Biochemical Evaluation of Ten Sorghum *(Sorghum bicolor* Cultivars Compared to Wheat for Baking Characterise,s

"Abu, A. I., 'Aba, D* A., [3]Chindo, P. S, 'Anigo, K. M. and [4]Maigida D.N.
'Department of Btochcmislry Ahmadu Bcllo University,Zaria.
'Drpartmenl of Plant Science Ahmadu Bello University Zaria.
"Food Science and TechnoMiy Rcsearch Programme, Institute for Agricultural Research Ahmadu Bcllo Univurdly, Zaria.
*Dcpnrlinenl of Agricultural Economics and RuralSocioology, Ahmadu Bello University, Zaria.

ABSTRACT

Ten sorghum (*S. bicolor*) cultivars compared to commercial wheat flour were investigated to determine their baking characteristics. Crude protein contents of some of the sorghum samples were higher than that of the wheat flour analyzed. Soluble and total starch contents of some of the sorghum cultivars compared favourably with that of wheat. Wet and dry gluten contents ranged from 16.52 - 73.12% and 6.60 - 12.76% for sorghum samples, and [illegible]% and [illegible]% for wheat, respectively. Implications of the results on the use of these sorghum samples for composite flour in bakery and confectionery industries are discussed.

INTRODUCTION

Baked products constitute a significant component of the diet in Nigeria. These products (bread, biscuits, doughnut, buns, etc.) are produced mainly from wheat flour, which is largely imported into the country thereby drawing on a significant portion of the scarce and meager foreign exchange earnings of the country.

In order to conserve foreign exchange and encourage local production of wheat substitutes (other cereals), project was initiated on the development of the technology for the production of acceptable composite flour to cut down on the major cost of production of baked products. Among the other cereals, sorghum has found important application in composite flour formulation due to the comparable biochemical characteristics to wheat in bread and other confectionaries (Olugbemi, 1993). Aluko and Olugbemi (1989) and Olugbemi (1993) reported that acceptable bread was produced when wheat flour was substituted with 30% sorghum flour. Onyenekwe and Olugbemi (1995) also reported that acceptable bread could be produced when up to 20% of wheat is substituted with sorghum flour, the bread however tended to crumble. Substitution of wheat flour up to 80% and 40% gave acceptable cookies and biscuits; cake and doughnut respectively (Onyenekwe, 1995). Consumer organoleptic evaluation showed that the appearance, taste and smell of the wheat/sorghum composite bread were more acceptable than the texture. Also protein content of the composite bread was lower than that of whole wheat bread (Onyenekwe, 1995).

Three major areas of importance in sorghum composite flour formulations are the yield, baking quality and nutritional value of the composite flour. Chemical composition of sorghum and its desirable qualities is markedly influenced by environmental conditions, grain yield, and available nitrogen as well as the genotype of the variety. Due to the high potentials composite flour holds for the bakery industries, continuous effort should be made to identify nearly released varieties of sorghum that have the desirable baking characteristics comparable to wheat.

MATERIALS AND METHODS

Materials

Ten cultivars of sorghum (*Sorghum bicol...*) used for this study were grown in the local experimental farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria in 1998. Matured seeds were harvested, cleaned and stored in tightly sealed containers at room temperature until ready for use. Commercial wheat flour was purchased from Ideal Flour Mill, Kaduna.

All chemicals and reagents used were of analytical grade and supplied by British Drug House (BDH).

Chemical Analysis

Moisture content, ash, crude fat (lipid), crude fibre, protein and total carbohydrate were determined by method of AOAC (1980) while wet and dry gluten content by method of AACC (1980). Soluble and total starch contents were analyzed by Dubois *et al.* (1956) method and maltose content by Berliner (1980) method.

