World Journal of Food Science and Technology
2017; 1(3): 97-100
http://www.sciencepublishinggroup.com/j/wjfst
doi: 10.11648/j.wjfst.20170103.12

Evaluation of Proximate and Mineral Composition Profile for Different Food Barley Varieties Grown in Central Highlands of Ethiopia

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To cite this article:
Yadesa Abeshu, Esayas Abrha. Evaluation of Proximate and Mineral Composition Profile for Different Food Barley Varieties Grown in Central Highlands of Ethiopia. *World Journal of Food Science and Technology*. Vol. 1, No. 3, 2017, pp. 97-100.
doi: 10.11648/j.wjfst.20170103.12

Received: August 4, 2017; **Accepted**: August 29, 2017; **Published**: September 12, 2017

Abstract: Barley (*Hordeum Vulgare L.*) is the healthiest cereal crop which is mainly grown in the central highland of Ethiopia. Also there were 22 food barley varieties which were improved, verified and released by different Agricultural Research Centers specially Holeta Agricultural Research Center which is strongly working on barley breading program. Therefore in order to evaluate their nutritional composition and quality performance of the varieties this study was aimed to profile the baseline information of nutrients. For this case the proximate and some mineral composition of the varieties were determined by using appropriate Standard Official Procedures. The proximate composition was determined according to AOAC method and like CP, MC, Crude fat, Crude fiber, Total ash, CHO and Energy were analyzed. All the proximate analysis result means were statistically significant and they were in the range of acceptable recommendation as FAO and other nutritional information sources. Varieties like Cross 41/98, Setegn, Estayish, HB1307, Ardu12-60B and Belemi were the highest in mean value of CP, Total ash, Crude fiber, Crude fat and CHO respectively. The mineral content of the varieties were also statistically significant as the study results and it was in average range of expected composition. Shege, Belemi, Agegnehu and Besso Varieties were significantly highest in Ca, K, Zn, Fe and Mg mean values than other varieties respectively. Therefore these food barley varieties were potent in proximate and mineral nutrient composition for human consumption especially good fiber content source.

Keywords: Barley, Food Barley, Nutrient, Proximate, Mineral

1. Introduction

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop worldwide, after wheat, corn and rice, belonging to family Poaceae [1]. It is a crop of ancient origin in Ethiopia and the country is considered as a center of diversity for barley, because of the presence of great diversity in ecology [2]. In Ethiopia barley has a long history of cultivation in the highlands [3]. The diversity of barley types found in Ethiopia is probably not exceeded in any other region of comparable size [4]. There are two main distinguished types of barley, two rowed and six rowed barleys [5]. 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 [6, 7]. But barely in Ethiopia is mainly used for making local recipes and drinks in Ethiopia such as Bread, kolo, Genfo, Animal feed, Beso, Tela and Borde. However the barley may be considered relatively underutilized with regard to its potential use as an ingredient in processed human foods [8]. Whole barley grain consisted of about 65–68% starch, 10–17% protein, 4–9% ß-glucan, 2–3% free lipids and 1.5–2.5% minerals [9]. ß-glucans the major fiber constituents in barley had been shown to lower plasma cholesterol, reduce glycemic index and reduce the risk of colon cancer [10].

Many studies have been conducted to determine the chemical composition and physical characteristics of cereal grains used in human and livestock feeding [11]. The environmental factors, such as rainfall, temperature, soil conditions, fertilisation and genetic factors, can contribute to

variations in the chemical composition and physical characteristics of cereal grains [12, 13]. 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 the value of cereal grains for nutrition [13]. It is important to investigate the nutritional value of barley in a given geographic location because their nutritional value depends on the variety, fertilization and environmental conditions.

These food barley varieties were verified and released from different Agricultural Research Centers. But the nutritional composition performance of these varieties was not evaluated and profiled as research information. Therefore the objective of this study was to evaluate the proximate composition and mineral content varieties of this food barley grown in central highlands of Ethiopia. Then to profile the overall food barley varieties nutritional information for both consumption and research purpose.

