Nutritional and Baking Quality of Newly Released Bread Wheat Varieties

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Abstract

The objective of this research was to study the nutritional and baking quality of newly released bread wheat varieties by the Wheat Improvement Program (WIP) of the Ethiopian Institute of Agricultural Research (EIAR). Grain hardness and softness, proximate composition, gluten content, falling number and bread sensory quality of five newly released bread wheat varieties (Wane, Hidasse ,Ogolcho, Kingbird and Lemu) and two varieties released earlier (Pavon and Kubsa) and grown at Kulumsa Agricultural Research Center were evaluated. Thousand kernel weights (TKW) of the newly released bread wheat varieties were found to be in the range of 35g (Kingbird) to 46.5g (Hidase), while the checks Kubsa and Pavon scored 42.5g and 43g, respectively. Hectoliter weight (HW) of grains of the cultivars followed almost closer trend as TKW and ranged between 78.4kg/hl (Kingbird) and 81.7kg/hl (Ogolcho), while the checks, Kubsa and Pavon, scored 85.9kg/hl and 86.1kg/hl, respectively. Results of grain protein content and single kernel characterization indicated that, except Hidase, all the cultivars could be considered as hard wheats that are suitable for making leavened baked products. From this study, it was concluded that the gluten quality and quantity, protein content, bread baking quality and sensorial quality of the five bread wheat varieties were acceptable and can be used for production of bread.

Introduction

Wheat (*Triticumaestivum*L.) is the most important cereal crop and staple food of about two billion people around the world (FAO,2016).Commercially cultivated wheat is basically of two types, i.e. durum wheat (*Triticum turgidum*) and bread wheat (*Triticum aestivum*), which differ in their genetic makeup, adaptation and uses. It is estimated that almost 90% of the total wheat produced is used for bread production. In terms of production and consumption, wheat is one of the main cereals grown in Ethiopia also as it is is produced by about 4.6 million farmers producing close to 4.2 million tons that cover 1.6 million hectares of land per annum (CSA,2015).

According to the same source, the average productivity of wheat in the country has been consistently increasing for the last 20 years and has reached about 2.5 t/ha. This was due to the efforts done in the use of recommended inputs like fertilizer, improved varieties and cultural practices (which the results of the national agricultural research system). However, the increase in the total production in the recent years has been somewhat slow mainly because of rust epidemics. This contributed to the wheat production lag behind consumption making the country to be net importer and the volume of annual imports is increasing over the years. In order to curve a trend the government is working to increase rapidly the total production to achieve self-sufficiency.Availability of high yielding and disease resistant wheat varieties with competent nutritional and processing quality is one of the critical factors that can contribute to the effort. Therefore, the national agricultural research system is working to address issue and so has released a number of improve varieties.

Recently, in addition to the focus for high yield, the national wheat research programis being pressured to revise its priority and to focus on quality-oriented breeding. Wheat quality depends upon the genetic factors but, environmental conditions, growth locations; agronomic practices prevailing during different wheat growth stages greatly alter the wheat end-use quality attributes (Kent and Evers, 1994). Generally, bread wheat quality refers to its suitability for making baked products, which is based on physical, chemical and nutritional properties of the wheat grain. Protein content is a key quality factor that determines the suitability of wheat for a particular type of product as it affects other factors including mixing tolerance, loaf volume and water absorption capacity (Shah *et al*., 2008). Both protein quantity and quality are considered important in estimating the potential of flour for its end use quality (Farooq*et al*., 2001).The sensory qualities of bread are affected by wheat variety composition, method of milling, storage conditions, rheological properties, kneading techniques, baking method and temperature (Siddique, 1989). Wheat is grown over wide agro climatic range and is expected to exhibit yield and quality differences (Chaudhry*et al*., 1995). Therefore, this study was done to evaluate nutritional, sensory, and baking quality of bread wheat varietiesnewly released by the national bread wheat-breeding program.

Materials and Methods

Materials and milling

Five recently released bread wheat varieties (Hidase, Ogolcho, Lemu, Wane and Kingbird) for high yield and disease resistance and two older varieties (Pavon and Kubsa -used as a check) were included in the study. The wheat samples were collected from Kulumsa Agricultural Research Center grown in the 2015/16 cropping season. The grain samples were manually cleaned and made ready for analysis.

