et al. (1995) reported that Kabuli cultivar has the highest seed weight and hydration capacity but in this study the desi cultivar, Mastewal, has the highest seed weight and hydration capacity. The reason might be the gene type and seed coat thickness. Habru which is kabuli variety has the second highest seed weight and hydration capacity. According to Clemente et al. (1998), cooking time depends on seed weight and volume, and on the hydration and swelling capacity of the seed. According to Kaur and Singh (2005), flour of desi and kabuli cultivars have significant difference (p<0.05) in oil absorption but not in water absorption capacity. However in this study Mastewal and Habru were found to have higher water absorption than local.

Jukantiet al. (2012) reported that protein content of chickpea varies from 17 to 22% which is in line with this study. Protein content of the three cultivars in this study is near to this range. According to Sharma et al. (2013) and Maheri-Sis et al. (2008), kabuli have significantly higher value of protein than desi. According to Sharma et al. (2013), the protein content of kabuli ranges from 28 to 31% while desi cultivar ranges from 18 to 23% and the reason for the difference is mainly genetic difference. In present study also Habru which is kabuli cultivar was found to have higher protein content than Desi cultivars and the difference might be genetic difference.

Fat content of 3.40-8.83% and 2.90-7.42% in kabuli and desi type chickpea seeds respectively was reported by Wood and Grusak (2007). In this study fat content of desi cultivars (Local and Mastewal) and kabuli cultivar (Habru) was found to be within this range. According to Sharma et al. (2013), fat content of kabuli (3.1-6.8%) is greater than desi cultivar (2.6-5.6%) and the reason for the difference is mainly genetic difference. In present study also Habru which is kabuli cultivar was found to have higher fat content than desi cultivars and the difference might be genetic difference. However, the crude fat content does not qualify Habru as an oil rich legume, especially when compared with groundnuts and soybeans.

Total fiber content for desi and kabuli chickpea seed is around 9.94% and 6.49% respectively according to Maheri-Sis et al. (2008). However, the desi cultivar (local) of this study has higher fiber content than Maheri-Sis et al. (2008). In the present study, Local desi cultivar has higher fiber content than Habru and Mastewal which is in line with Khan et al. (1995). According to Khan et al. (1995) Desi cultivar was found to have significantly higher value than Kabuli.According to Rincon et al. (1998) and Wood and Grusak (2007), the reason why desi have high fiber content compared to kabuli could be due to thicker hulls and seed coat (11.5 % of total seed weight) compared to the kabuli types (only 4.3-4.4 % of total seed weight).

Wood and Grusak (2007) reported that kabuli cultivar has higher energy value (357 to 446 k/cal) compared to desi cultivar (334 to 437 k/cal) and that might be due smaller seed coat component of kabuli. In the present study, energy value of Habru (Kabuli cultivar)and Mastewal (Desi cultivar) are within the above range but local desi cultivar is below the range. In line with the report of Wood and Grusak (2007), the present study also showed that Habru (Kabuli cultivar) was found to have higher energy value.

Maheri-Sis et al. (2008) found that carbohydrate contents of desi chickpea (46.8%) are lower than kabuli chickpea (49.13%). Carbohydrate contents of the three cultivars in the present study were greater than the above result. However, in line with Maheri-Sis et al. (2008) in present study, local desi cultivar scored the lower carbohydrate content.

Jukanti et al. (2012) reported that 100 g of raw chickpea seed on an average provides about 4.1 mg of zinc, 5.0 mg of iron and 160 mg of calcium. The amount of zinc obtained in this study for each of the three cultivars is less than the average value reported by Jukanti et al. (2012). However, amount of iron and calcium obtained in Habru and local cultivars respectively is greater than the average value reported by Jukanti et al. (2012). Calcium content of Local (Desi cultivar) was also greater than Zia-Ul-Haq et al. (2007).In case of Zia-Ul-Haq et al. (2007) the calcium content of four Desi cultivars ranged from 194 to 219 mg/100 g. Calcium content, zinc and phosphorous difference between the cultivars is in line with Wang et al. (2010). According to Wang et al. (2004), the calcium content is higher in desi cultivar while zinc and phosphorus contents are higher in kabuli. The difference might be explained by the seed coat thickness and biotype as reported by Ibanez et al. (1998).

FAO (2002) reported that about 100 g of chickpea seeds can meet about daily dietary requirements of iron (1.05 mg/day in males and 1.46 mg/day in females) and zinc (4.2 mg/day and 3.0 mg/day). In this study 100 g of the chickpea in the three cultivars can meet the daily requirement of iron but in case of zinc only daily requirement of females is fulfilled.

Phytic acid content of the three cultivars was less than that of Zia-Ul-Haq et al. (2007). Rincon et al. (1998) reported that desi cultivars exhibited lower phytic acid than kabuli cultivar due to coat thickness difference. Similar result was found in the present study also.From the molar ratio results Habru contain bio-available iron than the rest cultivars. The three cultivars contain bio-available zinc because molar ratio is less than the critical value 15 but the bio-availability is greater in Habru and local cultivars. As the phytate to mineral molar ratio is scored lower, bio-availability of minerals will increase and so greater bio-availability is there in Habru and local cultivars. The three cultivars also contain bio-available calcium because molar ratio is less than the critical value 0.24 but bio-availability is greater in local variety.

In study done by Thavarajah and Thavarajah (2012), the phytate to iron molar ratio was found to be greater than 1 which is in line with Mastewal and local cultivars of this study. In the study done by Mckenzie-Parnell & Guthrie (1986), the phytate to zinc and phytate to calcium ratios were found to be lower than that of the critical values 15 and 0.24 respectively which is in line with this study. However, excess of one mineral may prevent others being absorbed and utilized properly. Calcium to phosphorous ratio should not be less than 1 otherwise phosphorous will decrease calcium absorption (Amjad et al., 2006). In this study calcium to phosphorous ratios was found to be 1.85, 0.64, and 0.39 for Local, Mastewal and Habru cultivars respectively. The ratio is less than 1 for

Mastewal and Habru cultivars. The result is in line with Amjad et al. (2006) and Zia-Ul-Haq et al. (2007).

Tannins have been reported to inhibit the digestive enzymes and there by lower the digestibility of most important nutrients especially protein and starch (Khattab and Arntfield, 2009). Tannin content of the three cultivars was less than that of Zia-Ul-Haq et al. (2007). In terms Kabuli and Desi cultivar difference, the result in this study is in line with Sharma et al. (2013), Maheri-Sis et al. (2008) and Rincon et al. (1998) where desi cultivar was found to have high values compared to kabuli due to coat thickness difference. The result reveals that protein obtained from Habru is higher in digestibility compared to the rest two cultivars. According to Mulla et al. (2011), boiled forms of both desi and kabuli varieties scored average result of like moderately which is in line with this study.

Conclusion

The present study had shown that Habru is preferable cultivar in terms of amount of protein, fat, zinc, iron and phosphorus compared to the other two chickpea cultivars. The bioavailability of iron and zinc and digestibility of protein also make Habru preferable cultivar. Habru and Mastewal have better chance of being incorporated in aqueous food formulations. The local cultivar on the other hand is good source of calcium, ash and fiber. The amount and bioavailability of calcium is greater in the local variety. Mastewal has highest value for seed weight, swelling capacity and hydration capacity Boiled and roasted forms of Habru and Local chickpea cultivars are equally acceptable Hence, using the Habru as food source in addition to the local one has nutritional and functional advantages.

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