2. Materials and Methods

2.1. Material Collection and Preparation

In this study the sample was collected from barley breeding program of Holeta Agricultural Research Center and Other highland areas of Regional Research Centers. Tagged individually and transported to Holeta barley quality laboratory. These samples were improved, verified and released varieties of 22 food barley varieties. It was sorted and cleaned manually by using local materials, homogenized by using grain homogenizer machine. After cleaning the samples, it was milled separately by using cyclone sample miller with 0.5mm sieve size and each nutrient quality parameters were analyzed according to appropriate standard methods.

2.2. Proximate Composition

Proximate compositions of the whole food barley samples were determined according to the international analysis of official methods [14]. The moisture content (MC) was determined by drying samples in an oven at 105°C for 24 hours to obtain %MC. Crude protein percentage was determined using the Kjeldahl method with the SBS 2000 analyzer unit (Food ALYT, Germany) and the percentage nitrogen (%N) obtained was used to calculate the percentage crude protein (% CP) using the relationship: % CP = % N X 6.25. Ether extract percentage was determined using Soxhlet system Tecator-1050 extractor technique. The percentage 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 percentage (% CF) was determined by dilute acid and alkali hydrolysis. Carbohydrate was calculated by difference including fiber. CHO% = 100-(MC%+CP%+Fat%+Fiber%+Ash%), where CP=crude Protein, CHO=Carbohydrate, MC=Moisture Content. The energies of samples were also calculated by using the Atwater's conversion factor, 4kcal/g for protein and carbohydrate and 9kcal/g for fat.

2.3. Mineral Content Analysis

For mineral determination, dry and ashing method of the all samples were carried out according to the method [15]. Calcium, magnesium, potassium, Zink and iron were determined by atomic absorption spectrophotometer of (Agilent AAS series 200, USA).

2.4. Data Analysis

The proximate and mineral composition of the food barley varieties whole flour sample was determined in duplicate. The duplicated sample results were analyzed by one way ANOVA (Analysis of Variance) using statistical tools of SAS version 20 [16]. Significance was accepted at 0.05 level of probability ($p \leq 0.05$). Mean separation was performed by "Each pair LSD t-test" for multiple comparison of means.

3. Result and Discussion

3.1. Proximate Composition

The 22 food barley varieties whole flour samples proximate composition was determined according to AOAC method. The compositions like protein, moisture content, crude fiber, crude fat, total ash, carbohydrate and energy were significantly different to each varieties of the food barley even though they were grown in the same agro ecological. According to the results shown in table 1 below varieties like cross 41/98, Agegnehu and Abdene were high in CP mean value than other varieties significantly. Their mean values were 14.10%, 13.68% and 13.64% respectively. But others also have nearest mean value other than Dimtu and Dinsho. The same study also reported that the CP varied to different cultivars [17]. The MC of the samples were significantly different at ($P<0.05$). This was because of the moisture content depends on the storage condition and hydroscopic capacity of the seed. It ranged from 12.00% to 13.07%. Moisture (g/100g) in barley from Jordan, Morocco and the FAO was 4.5, 7.8 and 10.1%; also respectively reported by Sterna V and others [18]. Moreover rather similar results were previously reported by Erkan H [19], who found that moisture in hulled barley flour ranged between 10.7-11.8%, whereas it was 11.9% in hull-less barley flour. But in this study MC recorded was more than these reports. Total ash content was statistically different for all varieties. Setegn, Estayish and cross 41/98 were significantly higher total ash content than others, which mean values were 2.34%, 2.27% and 2.22% respectively. But Harbu was significantly lower in total ash content mean (1.43%). The crude fiber content was significantly different among the varieties. Estayish, Agegnehu, HB1307 and Tilla varieties were statistically highest in crude fiber content than others with 15.88%, 15.46%, 15.40% and 15.10% mean values respectively. The mean values were significantly different at ($p<0.05$). Crude fat was not expected to be higher in cereals (barley) as many

