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Breadmaking Potential of Sorghum Flour and Sorghum Bran

A. A. Osibanjo*, P. O. Ibidapo, N. E. Efuribe, G. N. Elemo

Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria.

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***Corresponding author:** A. A. Osibanjo, Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria.
Email: goldenfavour2000@yahoo.com

Abstract

Sorghum flour and sorghum bran were evaluated in terms of their baking quality, to determine possible use for breadmaking. The evaluation was done using a straight dough breadmaking process to make loaves of wheat composites, at different levels of combination, which were compared with those of cassava flour and wheat bran. Sensory evaluation of the bread produced shows that sorghum bran could be a promising alternative to wheat bran and the 30% level, with an overall acceptability score of 5.8, is preferred and better than the 50% with an overall acceptability score of 3.0. Sorghum flour, though gives slightly lower bread volumes in composites with wheat than cassava, also seems promising and can be further explored as it gives characteristics similar to whole grain bread. It thus appears that sorghum flour could be a suitable alternative to cassava flour and can be recommended for use in baking. This outcome can reduce the mounting pressure on cassava for baking and provide a ready alternative in sorghum growing areas, thereby adding value to sorghum and also making the bran a revenue generating material.

Keywords

Baking quality, Cassava, Composite flour, Wheat, Sensory evaluation

1. Introduction

Non wheat materials such as rye, barley, maize, rice have been incorporated in wheat to make composites for baking [1-2] especially in areas where wheat, (Triticum aestivum) which is the conventional raw material, is in deficit or absent. Of note among these materials, particularly in Africa and Nigeria are cassava flour and cassava starch [3-4], however, with so much dependence and pressure on cassava for making local staples as well as for a variety of non food products [5-6], which can reduceits availability for other uses, sorghum is now being investigated as a possible alternative to cassava and probably as a suitable material for use in baking.

Sorghum (Sorghum bicolor) is a nutrient rich cereal grain, widely grown and in abundance, especially in the northern part of Nigeria, with an annual production figure of about 7m tonnes [7] which is the highest in West Africa. It is in less demand and also less utilized than cassava [8-9]. In addition, the bran which contains tannins known to have antioxidant properties and to promote human health [10-11] is often discarded as a waste material during processing.

This study stemmed out of an investigation earlier reported by [12] on the rheological properties of sorghum flour and bran and the observation that sorghum flour seems comparable with cassava flour, as composite with wheat and hence could possibly be a suitable alternative, particularly in non-cassava growing areas.

A 50/50 wheat bran/sorghum flour from that study was reported as promising in terms of the rheological behaviour and was recommended for trials in making whole grain bread. Sorghum bran was also reported as a promising alternative to wheat bran for possible use in baking, based on the rheological characteristics.

The main objective of this investigationis to complete and confirm the fndings from that study, by evaluating the actual baking quality of sorghum flour and bran, to determine if sorghum flour could truly serve as a suitable alternative to cassava flour in composite bread as well as to find use for sorghum bran in baking.

The positive outcome of this work can help to reduce Nigeria's dependence on foreign wheat; reduce the mounting pressure on cassava for use in baking; provide a ready alternative to cassava in sorghum growing areas, particularly in the northern part of the Country; add value to sorghum and also turn the bran from a waste to a wealth creating material.

2. Materials and Methods

Samples of wheat flour, wheat bran, sorghum flour and sorghum bran were provided by Honeywell Flour Mills, Lagos, Nigeria while high quality cassava flour was obtained from the pilot plant of the Federal Institute of Industrial Research, Oshodi. Other bread making materials such as yeast, salt, sugar and fat were also locally sourced by FIIRO.

Bulk density was by the method of [13].

Breadmaking was done by the straight dough method of [14] using a Hobart planetary mixer and electric oven. After baking and cooling, loaf weight was taken and volume determined using the seed displacement method of [15].

Sensory evaluation was done by consumer organoleptic analysis in which bread attributes were evaluated and scored by Panelists, using a 9 point hedonic scale according to [16]where 1 = extremely unacceptable and 9 = extremely acceptable. Thereafter, the resulting data were analysed by Analysis of Variance and the means separated using Duncan's multiple range test [17]. Significance was accepted at 5% level of probability.

3. Results and Discussion

The resullts obtained from this work are presented in Tables 1-5.