Grain samples were completely floured using Perten Laboratory Mill 120 (Pertern Instruments, Sweden) fitted with 0.8 mm sieve. Flours immediately packed in to polyethylene bags and stored at 4^{o}C until flour physicochemical analysis andbaking test is done.

Grain physical characteristics

Wheat samples were uniformly divided through Boerner Divider to get representative sample for grain physical quality characteristics analysis. Characteristics of Grain physical quality analysis, such as thousand-kernel weight, hectoliter weight, grain purity and germination potential were done as described in AACC method (AACC, 2000).

Single kernel characterization system (SKS) **(**Single Kernel Characterization, SKCS 4100), a special equipment, was used to determine the weight, diameter, hardness/softness and moistureof a single kernel. In an instrument 12 to 16 grams of wheat sample free from broken kernels, weed seeds, and other foreign material was poured into the access hopper of the equipment and for each parameter mentioned above processed of 300 kernels was obtained.

Protein and ash content

The protein, ash and moisture content in the whole flours of bread wheat varieties were determined using near infrared (NIR) spectroscopy (NIR Grain analyzer model 1241) as described in AACC (2000).

Gluten content

Glutomatic system (Perten Instruments, Sweden) was used to determine wet and dry gluten as stated in AACC (2000). Where ten grams of flour samples were weighed and placed into the glutomatic-washing chamber on top of polyester screen, then every flour sample was mixed and washed with 2% salt (NaCl) solution for 5 minutes. Then the wetgluten was removed from the washing placed in the centrifuge holder and centrifuged to stop automatically. After this, the wet gluten passed through the sieve was quantified by weighing. The dry gluten content was then determined by weighing after drying the wet gluten dried in a Glutrok 2020 heater to give dry gluten.

Falling number

Falling Number was determined by using the standard method stated in AACC (2000) utilizing falling number analyzer (Falling No.1500, Perten Instruments, Sweden).

Bread making

The bread type prepared for the study was on cultural Ethiopian bread type made from completely floured bread wheat called "diffo" and the commonly known procedure was followed. The formulation utilized was 2 cups bread wheat whole flour, 1 cup of tapwater and 1 small cup of dried yeast.

Sensory evaluation

Sensory parameters included in the bread sensory analysis were color, taste, flavorand texture. The evaluation was carried out by 20 panelists and the samples were presented in succession.The panelists were asked to rate the samples a 5- point Hedonic scale as described in Land and Shepherd (1988).

Statistical analysis

The data collected were subjected to analysis of variance (ANOVA) by using SAS 9.1 software and SPSS version 20.0 for Windows (SPSS Inc, Illinois, USA). The mean separation was done with significant level of $p<0.05$ using a Fischer / LSD test.

Results and discussion

Grain physical characteristics

The physical characteristics of the grains of the bread wheat varieties are shown in Table 1. Thousand kernel weights (TKW) of the newly released bread wheat varieties were found to be in the range of 35g (Kingbird) to 46.5g (Hidase) while the checks Kubsa and Pavon scored 42.5g and 43g, respectively. The hectoliter weight (HW) score of the grains of the cultivars followed almost closer trend as TKW and it ranged between78.4kg/hl (Kingbird) to 81.2kg/hl (Hidasie) and 81.7kg/hl (Ogolcho) while the checks Kubsa and Pavon scored 85.9kg/hl and 86.1kg/hl respectively. The flour yield of the cultivars is expected to vary according to the TKW and HW they scored because the parameters are indicators of the flour yield (Leszcznyska and Cacak-Pietrzak, 2004). Purity scores of the grains were almost equivalent and lied between 97.9% to 98.9% and this could be due to the cleaning done before the test. Wider variation was observed in the germination potential of the newly released varieties (85.8%, Wane to 96.1 Kingbird) while the older varieties had 98.5% (Kubsa) and 98.9% (Pavon).

