Nutritional Composition of Chickpea Varieties Grown at Bishoftu, Ethiopia

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Abstract

*Chickpea (***Cicer arietinum** *L.) is an important legume contributing a huge amount of protein to the human diet and export produce to Ethiopia. So far a number of improved kabuli and desi varrities were developed based on their yeald performance and agronomic traits, by the research institutes in the agricultural research system of the country. However, comprehensive information on their nutritional composition and related quality traits is not as such available. Therefore, this study was conducted to generate base line information on the proximate (moisture, ash, protein, fat, fiber, and carbohydrate) and mineral (Na, Ca, P, Fe and Zn) compositions of 22 released chickpea varieties grown under uniform agronomic condition. The result showed that the presence of significant differences on proximate composition and mineral contents among the varieties. In addition, the protein, crude fiber, fat and mineral contents of these cultivars were found comparable with the reports elsewhere. The results will be useful in guiding future breeding activities and helping the food processors and consumers in selecting the varieties for various applications.*

Keywords: Chickpea, improved varieties, roximate composition, mineral content

Introduction

Chickpea (*Cicer arietinum* L.) is one of the top five important legumes on basis of whole grain production and consumption (Ionescu *et al.,* 2009). Chickpea, locally known as Shimbra, is one of the leading legume in Ethiopia and interms of production (with an annual production of over 322,000 metric tons) the country ranks sixth in the world and first in Africa, (FAO, 2010). According to Ethiopia's Central Statistics Agency (2010), more than 800,000 smallholder farmers are involved in chickpea productions in the country.

Nutritionally, chickpea is a good source of protein, carbohydrates, and minerals; its protein quality is consideredbetter than other pulses. It has significant amounts of all the essential amino acids except sulphur containing amino acids *i.e.* methionine and cysteine. Starch is the main storage carbohydrate in chickpea followed by dietary fiber, oligosaccharides, and simple sugars like glucose and sucrose (Chibbar *et al.,* 2010). Fats are present in low amounts; unsaturated fatty acids like linoleic and oleic acid being predominant (Kaur *et al.*, 2005). Chickpea grain is also a good source of important minerals like potassium, calcium, magnesium, phosphorus and important vitamins such as riboflavin, niacin, thiamin, folate and the vitamin A precursor, β-carotene (Cabrera *et al*., 2003). It is also being utilized in crop rotation practices with major cereal crops like tef and wheat playing a significant role in restoring soil fertility by fixing atmospheric nitrogen (Agarwal *et al.,* 2012).These makes the crop to be an alternative source of proteins and micronutrients for the consumers and good cash income source for the farmers. These show the potential important role that the crop can play in the effort being under taken to make the country food and nutrition secure.

So far, about 24 Kabuli and Desi type improved chickpea varieties were released by the chickpea improvement research teams in the Ethiopian Institute of Agricultural Research and regional agricultural research institutes However, comprehensive information on their nutritional composition and related quality traits is not as such available. Therefore, the aim of this activity was to generate base line information and robust quality database on these released and improved chickpea varieties that will help to guide future breeding activities and their utilization by processors and consumers at different levels.

Materials and Methods

Sample collection and preparation

Sample grains of 22 chickpea varieties grown under uniform condition were collected from the 2016/17 main crop production season of the Chickpea Improvement Program of the DZARC. The grain samples were manually cleaned and ground by a laboratory mill (Thomas Scientific Mill, USA) fitted with a 1mm opening sieve size. Then the flour was packed in moisture tight polyethylene bags stored until laboratory analysis.

Nutritional composition

Nutritional compositions of the stored chickpea samples were analyzed by using the following methods. Moisture content was determined by oven drying of 2g sample of chickpea flour at 130°c for 2hr. until constant weight reached. Protein, crude fiber, and ash were determined by the official methods (AOAC, 1984) with minor modification for Crude fiber as indicated in official journal of the European communities (No. L. 344/35). Crude fat (oil) was analyzed by NMR (Nuclear Magnetic Resonance) method. Carbohydrate content was found by difference method (FAO, 2003). Energy content was obtained as 4*Carbohydrate + 4*Protein + 9*Fat.