Table 1. Bulk density of samples

Parameter	Sample				
	WB	SB	WF	SF	CF
Bulk density (g/ml)	0.76	0.25	0.67	0.50	0.57
Loose bulk density (g/ml)	0.50	0.18	0.46	0.40	0.40

WB - Wheat bran, SB - Sorghum bran, WF – Wheat flour, SF – Sorghum flour, CF – Cassava flour

Table 2. Results of baking evaluations with flour samples

Parameter	Sample							
	TNN (10% SF)	**WNS (20% SF)**	**TTW (30%SF)**	**TWR (40% SF)**	**ONT (50% SF)**	**CNN (100% WF)**	**WCT (10% CF)**	**WCY (20% CF)**
Optimum Water (ml)	260	262	264	362	340	400	250	250
Optimum mixing time (min)	20	20	20	20	20	15	20	20
Scaled dough wt (g)	300	300	300	300	300	300	300	300
Proof time (min)	180	180	180	180	180	180	180	180
Baking time (min)	20	20	20	20	20	20	20	20
Loaf wt (g)	275	276	276	274	274	280	280	290
Loaf vol (cm^3)	925	830	810	800	780	1,025	1,025	917
Specific loaf vol (cm^3/g)	3.36	3.01	2.95	2.92	2.85	3.70	3.70	3.16

SF – sorghum flour, WF – wheat flour, CF – cassava flour

Table 3. Mean sensory scores of bread samples with flours

Sensory Attribute	Sample					
	TNN (10% SF)	**WNS (20% SF)**	**TTW (30%SF)**	**TWR (40% SF)**	**ONT (50% SF)**	**CNN (100% WF)**
Appearance	7.7a	6.9b	6.9b	6.5c	6.4c	7.8a
Crust colour	6.7a	6.9a	6.4b	6.3b	6.3b	7.3a
Crumb colour	7.7a	7.1a	7.1a	6.9b	6.1c	7.7a
Taste	6.9a	6.6a	6.3b	6.3b	6.3b	6.9a
Texture	7.1a	6.7a	6.3b	6.1b	5.8c	7.3a
Flavour	6.5a	6.5a	6.4b	6.4b	6.3b	6.7a
Overall acceptability	7.2a	7.0a	6.9a	6.6b	6.5b	7.4a

SF – sorghum flour, WF – wheat flour, Means with same letter on a row are not significantly different ($P > 0.05$)

Table 4. Results of baking evaluations with bran samples

Parameter	Sample			
	SVX 30/70 SB/WF	**FVX** 50/50 SB/WF	**THB** 50/50 WB/SF	**FUD** 50/50 WB/WF
Optimum water (ml)	385	440	366	320
Optimum mixing time (min)	25	25	20	20
Scaled dough wt (g)	300	300	300	300
Proof time (min)	150	150	180	180
Baking time (min)	20	20	20	20
Loaf wt (g)	264	259	262	276
Loaf vol (cm^3)	717	567	575	983
Specific loaf vol (cm^3/g)	2.70	2.20	2.20	3.60

SF – sorghum flour, WF – wheat flour, SB – sorghum bran, WB – wheat bran

Table 5. Mean sensory scores of bread samples with bran

Sensory Attribute	Sample			
	FVX (50/50 SB/WF)	**SVX (30/70 SB/WF)**	**THB (50/50 WB/SF)**	**FUD (50/50 WB/WF)**
Appearance	3.6c	6.3b	6.5b	7.7a
Crust colour	3.2c	5.8b	6.7a	6.9a
Crumb colour	3.5d	4.3c	6.0b	7.0a
Taste	3.2c	5.8b	6.3b	6.8a
Texture	4.0c	5.5b	7.1a	7.1a
Flavour	3.1d	5.7c	6.4b	6.9a
Overall acceptability	3.0d	5.8c	6.8b	7.7a

SB- sorghum bran, WB - wheat bran, SF sorghum flour, WF - wheat flour Means with same letter on a row are not significantly different ($P > 0.05$)

Bulk density: This parameter is a measure of particle heaviness, determined as mass per unit volume. The figures in Table 1 show that wheat flour (WF), with a value of 0.67 g/ml, is heavier than cassava flour (CF, 0.57 g/ml) and sorghum flour (SF, 0.5 g/ml) while wheat bran (WB), with a value of 0.76 g/ml, is more dense than sorghum bran (SB, 0.25 g/ml). Wheat bran is also heavier than wheat flour, but sorghum flour is heavier than sorghum bran. Higher bulk density values indicate the increasing ability to disperse in water during processing as well as to occupy a smaller space for a given mass of sample and therefore, have implications for packaging [18].

