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ORIGINAL RESEARCH ARTICLE

NUTRITIONAL AND QUALITY ASSESSMENT OF SOME IRRIGATED WHEAT GENOTYPES IN NIGERIA

F. Abubakar[1]* and A. Zigla[2]
[1]*Lake Chad Research Institute, Maiduguri, Borno State, Nigeria.*
[2] *National Agency for Food Drug Administration and Control, Maiduguri, Borno State, Nigeria.*
**Corresponding author's email address: fatidupli@yahoo.com*

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ABSTRACT

The aim of this study is to evaluate the nutritional and end-use qualities of some advanced irrigated Nigerian grown wheat genotypes which was developed and produced by Lake Chad Research Institute, Maiduguri, Borno State of Nigeria. Standard methods were used to determine the physical, milling, proximate, baking, sensory, functional, rheological and textural qualities of the Nigerian grown wheat. The result showed that grain physical characteristics of the eleven irrigated wheat genotypes were statistically significant. Flour extraction differed significantly from 66.1-79.6% in the irrigated wheat genotypes. Three irrigated genotypes namely, Florkwa-2, Soonot 5, and Hubara-3 had the highest flour extraction rate with flour yield above 75%. Proximate flour quality indicated significantly higher protein content in Hubara (15.2%), Pastor-2 (15.8%), Kauz (16.2%), Soonot-5 (15.8%), while Katila-17 had higher carbohydrate (73.2 %) than Hubara-1. The results for dough and bread functional and textural qualities further showed that Attila-7, Katilla17, Angi-2 and Soonot-5 were superior to the other genotypes, and comparable to the standard imported flour. However, bread sensory evaluation gave the standard flour higher score rating. Therefore, the nutritional and end use quality indicated that Nigerian grown wheat had properties suitable for bread production. The wheat genotypes namely Soonot - 5 and Attila-7, among the other irrigated genotypes used in this study, were rated higher in bread baking quality and were even comparable to the standard imported flour which indicated that Nigerian grown wheat can be used to produce bread

1.0 Introduction

Wheat (*Triticum aestavum* L.) is unique among cereals, because it contains gluten which has the characteristic of being elastic when mixed with water and retains the gas developed during dough fermentation (Makwai *et al*., 2013). Quality wheat flour is of prime importance to the baking industry, which depends largely on the amount of protein and quality of gluten. Wheat flour with large amount of protein and high quality gluten is used for normal bread, whereas that with lower amount of protein is mostly used for confectionary or cakes (Caballero *et al*., 2007). Wheat varieties exhibit different protein qualities and quantities, influenced mainly by environmental factors, and the quality of the protein is mainly a heritable characteristic (Bordes *et al.,* 2008).The annual global wheat production of about 620 million tons is mostly traded from developed temperate countries, to the high wheat-consuming developing countries (Bordes *et al.,* 2008). The consumption of bread has increased considerably due to population increase, urbanization, the changing preference for convenient foods particularly snacks and increased wealth in Nigeria and other tropical countries (Andrae and Beckman. 1985: Seibel, 2006; Shittu *et al.,* 2007; Odedeji and Adeleke, 2010; Malomo *et al.,* 2011). Wheat production by these high wheat-consuming developing tropical countries is very low, thus they almost solely rely on other developed temperate countries to supply their requirements through imports (Edema *et al.,* 2005; Abdelghafor *et al*., 2010). Data in 2010 indicates that import bill for African countries amounted to US$ 12.5 billion. Nigeria requires 3.7 million tons of wheat grain per year, but presently produces only 250,000 metric tons (3.2% self-sufficiency), and thus is the world's largest importer of USA hard red and white winter wheat, with total imports into Nigeria during 1999-2010 reaching US$6,792,934,000, and since 2005 the annual value was US$4.0billion (Ohinmain, 2014). The current value is about N632 billion indicating the growing dependence on wheat which needs to be curtailed. There is therefore the need to encourage local wheat production and to develop improved Nigerian grown varieties through biotechnology and agronomic practices in order to reduce the cost of importation expenses and to be more self-reliant. The production of locally grown wheat will lead to increase self-sufficiency, employment generation and increase in income through production, processing and value addition.