Table 1. Grain physical properties of bread wheat varieties

Wheat	TKW (g)	HW (Kg/hl)	Purity (%)	Germination potential (%)
Hidase	46.50	81.20	98.90	88.75
Kingbird	35.00	78.40	98.35	96.10
Lemu	39.50	80.65	96.39	86.25
Ogolcho	40.95	81.80	97.94	90.93
Wane	35.00	80.19	98.95	85.80
Pavon	43.00	86.12	98.89	98.93
Kubsa	42.50	85.87	98.22	98.49

TKW= Thousand Kernel Weight, HW= Hectoliter Weight

Results of the single kernel characterization (SKC) are depicted in Table 2. Available grain moisture in the kernels measured using SKC varied between 12.98% and 13.97%. Single kernel weight of the new cultivars ranged of 35.5mg (Kingbird) to 45.2mg (Hidase) while the checks Kubsaand Pavon scored 23.4mgand 34.5mg, respectively. The mean diameters of the kernels of the cultivars varied in almost

similar fashion with the kernel weight: Between 2.7mm (Wane) and 2.8mm (Kingbird) to 3.0mm (Hidasie), while the checks scored 2.7mm (Pavon) and 2.8mm (Kubsa).

In addition, both single kernel weights and kernel diameters of the cultivars had nearly the same trend as TKW and HW as they all are indicators of how much the grains of the cultivars were plumb which indicate the potential flour that can be extracted per unit weight of wheat grain.

Cultivars with higher TKW, HW, single kernel weight and diameter could give higher amount of flour per unit weight of grain. The newly released cultivars seem to be softer because the hardness index of their kernels (which ranged from 30.6%- Hidase to 72.6%-Wane) less than those of the older varieties (87.7% -Kubsa and 92.4- Pavon).

Table 2: Results of Single Kernel Characterization (SKC) test

Variety	Grain Moisture (%)	Single Kernel Weight (mg)	Kernel Diameter (mm)	Hardness index (%)
Hidase	13.40 ± 0.06	45.20 ± 1.30	3.02 ± 0.02	30.58 ± 1.70
Kingbird	13.19 ± 0.02	35.54 ± 0.17	2.75 ± 0.08	61.43 ± 0.70
Lemu	13.17 ± 0.02	40.46 ± 0.53	2.93 ± 0.03	62.16 ± 0.63
Ogolcho	12.98 ± 0.03	40.06 ± 0.87	2.80 ± 0.04	66.53 ±0.70
Wane	13.08 ± 0.06	35.61 ± 0.32	2.66 ±0.05	72.58 ± 0.68
Pavon	12.90 ± 0.01	34.47 ± 0.47	2.72 ± 0.03	92.41 ± 0.37
Kubsa	13.97 ± 0.07	23.40 ± 0.27	2.78 ± 0.01	87.69 ± 2.01

Flour chemical quality

The moisture contents in completely floured samples significantly varied ($p<0.05$) from measured from 12.07% (Hidasie and Kingbird) to 12.95% (Kubsa) showing some differences with the result from SKC (Table 3). This could be due to the differences in the methodologies utilized. Important ($p<0.05$) variation was observed in the protein contents of the bread wheat varieties. Protein is one of the critical quality components that influence most of wheat grain baking quality characteristics like bread volume. Among the newly released varieties, Wane (15.43%) had significantly higher protein content than all the remaining new and older cultivars.Except Hidase (11.3%) the newly released varieties scored higher protein content than Pavon (12.1%). However, Kubsa (14.3%) had significantly higher protein content than Hidase (11.3%), Ogolcho (13.5%), Lemu (13.4%), and Kingbird (13.7%). Except Hidase the protein contents of all the varieties were >12% and this could make them to be categorized under hard bread wheat thatis suitable for leavened bread preparation.In general the protein content of the newly released varieties was in the range recommended for bread wheat. Results of the present study were in consistent with the findings of Soboka *et al*. (2017). The ash contents of the seven varieties evaluated in this study had also important ($p<0.05$) differences and they varied between 1.0 % (Lemu) and 1.3% (Hidase and Kubsa).

Table 3: Protein and ash contents of the durum wheat varieties

Variety	Moisture	Protein	Ash
Hidase	12.07 ± 0.03 d	11.31 ± 0.10 f	1.28 ± 0.03a
Kingbird	12.38 ± 0.12 c	13.71 ± 0.07 c	1.20 ± 0.04 c
Lemu	12.07 ± 0.04 a	13.44 ± 0.09 d	0.96 ± 0.05b
Ogolcho	12.56 ± 0.01 b	13.50 ± 0.07 d	1.20 ± 0.02c
Wane	12.47 ± 0.60 b	15.43 ± 0.08a	1.20 ± 0.06c b
Pavon	12.53 ± 0.03 b	12.12 ± 0.03g	1.02 ± 0.03 b
Kubsa	12.95 ± 0.14a	14.30 ± 0.04 b	1.28 ± 0.05a

Values are mean ± SD and those with different letter are significantly different (P < 0.05).