*Corresponding Author

RESULTS AND DISCUSSION

The results of the proximate composition of the sorghum cultivars and wheat shown in Table 1 revealed that moisture content ranged from 1.20 to 1.92% for sorghum and 1.76% for wheat. The index level indicative of poor storing characteristics for cereal is 13.50% (Christian and Kaufwan, 1964). Ash content of sorghum ranged from 1.06 to 1.56% with improved SRN4841 and KSV4 having the lowest and highest values respectively. However, the ash content of wheat flour (1.03%) is the lowest compared to sorghum cultivars. Lipid content of the sorghum cultivars ranged from 2.22 to 3.56% as compared to 3.65% for wheat. The low level of lipid in the flour attest to the suitability of the cultivars for baking in terms of good keeping quality while sufficient enough to participate in the formulation of dough structure (Martin *et al,* 1991). Crude protein content of sorghum ranged from10.08 to 15.69% while that of wheat was 14.05%, which all fall within the 10-20% protein content required for good baking properties (Omwirhiren, 1991). Crude fibre level for sorghum ranged from 1.04 to 2.81 and that of wheat was 1.21%.

Table 2 showed the carbohydrate composition content of sorghum cultivars and wheat. The total starch content of the sorghum cultivars ranged from 32.81 to 93.80% while that of wheat was 79.69%. KSV8 had the highest (7.00%) soluble starch level with KSVI3 having the least (0.39%). however, the soluble starch content of wheat was 2.53%. Maltose content of sorghum samples ranged from 1.48 to 6.12% while that of wheat (1.14%) was the lowest. It is well established that the ability of flour to form highly acceptable dough is dependent on protein starch interactions. Soluble sugars have been reported to increase the loaf volume (Ment, 1962).

Table 1. Proximate Composition of Ten Sorghum (*S bicolor*) cultivars compared to wheat (% w/w)

	Moisture	Ash	Crude Fat	Crude Protein	Carbohydrate	Crude Fibre
KSV4	1.40 ± 0.01	1.56 ± 0.03	2.55 ± 0.29	12.92 ± 0.29	82.97 ± 1.02	2.81 ± 0.06
KSV8	1.37 ± 0.02	1.30 ± 0.05	2.29 ± 0.20	15.69 ± 0.35	80.72 ± 2.01	1.84 ± 0.01
KSV11	1.43 ± 0.04	1.22 ± 0.02	2.31 ± 0.11	11.08 ± 0.25	84.35 ± 1.04	2.70 ± 0.91
KSV12	1.76 ± 0.05	1.31 ± 0.03	2.22 ±0.09	15.55 ± 0.31	80.95 ± 0.99	1.04 ± 0.08
KSV13	1.92 ± 0.07	1.26 ± 0.04	3.41 ±0.08	13.44 ± 0.27	81.94 ± 1.03	2.60 ± 0.05
KSV14	1.48 ± 0.06	1.24 ± 0.04	3.22 ±0.01	10.66 ± 0.30	84.91 ± 0.89	2.72 ± 0.03
KSV15	1.44 ± 0.02	1.35 ± 0.08	2.48 ± 0.04	12.27 ± 0.30	84.89 ± 1.82	2.78 ± 0.09
ICSVIII	1.76 ± 0.03	1.20 ± 0.03	2.70 ± 0.09	12.45 ± 0.32	83.58 ± 1.01	1.52 ± 0.0[illegible]
ICSV400	1.76 ± 0.02	1.21 ± 0.04	2.83 ± 0.10	11.60 ± 0.34	84.50 ± 1.21	1.52 ± 0.0[illegible]
Improved SRN4841	1.20 ± 0.03	1.06 ± 0.04	3.56 ± 0.06	10.08 ± 0.18	85.32 ± 1.02	2.69 ± 0.06
WHEAT	1.76 ± 0.05	1.01 ± 0.01	3.65 ± 0.05	14.05 ± 0.15	81.32 ± 1.04	1.21 ± 0.08

Values are means ± standard deviations of triplicate determinations.