Bread and allied products are the major forms in which cereal grains particularly wheat is consumed worldwide and therefore, they occupy an important position in the diets of many people, (Kent-Jones and Amos, 1967). The acceptability of these products depends on their quality, which affects their final composition of the flour, recipe and the baking procedures, (Maga 1975). Baking quality is a criterion used to determine the quality and suitability of wheat. The baking quality depends on types of wheat uses and processing conditions. Strong (hard) wheat are considered of the higher quality and suitable for bread making, where most of cakes made from soft wheat flour. Baking quality is determined by the rheological properties of wheat flour (Ktenioudaki *et al*., 2010). The rheological property of wheat flour is essential because it determines other physical characteristics such as dough (baking) volume and sensory attributes (Muller, 1975). Bread production accounts for about 75% of the total wheat flour usage while confectioneries account for about 25%, (Ohinmain, 2014). About 6.2 billion loaves of bread are supplied into the Nigerian market annually from over 20,000 bakeries, estimated at about N105 trillion per annum (Ohinmain, 2014). The Federal Government of Nigeria had tried to find ways of reducing importation through policies and regulations over the years, such as substitution of wheat with cassava (Butt *et al.,* 2011; Ohinmain, 2014). There had been previous attempts to boost the production of wheat in the country, in order to reduce the dependency on wheat importation, and recently the Agricultural Transformation Agenda (ATA) of the Federal Government and African Development Bank (AfDB) and the sponsored Support to Agricultural Research and Development to Strategic Crops (SARD-SC) wheat project. However, success of these drives hinges mainly on the development and release of high yielding and good quality wheat varieties. Several, irrigated wheat genotypes had been identified and are currently at prerelease-advanced stage. Nutritional and baking quality tests are mandatory requirements for the release of varieties in Nigeria so as to encourage the production and consumption of Nigerian grown wheat. The aim of this study is to assess the end-use qualities of some advanced irrigated wheat genotypes, and to identify and release those that possess good physical, milling, proximate, baking, sensory, functional, rheological and textural qualities.

2. Materials and Methods

Eleven locally grown wheat genotypes were evaluated for grain, flour and bread baking qualities using standard procedures. The imported wheat flour (Hard Red Winter) was obtained from Golden Penny Company, Nigeria as a control. The physical characteristics of wheat grains which includes, grain weight, kernel length and thickness were determined using standard methods (Williams *et al*., 1986). Flour extraction was performed by Brabender quadrumat senior mill (German model Brabender OHG D47055 Duisburg, type 880200) at Lake Chad Research Institute, Maiduguri. The wet and dry gluten were determined by hand washing method for wet gluten and kept in hot air oven (Gallenkamp BS Oven 250, size 2, Germany) set at 100°C to dry for 24 h for dry gluten. The methods described by AACC (1973), and AOAC (2000) were followed to determine the moisture, crude fat, crude protein and ash contents in the different genotypes. Carbohydrate was determined by difference (Egan *et al.,* 1981). Bread baking quality was done using straight dough, single mixing and fermentation process and resulting loaves were evaluated in terms of the volume, weight, crust and crumb characteristics Sensory quality (consumer acceptability) of the bread samples was done using a panel of 25 trained persons and a 9-point hedonic scale (where 1 = extremely unacceptable and 9 = extremely acceptable) was used, (Iwe, 2010). Attributes evaluated include bread appearance, crust color, crumb color, texture, taste, chewability, flavour and overall acceptability. Keeping quality of packaged bread samples were evaluated on samples kept at ambient conditions for 5days, with microbiology and physical evaluations (weight, moisture, texture) were done at the start and end of the storage period. Resulting data were analyzed using analysis of variance (ANOVA) and mean separation was done using Least Significant Difference (LSD) test, at 5% level of probability ($p<0.05$), (Duncan, 1955).