Gluten content and falling number

The gluten protein is the major part of the total protein in wheat grain. Wet gluten content gives a good indication of wheat protein content. Dry gluten is now being measured after removal of water from wet gluten to get a more consistent comparison of gluten content among samples.The wet and dry gluten contents of the cultivars varied between 27.8% to42.4 percentage and 9.1% to 15.9%, while their gluten index ranged between 80.5% and 91.7% (Table 4). This range is in agreement with the report by Soboka et al. (2017) on some Ethiopian bread wheat varieties. Falling number indicates the alpha amylase activity in the wheat flours. All samples had high falling numbers (589s to 929.5s), which is similar with what is usually reported.

Table4: Analysis of gluten quality and quantity and falling number of the varieties.

Variety	Wet gluten content (%)	Dry gluten content (%)	Gluten Index (%)	Falling number (s)
Hidase	42.40 ± 0.43a	9.10 ± 0.07	80.50 ± 0.08 a	674.00
Kingbird	39.98 ± 0.45 b	9.55 ± 0.77	83.00 ± 0.14 a	722.00
Lemu	30.80 ± .28 c	11.54 ± 0.62	90.50 ± 0.70a	726.50
Ogolcho	27.81 ± 0.57 d	10.27 ± 0.44	91.66 ± 0.75a	929.50
Pavon	41.85 ± 0.21a	15.91 ± 0.26	90.65 ± 0.67b	731.50
Wane	31.12 ± 0.17 f	10.41 ± 0.12	87.92 ± 0.25c	589.00
Kubsa	29.95 ± 0.23 g	10.75 ± 0.21	88.13 ± 0.17d	852.00

Values are mean ±SD and those with different letter are significantly different (P <0.05).

Bread sensory evaluation

The results of the sensory analysis of the bread samples produced from newly released bread wheat varieties are presented in Table 5. Visible variations in the bread volume, color and overall acceptability were observed of the bread samples from the different varieties studied. For instance, breads from Wane, Hidasse, and Ogolcho had the highest color and bread loaf volume scores, whereas breads from Kingbird and Lemu showed the lowest color and loaf volume. However, their texture and taste were almost similar. In general, the breads obtained from the new cultivars were acceptable to the panelists.

Table5: Sensory evaluation of bread made from wheat varieties

Variety	Loaf volume	Color	Texture	Taste	Overall acceptability
Hidasse	3.56±0.96 a	3.63±0.50 b	3.00±1.10 a	3.44±0.81 a	3.50±1.21 b
Kingbird	2.94±1.06 b	3.50±0.89 bc	3.19±1.05 a	3.31±1.01 a	3.31±1.19 b
Lemu	2.44±1.21 b	3.75±0.93 b	3.13±1.02 a	3.75±1.06 a	3.63±1.02 b
Ogolcho	3.19±1.17 ab	3.56±1.09 b	3.00±0.97 a	3.63±1.02 a	3.19± 0.91 c
Wane	3.38±1.15 ab	3.25±1.06 c	3.13±1.26 a	3.44±1.09 a	3.50±1.15 b
Pavon	3.31±0.87 ab	3.06±1.12 c	3.13±1.15 a	3.50±1.03 a	3.56±1.09 b
Kubsa	3.56±0.81 a	4.25±0.68 a	3.50±0.89 a	3.69±0.87 a	4.00±0.82 a

Values are mean ±SD, and those with the same letter are not significantly different at $P \geq 0.05$.

Conclusions

The results of this research illustrated the variations between newly released and the older bread wheat varieties (used as checks) in their grain physical properties, flour chemical properties, and bread sensorial characteristics. Except Hidase, which could be classified as soft wheat, all the new bread wheat varieties could be considered as hard wheat and suitable for leavened bread preparation. However, as this study is just a preliminary evaluation, flour physicochemical and rheological properties and controlled baking, which can give a better insight in to the quality of recently released varieties and feedback to bread wheat-breeding program, should be investigated.

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