Baking: With the flours, results for wheat/sorghum compared with wheat/cassava composites (Table 2) show that sorghum is comparable with cassava as composites with wheat, though loaf volume figures for cassava are slightly higher and closer to 100% wheat than sorghum under the same conditions. The specific loaf volume is regarded as a very important bread characteristic as it provides a quantitative measure of baking performance [19] and according to [20], specific loaf volume for standard bread has been documented by the China Grain Product Research and Development Institute as ranging from 3.5-6.0 cm^3/g. The values of about 3.0 for these composites, though lower, can be considered commendable andshows that sorghum flour can serve not only as a partial replacement for wheat but also as a suitable composite material, like cassava.

The composite flours do not accomodate as much water for mixing as the 100% wheat as they are low in gluten which provides the elastic network for trapping gas and which gives white bread its characteristic volume and spongy texture [21]. Even with the same starting dough weight, resulting loaf weights vary for the different composites.

Composites with sorghum flour have been reported [12] to have comparable pasting properties with cassava and even better in retrogradation than wheat and this can have a positive effect on shelf stability ofthe resulting products.

Bran composites: For making whole wheat bread, wheat bran is usually mixed with white flour at a ratio of 50/50. Comparing the baking result of this conventional formulation with 50/50 and 30/70 SB/WF (Table 4) shows the possibility of using sorghum bran in making whole grain bread.

The low retrogradation tendency of sorghum bran, as reported for cassava and even better than wheat or sorghum flour [12] can be beneficial with respect to keeping quality and shelf life of sorghum bran products. The pasting characteristics, however, reported for WB, SB and their composites tend to suggest that an all bran formulation (such as 100% WB, 100% SB as well as mixtures of WB/SB alone) is not ideal for making bread, so these were not investigated.

The bran samples,even with more water used for mixing than with the flours, Table 4 did not translate to a higher loaf volume because of further dilution of the low quantity of gluten available for gas retention and volume increase [22].

With the SB/WF composites, 30/70 gave better results than 50/50 in terms of loafvolume and characterand can be further explored, however, results for the 50/50 SB/WF and 50/50 WB/SFformulations also seem comparable (Table 4) showing the breadmaking potential of sorghum.

Sensory evaluation: The results of consumer acceptability of the bread samplesfrom flours, presented in Table 3, show that though sensory attributes of colour, texture, taste, flavouras well as appearance were getting affected with increasing inclusion of sorghum flour, the 10%, 20% and 30% sorghum flour composites with wheat are not significantly different from the 100% wheat control in terms of overall acceptability, meaning that these are all similar in acceptability to consumers. Difference in acceptability became significant from the 40% level of sorghum flour inclusion.

With the bran, however, (Table 5), all the samples are significantly different.Colour, taste and flavour were more affected, giving a dark coloration andclosed grain structure.In terms of acceptability, the 50/50 WB/SF (THB), with an overall acceptability score of 6.8, is the closest to the 50/50 WB/WF conventional formulation (FUD, with a score of 7.7) which was used as the control, followed by the 30/70 SB/WF sample (SVX, with a score of 5.8). The differences notwithstanding, these results show the potential of both sorghum flour and sorghum bran as suitable composite materials innovel,whole grain bread formulations.

4. Conclusion and Recommendations

The following inferences can be made from this study.

Sorghum flour and sorghum bran are possible alternatives to cassava flour and wheat bran respectively. Both sorghum flour and sorghum bran seem suitable and promising materials as composites with wheat and can be recommended for use in baking, particularly in whole grain bread formulations.

With increasing sorghum flour in the composite, acceptability score decreases and becomes significantly different from 100% wheat at 40% level of inclusion. As composites with wheat bran, 50/50 wheat bran/sorghum flour, with an overall acceptability score of 6.8, is the closest to the 50/50 wheat bran/wheat flour conventional formulation.

With sorghum bran, a 30% level of inclusion is better and preferred to the 50% level in the composite.

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