3. Results and Discussion

3.1 Physical Characteristics of Eleven Genotypes of Irrigated Wheat

Table 1 show the results on grain physical characteristics of the fourteen irrigated wheat genotypes. The irrigated wheat genotypes did not differ significantly (P>0.05) with respect to grain physical characteristics (Table 1). Grain physical characteristics correlates very well with flour yield and quality as reported by various workers, Pena, (1995); Nkama and Bijik (2001); Dziki and Laskowski, (2005); Nuttall *et al.*, (2017).

The result for the physical properties of the irrigated wheat grains is shown in Table 1. The 1000 grain weight indicated that there were significant differences among samples. It observed that the values ranged from 33.46-38.88g with Florkwa-2 having the highest value while pastor-2 had the lowest grain weight of 33.46g. The grain length indicated that there were significant differences among samples which ranged from 5.96-6.47mm with hubara-2 having the highest value of 6.47mm while Pastor-2 had the lowest length. The grain volume indicated that there were significant differences among samples as the grain volume ranged from 27.24 to 31.13mm^3 with Katilla-17 having the highest value of 31.13mm^3 while Soonot-5 had the lowest volume. Grain thickness indicated that there were also significant differences among samples which indicated that the thickness width ranged from 3.06mm with Soonot-5 having the lowest thickness while angi-2 had the highest thickness value. The grain density indicated that there were significant differences among samples and these values ranged from 1.20-1.31g/ml with Atilla-7 having the lowest density value while Soonot-5 had the highest value for density with 1.20g/ml. As the result indicates, the values are within the range reported by workers for various physical properties of wheat varieties, (Pomeranz, 1971 and Kent, 1983).

Table 1. Physical Characteristics of Eleven Genotypes of Irrigated Wheat

Genotype	Length	Thickness	I000-grain weight (g)	1000-kernel volume (mm^3)	Kernel density
Attila-7	6.18 c	3.61a	34.30i	28.54 e	1.20e
Hubara-1	6.18c	3.59 a	35.52 h	28.56e	1.24d
Pastor-1	6.26bc	3.56a	36.07f	28.57e	1.26c
Pastor-2	5.97d	3.59a	33.46 j	27.58f	1.21e
Angi-2	6.31b	3.63a	38.16b	30.25c	1.26c
Kauz'S'	6.28bc	3.25b	37.28e	30.16c	1.24d
Hubara-2	6.47a	3.30b	37.96c	30.15c	1.26c
Florkwa -2	6.18c	3.22b	38.88a	30.64b	1.26c
Katila-17	6.28bc	3.25b	38.78a	31.13a	1.24d
Hubara-3	6.20bc	3.27b	37.57d	29.26d	1.28b
Soonot5	6.28bc	3.06c	35.75g	27.24g	1.31a

Values are means of duplicate determinations and values with different superscript along the columns are significantly different (p<0.05)

3.2 Proximate Composition of Eleven Genotypes of Irrigated Wheat

The irrigated wheat genotypes expressed significant (P<0.05) differences in flour proximate quality. The result of proximate composition is as shown in Table 2 and the results were within the range reported by various workers, Pomeranz, (1971); Kent, (1984), Nkama, (1995); Dziki and Laskowski, (2005); and Anon, (1982). The result of the crude protein ranged from 11.35% - 10.45%. Kattilla-17 had the highest protein content while Kauz had the lowest protein content. The protein content was significantly higher in Hubara-1 (15.40%), Kauz's' (16.35%), and Soonot 5 (15.85%). The quality of wheat flour for bread-making is generally evaluated by the amount of protein and quality of gluten; and wheat is unique among cereals, because it contains gluten which has the characteristic of being elastic when mixed with water and retains the gas developed during dough fermentation (Khatkar *et al.,* 1995). The moisture content ranged from 9.35-11.65% with Atilla-7 having the least moisture content while Angui-2 had the highest moisture content. The crude fibre ranged from 2.90% for Kauz's' to 3.10% for Angui1. The ash content ranged from 1.25% for Hubara1 and Katila7 to 1.55% for Pastor. The fat content ranged from 1.00% for Hubara-2 to Hubara1 with 1.30% while carbohydrate content ranged from 67.60% for Hubara-1 to 72.75% for Katila-I7 (Table 2).

