Proximate and Mineral Composition of Food Barley Varieties

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Abstract

Barley (HordeumVulgare L.) is an annual monocotyledonous herb, belonging to the tribe Triticeae. It is the healthiest cereal crop mainly grown in the central highland of Ethiopia. So far, the national barley research program in Ethiopia has released 22 improved food barley varieties. Therefore, this study was conducted to generate information about the nutritional composition such as proximate and mineral contents of these varieties. Proximate composition (crude protein, crude fat, crude fiber, total ash and carbohydrate) and micronutrients such ascalcium (Ca), magnesium (Mg), Iron (Fe) and Zinc (Zn) of the varieties were determined. Proximate composition and micronutrient contents varied (P < 0.05) among all varieties. Cross 41/98, Agegnehu and Abdene showed the highest protein content (14.10, 13.68 and 13.64% respectively). Differences (P < 0.05) in the protein content was detected, and might be attributed primarily to genetic background since all varieties were grown under the same environmental conditions.Therefore, these results may be useful in the food industry for the selection of barley varieties for human consumption and to produce substantially protein-enriched flour.

Introduction

Barley (*Hordeumvulgare*L.) is the fourth most important cereal crop worldwide, after wheat, corn and rice (Marwat*et al*., 2012). In Ethiopia, barley has a long history of cultivation in the highlands (Fridissa*et al*., 2010). The diversity of barley types found in Ethiopia is probably not exceeded in any other region of comparable size (Bekele, 1983). The principal uses of barley are as feed for animals, in the form of barley meal and as grain for malting and brewing in the manufacture of beer and whisky (Molina *et al*., 2002, Edney and Mather, 2004). However, in Ethiopia it is mainly used for making local food recipes and drinks, such as bread, kolo, genfo, beso, tela and borde and, thus, may be considered relatively underutilized with regard to its potential use as an ingredient in processed human foods (Malkki, 2004). Whole barley grain consists of about 65 - 68% starch, 10 - 17% protein, 4 - 9% β -glucan, 2 - 3% free lipids and 1.5–2.5% minerals (Izydorczyk*et al*., 2000). β –glucan isthe major fiber constituents in barley and had been shown to lower plasma cholesterol, reduce glycemic index and reduce the risk of colon cancer (Brennan and Cleary, 2005). Many studies have been conducted to determine the chemical composition and physical characteristics of cereal grains used in human and livestock feeding (Andersson *et al*., 1999). The genetic make-up and environmental factors, such as rainfall, temperature, and soil conditions and fertilization can contribute tovariations in the chemical composition and physical

characteristics of cereal grains (Metayer *et al*. 1993 and Rodehutscord *et al*. 2016). Thus, characterization of variations in the nutritional value of cereal grains that result from such factors may help to define appropriate breeding objectives for improving their value in nutrition (Rodehutscord*et al*., 2016).

So far, the national barley-breeding program in Ethiopia has releaseda number of food barley varieties, targeting at only productivity and disease resistance, without any information regarding their nutritional composition.Therefore, the objective of this study was to assess the proximate composition and mineral content of twenty-two improved food barley varieties grown in the central highlands of Ethiopia.

Materials and Methods

Sample collection and preparation

Grain samples of twenty-twoimproved food barley varieties harvested in 2015 cropping season were collected from barley breeding program of Holetta Agricultural Research Center and DebreBirhan Regional Agricultural Research Center separately tagged individually and transported to Holetta barley quality laboratory. The samples were manually sorted, cleaned and homogenized by using grain homogenizer. Then, each sample was milled separately by using cyclone sample mill with 0.5mm sieve size and stored in paper bag for laboratory analysis.

Proximate Composition

Proximate compositions were determined usingthe method developed by Association of Official Analytical Chemist (AOAC, 2005). Moisture content (MC) was determinedusing weight difference by drying samples in air conviction oven at 105°C to a constant weight. Crude protein was determined using Kjeldahl method with SBS 2000 analyzer unit (Food ALYT, Germany), where, the percentage nitrogen (%N) obtained was converted in to crude protein (% CP) using the relationship: % CP = % N multiplied by 6.25. Ether extract (crude fat content) was determined using soxlet extraction technique (Tecator-1050 extractor). Total ash (%) was determined by incinerating the samples in a muffle furnace at 550°C for 4hrs. The ash was cooled in a desiccator and weighed. Crude fiber content (% CF) was determined by dilute acid and alkali hydrolysis. Carbohydrate (CHO) content was calculated as CHO (%) = 100-(%MC+%CP+%Fat+%Fiber+%Ash).

Analysis of mneral content

Calcium, magnesium, zinc and iron were determined by atomic absorption spectrophotometer (Agilent AAS 240, USA) after dry ashing to digest the sample according to the method of AOAC (2000).