studies described. The crude fat content was significantly different at (P<0.05) among varieties. HB1307 was higher in crude fat content mean value (7.40%) while Setegn was less in mean value than the other varieties statistically. Cereals especially barley was higher in carbohydrate than other crops as many reviewers indicated in their studies. Similar results were shown by Yamada S and others [20] who found that oil content ranged from 1.9-4.1% and represented positive correlation with protein content. In this study the varieties were evaluated in their CHO content and it was significantly different in mean value at (P<0.05). Ardu-12-60B, Diribie, Dinsho and Belemi were statistically higher in CHO mean value than other varieties with which 58.45%, 56.13%, 55.92% and 55.14% respectively. HB1307, Tilla and Mezezo were significantly lowest in CHO content mean value than the other varieties. Energy calorie mean was significantly different as the table result shown below. According to the statistical result Belemi and Ardu-12-60B were significantly higher in mean value 324.30 and 320.81 respectively than the other varieties. And it was also in good range of calorie level as some cereal studies reflected. Crude fiber, ash and carbohydrates recorded in barley from Jordan, morocco and the FAO [19] shown the ranges that correlated to this study result. The crude fiber content was higher in the hulled barley (3.7%), while it was 1.9% in the dehulled barley; as well as hull-less barleys had more digestible energy than the hulled varieties [21]. This study results nearly correlated to these reports for whole barley varieties. Likewise, in agreement with the the study data [22] reported that ash content of whole kernels was significantly lower in hulled barley than in whole barley, on the other hand [22] showed that ash content was varied to cultivars. There was a negative relationship between carbohydrates and protein content of barley grain [23], the same trend was also observed in this study.

3.2. Mineral Content

As the result in table 2 below reflected the major mineral content were determined for each varieties. The Ca content was significantly different among varieties. Shege and Dimtu were statistically higher in Ca content mean value than others, which 0.052% and 0.072% were their Ca content mean respectively. Diribie and Tilla were lower in Ca content than others. But all varieties were almost significantly different in Ca content at (p<0.05). The K mean values were significantly different at (P<0.05) among the varieties. Belemi (1.674%) and Dimtu (1.504%) were highest in K mean values than others whereas Biftu were the least in K mean value (0.548%). Zn and Fe were the most important macro nutrient especially for developing countries as described by many reviewers. But as table 2 shown below Agegnehu and Belemi were significantly highest in Zn mean value than others with 0.024% and 0.013% mean respectively. Zn mean result shown significant difference to each variety. Again Belemi and Agegnehu were highest Fe content mean than others significantly. Tilla was statistically lower in Fe mean than other varieties which shown 0.007% mean value. Mg is very important mineral especially in barley. As the result reflected Besso and Dimtu were higher Mg mean value than others statistically. Also it was significantly different to all varieties at (P<0.05). Generally all varieties mineral contents were almost in the range of important level of composition. And these five minerals were common in cereals especially barley as some studies output. The chemical composition of selected Jordanian cereals and legumes as compared with the FAO, Moroccan, East Asian and Latin American tables also show the same trend of mineral composition [19].

Table 1. *Some selected Food barley varieties proximate composition results.*

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

CP: Crude Protein, MC: Moisture Content, CHO: Carbohydrate, a-k: means in the same column with varying superscript letters differs significantly at (p<0.05).