Table 2 Proximate Composition of Eleven Genotypes of Irrigated Wheat

Genotype	Moisture	Protein	Fibre	Fat	Ash	Carbohydrate
Attila-7	9.35g	14.65d	2.95ab	1.25ab	1.50a	70.30 c
Hubara-1	11.20b	15.40c	3.05ab	1.30 a	1.45ab	67.60i
Pastor-1	11.37b	13.45g	3.10a	1.25ab	1.50a	69.33ef
Pastor-2	10.50d	15.65bc	2.95ab	1.30a	1.55a	68.05hi
Angi-2	11.65a	13.75f	3.10a	1.17abc	1.46a	68.86fg
Kauz'S'	9.70f	16.41a	2.90b	1.15abc	1.30bc	68.53gh
Hubara-2	10.70c	14.45de	3.05ab	1.00c	1.25c	69.55de
Florkwa -2	10.20e	12.60h	2.95ab	1.00c	1.45ab	71.80b
Katila-17	10.50d	11.35i	3.00ab	1.15abc	1.25c	72.75a
Hubara-3	10.10e	14.30e	3.10a	1.10bc	1.30bc	70.10cd
Soonot5	10.65cd	15.85b	3.00ab	1.20ab	1.45ab	67.85i

Values are means of duplicate determinations and values with different superscript along the columns are significantly different ($p<0.05$)

3.3 Flour Extraction, Wet and Dry Gluten Eleven Genotypes of Irrigated Wheat

The result for flour extraction, wet and dry gluten fourteen genotypes of irrigated wheat is shown in Table 3. Similar results have also been reported by Aluko, *et al*., (1990); Bijik (2001); and Nkama *et al.* (1998). The result of flour extraction for the irrigated genotypes indicated that there are significant differences among the wheat samples. This could be attributed to the difference in the genetic characteristics and physical quality of each grain and therefore, some wheat grains have higher floury endosperm than other wheat grains.

The result of the flour extraction ranged from 66.25% for Angui-2 to 78.55% for Reyna 28. (Table 3). Florkwa-2, Soonot-5, Hubara-3, and Angui-2 are among the irrigated wheat with flour yield above 75% and were the best performing genotypes on the field. These fall within the standard range of flour yield reported by Li and Posner, (1987); Li and Posner, (1989). Milling is very important in wheat processing, and hard and soft wheat with high protein content (>11%) are preferred in wet- milling to co-produce vital gluten and starch (Khatkar *et al.,* 1995; Tronsmo *et al*., 2003). The flour yield and flour properties are strongly related to wheat kernel properties, especially to the kernel colour, vitreousness, mass, shape, test weight, density, size and size uniformity are taken into consideration during wheat milling value evaluation (Dendy and Dobraszczyk, 2001;Abdulvahit, 2004; Bordes *et al.,* 2008). The wet and dry gluten contents differed significantly among irrigated genotypes. The wet gluten ranged from 18.60% for Pastor2 to 46.40% for Angui2 while the dry gluten content ranged from 10.05% for Angui2 to 14.70% for Florkwa-2 with Angi-2, Florkwa-2 and Hubara-3 having higher gluten content than the other genotypes (Table 3). As the result indicates, the values are within the range reported by workers for various wheat varieties, (Pomeranz, 1971 and Kent, 1983) and also that Nigerian wheat can be comparable to imported wheat.

Table 3: Flour Extraction, Wet and Dry Gluten of the Eleven Genotypes of Irrigated Wheat

Genotype	Flour extraction (%)	Wet gluten (%)	Dry gluten (%)
Attila-7	69.40bcd	36.15a	12.35ab
Hubara-1	67.30cd	32.05ab	10.10b
Pastor-1	73.65abcd	33.00ab	10.70ab
Pastor-2	73.45abcd	18.60b	10.11b
Angi-2	66.25d	46.40a	10.05b
Kauz'S'	72.70abcd	40.05a	12.80ab
Hubara-2	71.30abcd	41.40a	13.35ab
Florkwa -2	78.55a	45.35a	14.70a
Katila-17	72.57abcd	43.15a	13.80ab
Hubara-3	76.69ab	46.10a	14.60a
Soonot5	76.25abc	33.03ab	10.60ab