Mineral analysis

The minerals (Fe, Ca, and Zn) were evaluated by atomic absorption while P and Na were analyzed by Flame photometer.

Statistical analysis

Data was statistically analyzed using Minitab 17 software. The significant differences between means were calculated by one-way analysis of variance (ANOVA) using Fishers multiple range test at $p<0.05$.

Results and Discussion

Nutrional composition

The results of the study showed the presence of significant ($p<0.05$) varation in the nutritional contents of the 22 improved chickpea varities evaluated.

Moisture content

Moisture level determination is an integral part of the proximate composition analysis of the foods.The highest results were recorded from Dalota (9.37) & Chafe (9.33) chickpea varieties. The lowest moisture content is recorded from Teji (6.24), Dz-10-01(6.13), and Arerti (5.6). The of moisture content in the chickpea grains studied is closer to earlier work of Beruk (2015) on similarly field dried grains.

Protein content

Chickpeas are highly valuable and economical source of vegetable protein, which include essential amino acids (Clemente *et al.,* 2000, Menkov, 2000). The crude protein contents of the chickpea varieties varied from 16.13 – 23.84 % (Table 1) where Ejere (23.84±3.92) and DZ-2012-19 (22.60±0.76) lied in the highest range while Arerti (16.48±0.94), Mariye (16.49±0.07) and Akaki (16.13±0.44) scored lower protein content. In addition, the protein content in the kabuli type chickpeas was than the Desi types. The results obtained are inline with earlier reports that underline the influence of genetic and environmental factors on such quality trait (Owusu-Ansah and McCurdy, 1991). Similar trends were also reported earlier where desi type chickpeas scored lower crude protein contents than the kabuli types (Sharma *et al.,* 2015). Esayas et al. (2012) also reported that the protein contents of Habru, Mastewal, local (Desi type) were 20.92, 19.88, and 19.57 respectively, while the report by Beruk (2015) indicated the protein content of Kabuli type chickpea to be 21.07.

Table 1.Proximate composition (g/100g) and energy content (Kcal/100g) of the chickpea varieties