Table 2. *Some major mineral content results of selected food barley varieties.*

Mineral content parameters and results in (%)					
Variety	**Ca**	**K**	**Zn**	**Fe**	**Mg**
Shege	0.0819^{a}	0.8024^{hi}	0.0094^{c}	0.0194^{de}	0.3356^{cde}
Dimtu	0.0717^{b}	1.5040^{ab}	0.0051^{efgh}	0.0323^{ab}	0.4027^{b}
Harbu	0.0683^{bc}	0.8710^{hi}	0.0028^{kl}	0.0108^{hi}	0.2339^{gh}
Setegn	0.0665^{bcd}	1.2988^{cd}	0.0050^{fghj}	0.0129^{ghi}	0.3356^{cde}
Belemi	0.0646^{bcd}	1.6737^{a}	0.0129^{b}	0.0334^{a}	0.3726^{bc}
Cross 41/98	0.0635^{cde}	1.0751^{egf}	0.0066^{def}	0.0149^{efg}	0.3059^{efd}
Mezezo	0.0597^{def}	1.4313^{bc}	0.0049^{fgh}	0.0183^{def}	0.3309^{cde}
Estayish	0.0569^{efg}	0.7741^{ij}	0.0039^{hij}	0.0266^{bc}	0.2382^{gh}
Abdene	0.0547^{fg}	0.9650^{fgh}	0.0024^{l}	0.0118^{hi}	0.2106^{hi}
Dinsho	0.0505^{gh}	1.2814^{cd}	0.0035^{jkl}	0.0134^{fgh}	0.2991^{ef}
Besso	0.0504^{gh}	1.2142^{de}	0.0078^{cd}	0.0186^{def}	0.4707^{a}
IAR/H/485	0.0503^{gh}	0.8878^{ghi}	0.0083^{cd}	0.0235^{cd}	0.2707^{fg}
Mulu	0.0501^{gh}	1.1158^{def}	0.0054^{efg}	0.0192^{def}	0.3097^{efd}
HB1307	0.0462^{hi}	0.8289^{hi}	0.0057^{efg}	0.0266^{bc}	0.2377^{gh}
Gobe	0.0456^{hij}	0.8845^{hi}	0.0038^{hij}	0.0242^{cd}	0.2276^{gh}
Tiret	0.0432^{hij}	0.8423^{hi}	0.0045^{ghi}	0.0122^{hi}	0.1686^{ij}
HB-42	0.0415^{ij}	0.5950^{jk}	0.0023^{l}	0.0191^{def}	0.1499^{j}

Mineral content parameters and results in (%)					
Variety	**Ca**	**K**	**Zn**	**Fe**	**Mg**
Ardu-12-60B	0.0390^{ij}	0.7138^{ijk}	0.0030^{kl}	0.0108^{hi}	0.2407^{gh}
Biftu	0.0387^{ij}	0.5478^{k}	0.0029^{kl}	0.0291^{abc}	0.1906^{hij}
Agegnehu	0.0375^{j}	0.8326^{hi}	0.0245^{a}	0.0136^{efg}	0.2204^{ghi}
Diribie	0.0265^{k}	0.5901^{jk}	0.0068^{de}	0.0071^{i}	0.1998^{hij}
Tilla	0.0032^{l}	0.7574^{ij}	0.0033^{jkl}	0.0191^{def}	0.3264^{cde}
LSD	0.0080	0.1890	0.0020	0.0060	0.0580

a-1: means in the same column with varying superscripts differs significantly at ($p<0.05$).

4. Conclusion

The study proved that there was a significant difference in proximate and some mineral content between the varieties. But since the varieties were from similar agro ecological locations the nutrient compositions were in acceptable range for barley human consumption. Especially varieties like Cross41/98, Setegn, Estayish, HB1307, Ardu12-60B and Belemi were well performed in proximate composition results. But Shege, Belemi, Agegnehu and Besso varieties shown good performance in mineral content result. Generally these food barley varieties were potent in proximate and mineral nutrient composition for human consumption especially for their good fiber content, Carbohydrate and energy source. And the basic nutritional information of these varieties was generated for further research purpose and also for community nutrient choice.

Conflict of Interest

The author declares that there is no conflict of interests regarding the publication of this paper.

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