Data collection and analysis

All parameters were determined in duplicate. The results were analyzed using one-way ANOVA (Analysis of Variance) with statistical analysis software (SAS) version 20 (SAS, Statistical Analysis System, 2004). Significance was accepted at 0.05 level of probability ($p \leq 0.05$) andmean separation was performed by "Each pair LSD t-test" for multiple comparisons of means.

Results and Discussion

Proximate composition

There were significant variations ($P<0.05$)among the food barley varieties for proximate composition of whole flour samples as determined by the composition of protein, moisture content, crude fiber, crude fat, total ash, carbohydrate and energy, though they were grown in the same agroecology (Table 1). Protein content of food barley varieties ranged from 10.07% to 14.10% and such variation between different cultivars was also reported by Welch (1978). The result showed that varieties such as Cross 41/98, Agegnehu and Abdene have higher protein content than the other varieties with mean values of 14.10%, 13.68% and 13.64%respectively and could be considered as good source of protein as compared with other cereals.

Moisture content of the samples were also significantly different ($P<0.05$) and ranged from 12.00% to 13.07% and this may due to the storage condition and hydroscopic capacity of the grains. Similarly, total ash content was significantly different among varieties and ranged from 1.43 to 2.3%, where Setegn, Estayish and Cross 41/98 were exhibited higher mean values 2.34%, 2.27% and 2.22% respectively than did the other varieties while Habru had lower mean total ash content (1.43 %). Crude fiber content was also significantly different among the varieties and ranged from 9.5 to 15.8% where Estayish and Agegnehu showed higher mean values 15.88% and 15.46%, respectively did that others (Table 1).

Crude fat content was significantly different ($P<0.05$) among varieties, where HB1307 exhibited higher (6.40%), while Tiret had lower (2.2%) mean value than did the other varieties. Rodehutscord et al. (2016), who reported that oil content ranged from 1.9 – 4.1% and presented positive correlation with protein content, have reviewed similar result. The result of carbohydrate content of barley varieties under this study significantly differentat ($P<0.05$) and ranged from 45.69 to 58.45 %. Ardu-12-60B, Diribie, Dinsho and Belemi had higher CHO with meanvalue of 58.45%, 56.13%,55.92 % and 55.14% respectively than did the other varieties (Table 1). Energy valuein Kcal/100g was significantly different for varieties and ranged between 271 – 324.30 Kcal/100g. And this was also in good range of calorie level as some previous studies on cereals showed. Crude fiber, ash and carbohydrates contents of this study was similar with the result recorded in barley from Jordan, morocco and FAO (Erkan et al., 2006). There was a negative relationship between carbohydrates and protein content of barley grain (Macleod, 1960), the same trend was also observed in this study.

Table 1:Proximate composition and energy in whole flour sample of food barley varieties

Variety	CP (%)	MC (%)	Ash (%)	Fiber (%)	Fat (%)	CHO (%)	Energy (Kcal/100g)
Shege	11.61ab	13.07a	2.16ab	10.00f	3.60cd	51.31bc	293.60gh
Dimtu	10.54b	12.18b	1.96ab	11.47e	4.50bc	52.36b	300.28de
Harbu	11.88ab	12.98a	1.43d	14.42b	5.01b	48.72bc	296.00fg
Setegn	12.92ab	12.19b	2.34a	14.16b	2.75de	51.87b	292.39gh
Belemi	12.61ab	12.39ab	2.21ab	10.13f	4.90b	55.14a	324.30a
Cross41/98	14.10a	12.42a	2.22a	14.30bc	3.10d	48.04bc	285.74i
Mezezo	12.40ab	11.72cd	2.03b	14.11bc	5.33b	47.21c	294.53fgh
Estayish	13.10ab	12.61a	2.27a	15.88a	3.31d	48.76bc	286.78i
Abdene	13.64a	11.35d	2.01b	13.45cd	4.43bc	49.66bc	301.97d
Dinsho	10.07b	12.02bc	2.26ab	10.44f	3.40cd	55.92a	303.66d
Besso	12.24ab	11.95bc	1.91bc	13.85c	4.71b	49.34bc	297.87ef
IAR/H/485	12.13ab	12.16b	2.02b	12.83d	4.60bc	48.28bc	291.86h
Mulu	12.53ab	12.00bc	2.08ab	12.21de	2.60de	52.38b	292.40gh
HB-1307	12.77ab	12.09b	2.12ab	15.40ab	6.40a	45.69c	300.60de
Gobe	11.35ab	12.15bc	1.84bc	14.74b	2.62de	51.34bc	283.83i
Tiret	12.94ab	12.09bc	2.06b	14.79b	2.20e	49.56bc	283.61i
HB-42	11.99ab	11.87cd	1.92bc	14.46b	3.20d	48.08bc	282.15i
Ardu-12-60B	11.03ab	12.02bc	2.31ab	9.65f	3.70cd	58.45a	320.81ab
Biftu	11.01ab	12.14b	2.07b	14.26b	2.73d	50.30bc	278.58j
Agegnehu	13.68a	12.86a	1.74c	15.46ab	4.61bc	51.49bc	311.25c
Diribie	12.48ab	12.39ab	1.69cd	10.90e	4.06c	56.13a	320.11b
Tilla	11.70ab	12.01bc	1.96b	15.10ab	3.13d	46.97c	271.61k
LSD	3.34	0.84	0.27	0.82	0.66	5.02	2.66