Akaki	$9.00+0.33^{ab}$	$16.13+0.44^{f}$	$6.89+0.14^{j}$	$7.44+1.07^{d}$	$2.03+0.03^{g}$	$58.51+1.05^{cd}$	$360.54+5.09^{h}$
Mariye	$7.67+0.30^{def}$	$16.49+0.07^{ef}$	$7.32+0.18^{i}$	$7.67+0.88^{d}$	$3.07+0.27^{def}$	$57.79+0.87^{cdef}$	$363.00+3.70^{hi}$
Tekataye	$7.00+0.33^{g}$	$18.58+1.58^{de}$	$8.82+0.02^{c}$	$7.41+1.81^{d}$	$3.47+0.13^{cde}$	$54.73+2.55^{efgh}$	$372.58+7.26^{g}$
Shasho	$9.00+0.33^{ab}$	$18.55+0.38^{de}$	$6.81+0.01^{j}$	$2.93+0.27^{gh}$	$3.07+0.40^{def}$	$59.64+1.26^{abc}$	$374.06+3.63^{f}$
Chefe	$9.33+0.67^{a}$	$19.03+2.03^{cd}$	$7.85+0.03^{g}$	$3.64+0.91^{fgh}$	$1.93+0.07^{g}$	$58.22+0.52^{bcde}$	$379.60+6.64^{def}$
Hora	$6.33+0.33^{h}$	$19.10+0.18^{cd}$	$9.83+0.03^{a}$	$3.75+0.92^{fgh}$	$2.03+0.03^{g}$	$58.96+0.85^{bc}$	$400.68+3.20^{a}$
Dhera	$8.13+0.13^{cd}$	$17.70+0.76^{def}$	$9.59+0.01^{b}$	$7.50+1.17^{d}$	$2.69+0.03^{efg}$	$54.39+1.77^{fghi}$	$374.62+4.00^{fg}$
Habru	$8.97+0.30^{ab}$	$16.70+0.57^{def}$	$8.34+0.04^{e}$	$3.97+1.92^{fgh}$	$4.20+1.13^{bc}$	$57.84+2.08^{cdef}$	$373.15+9.57^{f}$
DZ-10-11	$7.43+0.10^{efg}$	$18.80+0.68^{de}$	$8.05+0.02^{f}$	$10.67+0.00^{ab}$	$4.13+0.13^{c}$	$50.93+0.47^{i}$	$351.29+1.008^{j}$
Dimtu	$8.10+0.10^{cd}$	$18.46+0.76^{def}$	$8.09+0.01^{f}$	$9.74+0.36^{abc}$	$3.35+0.02^{cdef}$	$52.26+0.42^{hi}$	$355.66+ 1.81^{hij}$
Teji	$6.24+0.24^{hi}$	$17.02+0.2^{def}$	$8.36+0.01^{e}$	$4.22+0.60^{fg}$	$2.69+0.02^{efg}$	$61.48+0.32^{ab}$	$389.22+ 1.43^{bc}$
Worku	$8.37+0.30^{bc}$	$18.02+0.14^{def}$	$7.45+0.03^{i}$	$8.92+1.06^{bcd}$	$3.83+0.17^{cd}$	$53.42+0.50^{ghi}$	$352.76+2.34^{ij}$
Natoli	$8.57+0.10^{bc}$	$17.40+0.33^{def}$	$7.85+0.05^{g}$	$8.65+0.67^{cd}$	$3.16+0.04^{def}$	$54.38+0.60^{fghi}$	$357.71+ 2.66^{hij}$
Dubie	$7.53+0.20^{def}$	$17.80+0.51^{def}$	$5.85+0.15^{k}$	$5.26+1.28^{ef}$	$5.70+2.30^{a}$	$57.85+3.91^{bcdef}$	$355.24+12.37^{hij}$
DZ-2012-24	$8.03+0.03^{cde}$	$18.58+0.76^{de}$	$9.86+0.01^{a}$	$3.13+0.47^{gh}$	$2.45+0.25^{fg}$	$57.95+0.84^{bcdef}$	$394.80+1.62^{ab}$
Arerti	$5.60+0.93^{i}$	$16.48+0.94^{ef}$	$7.81+0.01^{g}$	$3.33+0.67^{gh}$	$3.74+0.26^{cd}$	$63.05+2.02^{a}$	$388.34+4.65^{bcd}$
Dalota	$9.37+0.70^{a}$	$16.78+0.51^{def}$	$8.84+0.04^{c}$	$11.22+2.11^{a}$	$2.01+0.01^{g}$	$51.79+2.04^{hi}$	$353.79+7.43^{hij}$
DZ-10-01	$6.13+0.13^{hi}$	$18.99+0.38^{cd}$	$8.34+0.04^{e}$	$7.12+ 0.41^{d}$	$3.24+0.09^{cdef}$	$56.18+0.79^{cdefg}$	$375.71+2.01^{efg}$
Minjar	$7.97+0.63^{cde}$	$21.36+4.22^{bc}$	$8.62+0.22^{d}$	$7.07+1.74^{de}$	$2.03+0.69^{g}$	$52.96+6.38^{ghi}$	$374.81+11.56^{fg}$
Acos dubie	$7.70+0.37^{def}$	$19.76+0.16^{bc}$	$8.15+0.05^{f}$	$3.61+0.27^{fgh}$	$3.34+0.01^{cdef}$	$57.45+0.44^{cdef}$	$382.14+2.81^{cdef}$
Ejere	$7.70+0.30^{def}$	$23.84+3.92^{a}$	$7.65+0.05^{h}$	$2.35+1.01^{h}$	$3.36+0.03^{cdef}$	$55.10+4.62^{defgh}$	$384.58+3.20^{cde}$
DZ-2012-19	$7.17+0.17^{fg}$	$22.60+0.76^{ab}$	$7.41+0.01^{i}$	$3.04+1.27^{gh}$	$5.15+0.18^{ab}$	$54.63+ 0.93^{efgh}$	$375.58+4.24^{efg}$
CV	5.01	7.7	3.92	18.3	18.18	3.92	1.51

Data were interpreted as Mean ± SD, varieties that share the same letters are not significantly different ($p \le 0.05$). CHO-carbohydrate