Table 2. Carbohydrate and Gluten Composition of Ten Sorghum cultivars compared to wheat (% w/w)

	Total Starch	Soluble Starch	Maltose	Wet Gluten	Dry Gluten
KSV4	32.8[illegible] ± 0.20	0.56 ± 0.30	3.09 ± 0.07	69.44 ± 0.94	8.52 ± 0.54
KSV8	32.8[illegible] ± 0.32	7.00 ± 0.09	2.96 ± 0.1[illegible]	57.56 ± 0.8[illegible]	11.04 ± 0.06
KSV11	46.8[illegible] ± 0.12	0.78 ± 0.01	4.30 ± 0.32	16.52 ± 0.41	12.76 ± 0.31
KSV12	37.50 ± 0.40	0.39 ± 0.02	6.12 ± 0.51	50.12 ± 0.51	10.84 ± 0.43
KSV13	93.80 ±0.08	0.39 ± 0.04	1.48 ± 0.07	67.92 ± 1.02	5.68 ± 0.070
KSV14	51.50 ± 0.10	2.53 ± 0.21	4.30 ± 0.10	67.92 ± 1.21	7.28 ± 0.1[illegible]
KSV15	56.26 ± 0.14	3.89 ± 0.23	3.50 ± 0.20	56.84 ± 0.85	11.04 ± 1.06
ICSVIII	93.86 ± 0.06	3.50 ± 0.08	6.12 ± 0.22	73.12 ± 1.09	8.48 ± 0.12
ICSV400	84.38 ± 0.50	0.78 ± 0.05	6.12 ± 0.34	60.52 ± 0.91	8.32 ± 0.11
Improved SRN4841	90.70 ± 1.05	0.58 ± 0.06	3.43 ± 0.09	64.08 ± 1.01	9.56 ± 0.06
WHEAT	79.6[illegible] ± 0.98	2.53 ± 0.09	1.14 ± 0.01	39.60 ± 0.73	18.52 ± 0.34

The wet and dry gluten content of sorghum samples ranged from 16.52-73.12% and 5.68-12.76% while that of wheat was 39.60% and 18.52% respectively. Although the dry gluten content of the sorghum cultivars was generally lower than the commercial wheat studied, some cultivars from this study such as KSV8, KSV11, KSV12 and KSV15 had gluten contents that compared favourably with local variety of wheat (13%) that have been reported to have good baking properties (Orakwe *et al,* 1995).

Essentially wheat contains five different classes of protein, which include albumin, globulin, protease, prolamin (gliadin) and glutenin). Gliadin and glutenin together with water and salts form the well-known gluten. Glutenin imparts rigidity to the gluten while gliadin, which is soft is responsible for the binding (Omwirhiren 1991). Studies on the amino acid composition of gluten showed that glutamine account reasonably well for the high level of nitrogen present (Castimpoolas *et al*, 1971). The neutral polar residue of glutamine makes gluten water insoluble but sufficiently hydrophilic to compete strongly with starch for the absorption of water in dough. Furthermore, the strong tendency of glutamine residue to hydrogen-bond together contributes to the viscoelastic properties of gluten necessary for a dough to retain gas bubbles during bread making (Omwirhiren 1991). Sorghum proteins, although made up of globulin, albumin, prolamins and gluten are low in glutamine. This low level of glutamine could be responsible for the inelastic nature of sorghum gluten and the inability of dough to retain gas bubbles compared to wheat. More so, pentosans have been discovered of recent to act as swelling and starch binding agent in composite flour in developing dough with high enough gas retention capacity. Pentosans which are water-insoluble arabinoxylan have the capacity to swell when mixed with water. Sorghum has been reported to contain 5% pentosans. Its baking quality could be improved by pre-fermentation during which the bound pentosans present in the cell wall are released to participate in dough formation (Martin *et al*, 1991).

The present study has identified KSV8, 11, 12 and 15 as sorghum cultivars with favourable biochemical parameters compared to wheat for baking. Assessment of the gluten quality with respect to amino acid composition and the application of identified varieties in baking is in progress.

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