Figures followed by same letters with in a column are not significantly different ($P \leq 0.05$). Where, CP: Crude Protein, MC: Moisture Content, CHO: Carbohydrate.

Mineral content

Barley varieties showed significant difference ($P \leq 0.05$) for major minerals (Table 2). Accordingly, the content of calcium was ranged from 0.003 to 0.082% and significantly higher in Shege and Dimtu (0.082% and 0.072%, respectively) than in the other varieties. On the other hand, variety Direbie and Tilla were lower in Ca content than others were.

Table 2: Some major mineral content of whole flour samples of food barley varieties

Variety	Ca (ppm)	K (ppm)	Zn (ppm)	Fe (ppm)	Mg (ppm)
Shege	0.0819a	0.8024hi	0.0094c	0.0194de	0.3356cde
Dimtu	0.0717b	1.5040ab	0.0051efgh	0.0323ab	0.4027b
Harbu	0.0683bc	0.8710hi	0.0028kl	0.0108hi	0.2339gh
Setegn	0.0665bcd	1.2988cd	0.0050fghj	0.0129ghi	0.3356cde
Belemi	0.0646bcd	1.6737a	0.0129b	0.0334a	0.3726bc
Cross 41/98	0.0635cde	1.0751egf	0.0066def	0.0149efg	0.3059efd
Mezezo	0.0597def	1.4313bc	0.0049fgh	0.0183def	0.3309cde
Estayish	0.0569efg	0.7741ij	0.0039hij	0.0266bc	0.2382gh
Abdene	0.0547fg	0.9650fgh	0.0024l	0.0118hi	0.2106hi
Dinsho	0.0505gh	1.2814cd	0.0035jkl	0.0134fgh	0.2991ef
Besso	0.0504gh	1.2142de	0.0078cd	0.0186def	0.4707a
IAR/H/485	0.0503gh	0.8878ghi	0.0083cd	0.0235cd	0.2707fg
Mulu	0.0501gh	1.1158def	0.0054efg	0.0192def	0.3097efd
HB1307	0.0462hi	0.8289hi	0.0057efg	0.0266bc	0.2377gh
Gobe	0.0456hij	0.8845hi	0.0038hij	0.0242cd	0.2276gh
Tiret	0.0432hij	0.8423hi	0.0045ghi	0.0122hi	0.1686ij
HB-42	0.0415ij	0.5950jk	0.0023l	0.0191def	0.1499j
Ardu-12-60B	0.0390ij	0.7138ijk	0.0030kl	0.0108hi	0.2407gh
Biftu	0.0387ij	0.5478k	0.0029kl	0.0291abc	0.1906hij
Agegnehu	0.0375j	0.8326hi	0.0245a	0.0136efg	0.2204ghi
Diribie	0.0265k	0.5901jk	0.0068de	0.0071i	0.1998hij
Tilla	0.0032l	0.7574ij	0.0033jkl	0.0191def	0.3264cde
LSD	0.008	0.189	0.002	0.006	0.058

Figures followed by same letter (s) with in a column are not significantly different ($P \leq 0.05$).

Mean values of potassium (K) were also significantly different ($P<0.05$) for the varieties and ranged from 0.55 to 1.67%. Belemi (1.674%) had higher mean value of Kwhereas Biftuexhibeted the lowest value (0.55%). Similarly,Zinc (Zn) content of varieties also differ significantly and among the varieties.Agegnehu and Belemihad higher Zn content with average values of 0.024% and 0.013%, respectively than did others. Iron (Fe) content of barley varieties ranged from 0.007% to 0.033%.Again, Belemi and Agegnehu had higher Fe content than did others. As the result showed, Besso and Dimtu had higher mean value of Magnesium (Mg) content than did the other varieties (Table 2). Comparatively, Belemi was rich in major minerals than did the other varieties. The trend of mineral composition observed in present study was similar with the chemical composition table of the FAO, Moroccan, East Asian and Latin American (Erkan et al., 2006)

Conclusion

The proximate composition and mineral contents of improved food barley varieties in Ethiopia has not been reported and documented. Therefore, in this study, proximate and mineral composition of twenty-two varieties was determined and significant difference

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