Fat content

Legumes generally contain higher fat content than cereals (Salunkhe *et al.* 1985). Among the varieties studied, the total fat contents of DZ-2012-24(9.86±0.01) and Hora (9.83±0.03) followed by Dhera (9.59±0.01) were relatively higher than while those of DZ-2012-24 and Hora The lowest fat contents were recorded for Akaki (6.89±0.08), Shasho (6.81±0.08) and Dubie (5.85±0.08). Fat content of chickpea was reported to be 3.40-8.83 % (Kabuli) and 2.90-7.42 % (Desi) Wood and Grusak (2007) and the fat content of all the varieties under this study were found to be within therange. 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 difference might be environmental and soil type difference.Esayas *et al*., (2012) has reported that the fat content of chickpea is about 7.01 for Habru and 6.02 for mastewal varieties. This result is fully in agreement with the current result obtained for Habru (8.34). It also closer the report by Beruk (2015) 5.94% for DZ 10-11.

Fiber content

Fibre constitutes a considerable proportion in human nutrition and dietary fibers are useful in reducing blood cholesterol levels (Chavan *et al*., 1986). Crude fiber is mainly concentrated in the seed coat. The study showed that though there is no significant ($p>0.05$) differences among them, the fiber contents of Dalota (11.22), DZ-10-11 (10.67) and Dimtu (9.74) were higher. On the otherhand, the fiber contents of Shasho (2.93) and Ejere (2.3) the lowest. This result indicates that the desi chickpea type varities contained higher crude fiber contain than kabuli types.

The probable reason for such finding could be the higher grain size and thinner seedcoat of the kabuli type chickpeas than the desi types (Wood *et al.*, 2011).

Ash content

The ash contents of the chickpea cultivars were significantly ($p<0.05$) different (Table 1), where highest ash content was recorded for Dubie (5.73) and DZ-2012-19 (5.15±0.18) while lowest ash contents were scored by Akaki (2.03), Hora (2.03), Minjar (2.03), Dalota (2.01), and chefe (1.93). The result also showed that desi type chickepea varities had higher ash content than the kabuli types corborating earlier results elsewhere (Sharma *et al*., 2015). This could be the higher grain size and thinner seedcoat of the kabuli type chickpeas than the desi types (Wood *et al.,* 2011).

Carbohydrate

Legumes are good dietary carbohydrate sources (Salunkhe *et al.*, 1985; Chavan *et al.,* 1986). Chickpeas contain 52.4 – 70.9% total carbohydrates that constitute a major portion of the seed. The starch in chickpea is a major component of total carbohydrate (Salunkhe *et al.,* 1985, Chavan *et al.,* 1986). Starch is the major component of chickpeas and constitutes 37.2–50.8 % of the whole seed and 55.3 – 58.1 % of the de-hulled seed (Biliaderis *et al.,* 1981, Chavan *et al.,* 1986). In this study, the highest average of carbohydrate was recorded by Arerti (63.05), Teji (61.48) and shasho (59.64) varieties. These chickpea varieties are kabuli type and no significant ($p>0.05$) difference found between them. However, there was a significant difference between these varieties and all the other varieties assessed in this study. The lowest carbohydrate content was found in desi type those are Dimtu (52.26), Dalota (51.79) and dz-10-11(50.93) respectively. The report by Esayas et al., (2012) has shown that the carbohydrate content of Habru, Mastewal and Local (Desi type) were 56.30, 55.67, 52.61 respectively. In this study, the result obtained for Habru variety was 57.84% which is in line with the previous report.

Energy

Energy value of chickpea is the amount of potential energy in chickpea that can be converted into actual food energy. There was significant ($p<0.05$) difference among the energy value of the cultivars (Table.1). The two chickpea cultivars, Hora (400.68) and DZ-2012-24 (394.80) had the highest gross energy value, while Worku (352.76) and DZ-10-11 (351.29) scored the lowest energy value. Beruk Berhanu (2015) reported that the energy value scored by Kabuli chickpea varieties to be 388.12Kcal/100g. The current average result obtained shows that the energy content for this variety was 351.29, which is lower than the reported one. However, the result obtained from Arerti variety was similar with this reported result (388.34). The energy contents of Habru, Mastewal and Local (Desi type) chickpea were reported to be 371.91, 356.38, 322.58 respectively (Esayas *et al.,* 2012).