Values are means of duplicate determinations and values with different superscript along the columns are significantly different (p<0.05)

3.4 Bread sensory evaluation

Table 4 showed the sensory evaluation of the bread samples from the irrigated wheat and the control. Attributes evaluated include bread appearance, crust color, crumb color, texture, taste, chewability, flavor and overall acceptability. Although the result indicates significant differences among the samples (P<0.05), the values were closely ranged, and the bread samples were all accepted by the panels for all parameters determined. The appearance ranged from 6.70 for Soonot-5 Cettia to 820 for the control. The crust colour ranged from 6.15 for Atilla-7 to 8.20 for the control. The crumb colour ranged from 6.60 Atilla-7 to 8.2 for the control. The taste ranged from 6.95 for Angi-2 to 8.40 for the control. The texture ranged from 6.30 for Angi2 to 7.95 for the control. The chewability values ranged from 6.60 for Angi-2 to 8.25 for the control. The flavor ranged from 6.60 Atilla7 to 8.10 for the control. The overall acceptability ranged from 7.10 for Angi to 8.35 for the control sample. The bread produced from the commercial wheat flour has shown to have better qualities than the Nigerian grown wheat, and this could be attributed to additives in commercial flour that was not added to the locally grown Nigerian wheat test genotypes. Notwithstanding, the results shows that Nigerian grown wheat can perform well as the imported wheat in terms of bread quality.

Table 4: Bread sensory evaluation using 9-point hedonic scale of the Eleven Genotypes of Irrigated Wheat flour and the control flour

Samples	Appearance/ loaf shape	Crust colour	Crumb colour	Taste	Texture	chewability	Flavor	Overall acceptability
Attila-7	7.10bc	6.15h	6.60c	7.00c	7.10bc	7.00cd	6.60d	7.35bc
Hubara-1	7.20bc	6.85cdefg	7.05bc	7.40b	7.00bc	6.90de	7.20b	7.20c
Pastor-1	7.05bc	6.70defg	7.05bc	7.15bc	6.60de	6.95cde	7.05bc	7.30bc
Pastor-2	6.95bc	6.65efg	7.05bc	7.25bc	6.55de	7.00cd	6.90bcd	7.30bc
Angi-2	7.10bc	7.00bcdef	7.10bc	6.95c	6.30e	6.60e	7.20b	7.70b
Kauz'S'	7.20bc	7.30b	7.00bc	7.20bc	6.75cd	7.05bcd	6.80bcd	7.20c
Hubara-2	7.25b	7.05bcde	7.20b	6.95c	7.20b	7.40b	7.20b	7.15c
Florkwa -2	7.25b	6.50gh	6.65c	7.05c	7.25b	6.90de	7.15bc	7.10c
Katila-17	7.00bc	6.60fg	6.80bc	7.00c	7.15b	7.30bc	6.85bcd	7.35bc
Hubara-3	7.20bc	7.25bc	6.80bc	6.95c	7.15b	7.00cd	6.75cd	7.25bc
Soonot-5	6.70c	7.10bcd	6.65c	7.20bc	7.10bc	7.05bcd	7.15bc	7.10c
Control Sample	8.20a	8.20a	8.20a	8.40a	7.95a	8.25a	8.10a	8.35a

Values are means of duplicate determinations and values with different superscript along the columns are significantly different ($p<0.05$)

4. Conclusion

This study has shown that wheat can be grown in Nigeria under irrigated conditions in some Northern parts of the country. The sensory evaluation indicated that the bread produced from the Nigerian grown wheat performed well along with the control, but the control sample had a higher rating than the Nigerian grown wheat. This could be attributed to the improved processing conditions of the larger commercial mills and probably due to the addition of additives for the control sample which resulted in bread with higher characteristics.

Despite these factors, it could be observed that the Nigerian wheat compared favourably with the imported wheat and can be used to produce baked products especially bread and other wheat products with improved processing technologies similar to the foreign wheat. Therefore, it Nigerian grown wheat should be patronized by both millers and individuals to reduce the importation of wheat into the country

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