Mineral contents

The mineral cntent study done on the 22 improved chickpea varities showed the existence ofsignificant variations ($p<0.05$) among the varieties (Table 2).

Iron (Fe)

Iron contents of the cultivars ranged from 3.2 mg/100g to 4.66 mg/100g. Highest Fe was found in Akaki (4.66) (desi type) while lowest was in Ejere (3.2) (kabuli type) and Natoli (3.06) (desi type) (Table 2). The results obtained for vatites like Mastewal are closer to the past findings by Esayas et al. (2012).

Sodium (Na)

The Na of the chickpea cultivars ranged between Teji (21.06) and Arerti (3.74). In addition, the Na content Tegi was significicantly higher than the rest of the varieties compared under this study.

Calcium (Ca)

The highest average of calcium content was recorded in Arerti (159.8) followed by DZ-10-11(158.79), Minjar (156.66), Worku (156.1) and Akaki (145.69). However, no significant ($p>0.05$) difference was observed between the Ca contents of these five ciltivars. The minimum average calcium content was recorded in Dimtu (90.19). The Ca contents measured in this study are mostly in agreement with previous works (Esayas *et al*., 2010 and Biruk, 2015).

Zinc (Zn)

Znic contents of the varieties studied varied between 2.38 - 3.86 (Arerti, kabuli type) mg/100g. The results found corborate earlier researches on some of these cultivars (Esayas *et al*., 2012 and Beruk, 2015).Similar trend was reported by Wang and Daun (2004), i.e., lower Zn content in desi type chickpea (2.8 mg/100g) and higher Zn content in kabuli type chickpea (5.10 mg/100g).

Phosphorus (P)

The experiment revealed that the phosphorous content of the chickpea verities significantly ($p<0.05$) varied ranging between 344.74 (Akaki, desi type) and 615.16 (DZ-2012-19, kabuli type). Past report by Esayas et al. (2012) indicated the phosphorus content of Habru, Mastewal and Local (Desi type) chickpea as 375.24, 228.24, 216.35, respectively. Some of the results obtained in this study are somewhat similar with others finding.

Table 2. Mineral contents of the chickpea varieties in mg/100g

Varietiy	Fe	Na	Ca	Zn	P
Akaki	4.66+0.03^{a}	11.21+0.45^{cd}	145.69+2.45^{ab}	2.84+0.1^{cdef}	344.74+0.716^{j}
Mariye	4.00+0.12^{abc}	11.51+0.24^{c}	124.40+5.92^{bc}	2.36+0.06i	391.67+0.479^{h}
Tekataye	4.31+0.07^{abcd}	6.72+0.42^{g}	116.71+6.02^{bcd}	2.78+0.04^{defg}	503.07+0.856^{e}
Shasho	4.58+0.17^{ab}	4.88+0.14^{ij}	116.41+3.53^{bcd}	3.08+0.24^{c}	475.88+0.665^{f}
Chef	3.57+0.03^{efg}	6.60+0.53^{g}	112.46+4.72^{cd}	3.06+0.13^{c}	475.37+0.521^{f}
Hora	2.45+0.39^{h}	13.34+0.53^{b}	111.23+3.73^{cd}	2.52+0.03^{hi}	392.57+0.543^{h}
Dhera	4.13+0.07^{abcd}	10.52+0.44^{cd}	112.75+2.88^{cd}	3.00+0.12^{cd}	364.05+0.239^{i}
Habru	3.56+0.19^{efg}	9.96+0.19^{de}	114.08+2.33^{cd}	3.49+0.08^{b}	503.16+0.725^{e}
dz-10-11	3.82+0.01^{def}	8.73+0.34^{ef}	158.79+4.60^{a}	2.71+0.07^{efgh}	559.85+0.492^{c}
Dimtu	3.42+0.06^{fg}	11.64+0.49^{c}	90.19+11.10^{d}	2.62+0.01^{fghi}	363.84+0.23^{i}
Teji	3.88+0.07^{cdef}	21.06+0.61^{a}	114.51+3.95^{cd}	2.38+0.08^{i}	392.67+0.59^{h}
Worku	4.57+0.02^{ab}	11.59+0.56^{c}			

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