Quality of wheat-cassava bread as affected by selected improvers

Michael Ayodele Idowu and Kazeem Iroko
Department of Food Science and Technology, Federal University of Agriculture, Abeokuta, Nigeria
Abiodun Aderoju Adeola
Institute of Food Security, Environmental Resources and Agricultural Research, Food and Nutrition Research Programme, Federal University of Agriculture, Abeokuta, Nigeria
Isaac Babatunde Oluwalana
Department of Food Science and Technology, Federal University of Technology, Akure, Nigeria
Jerome Ayokunle Ayo
Department of Food Technology, The Federal Polytechnic, Bauchi, Nigeria, and
Damilola Shayo Ikuomola
Department of Food Science and Technology, Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria

Abstract

Purpose – The purpose of this paper is to evaluate some common bread improvers (normally used for 100 per cent wheat bread) for their effect on the quality attributes of wheat-cassava (90:10) composite bread.

Design/methodology/approach – Four commonly used bread improvers (ASA, ABT, EDC and PTB) in Nigeria were evaluated for their effect on the baking potential of wheat-cassava (90:10) composite flour. Bread samples were baked from wheat-cassava (90:10) composite flour, with and without bread improvers. Changes in dough height during fermentation, oven spring, yield and specific volume of bread samples were determined. Bread samples were also evaluated for their sensory and staling characteristics.

Findings – Results showed that dough height during fermentation did not change significantly ($p < 0.05$) and crumb colour, firmness, taste and aroma were unaffected by addition of bread improvers; but oven spring, yield, specific volume, bread shape, crust colour, texture and overall acceptability of bread were significantly different ($p > 0.05$). All the bread improvers except ABT extended the shelf life of wheat-cassava (90:10) composite bread for a period of 24-48 hours.

Practical implications – Bread improvers normally used for 100 per cent wheat bread could be used effectively for wheat-cassava (90:10) composite bread without an adverse effect on quality of bread.

Originality/value – Bread makers need little or no additional training to handle wheat-cassava (90:10) composite flour for bread making process hence, Nigeria can sustain her policy of using wheat-cassava composite flour for baking without any serious technical problem.

Keywords Sustainability, R&D, Technology, Baking, Composite flour, Bread improvers, Quality attributes, Wheat, Cassava, Additives

Paper type Research paper

The authors acknowledge the assistance and contributions of the laboratory technologists and technicians of the bakery and sensory Laboratories of the Federal University of Agriculture, Abeokuta and Joseph Ayo Babalola University, Ikeji-Arakeji.

World Journal of Science, Technology and Sustainable Development
Vol. 12 No. 1, 2015
pp. 79-86

2042-5945
DOI 10.1108/WJSTSD-08-2014-0025

Introduction

Composite flour may be defined as a mixture of flours from tubers/roots rich in starch (e.g. cassava, yam, potato) and/or protein (e.g. soy, peanut) and/or cereals (e.g. maize, rice, millet), with or without wheat flour (Dendy, 1993). Composite flours are commonly used as staple foods in developing countries like Nigeria which imports, wheat (Idowu *et al.*, 1996). The inclusion of non-wheat flour as ingredient for bread means a reduction in gluten, the wheat protein responsible for the visco-elastic property in wheat flour. Hence, when gluten-free starch/flour is used in bread making, dough conditioners called bread improvers are often needed to improve quality of bread.

Improvers could be defined as mixtures of foods including additives intended to facilitate or simplify the production of baked goods, to compensate for changes in processing properties due to fluctuations in raw materials and to improve the quality of baked products (Abd Elmoneim *et al.*, 2007). There are several types of improvers and their utilization is gaining popularity as a health food, dietary supplement and as ingredient in bread and other breakfast cereals. Some of the improvers include: α-xanthan, κ-carrageenan, hydroxyl-propyl-methyl cellulose (HPMC), guar gum, ascorbic acid, carboxy-methyl cellulose (CMC), alginate, pectin, potassium bromate, alpha malt BXT and edlen dough conditioner, etc. (Moreira *et al.*, 2011). However, the use of Potassium bromate was recently prohibited by the World health Organization (WHO) and National Agency for Food and Drug Administration and Control (NAFDAC), because of its residual effects on human health (Ojeka *et al.*, 2006; Ekop *et al.*, 2008). NAFDAC is the Nigerian agency responsible for regulating and controlling every aspect of production, distribution and utilization of food, drugs and other chemical products. The functions of improvers in dough vary and may include: Improved dough yield and increased loaf count, strengthening of the dough to prevent it from falling, providing excellent body and smooth creaming texture, softening the bread and improving taste, providing tolerance for variation in ingredients and processing, increasing shelf life and preventing mould growth, ensuring uniform oxidation of flour and improving gas retention in dough (Moreira *et al.*, 2011).

The Federal Government of Nigeria recently advocates a minimum substitution of 10 per cent cassava flour for all wheat flour meant for baking in Nigeria. This decision , if enforced could be beneficial to the country in the areas of conservation of foreign currency, promotion of high-yielding native plant species, better overall use of domestic agricultural produce, among others. Wheat-cassava (90:10) composite flour, however, may require a handling technique or additives which may be quite different from those normally used for 100 per cent wheat flour bread (Ogunsua, 1987). Embracing the use of wheat-cassava (90:10) composite flour in bread making therefore, underscores the need for inclusion of bread improvers as additive. Bread improvers have been in use for 100 per cent wheat bread for a very long time in Nigeria. Information is, however, scanty on the effect of such improvers on the quality of wheat-cassava composite bread.

This paper therefore examines the effect of four commonly used bread improvers on the baking quality, sensory attributes and storage stability of wheat-cassava (90:10) composite bread.

Materials and methods

Materials

Four commonly used bread improvers (coded and hereafter referred to as ASA, ABT, EDC and PBT) in Nigeria were purchased from a baking material store at Agege, Lagos. Cassava flour was purchased from the office of Ogun State Agricultural Development

Programme, while other materials such as Honeywell wheat flour, salt, fat, sugar, bakers' yeast and polyethylene bags were bought from Lafenwa market in Abeokuta.

Methods

Wheat-cassava flour mix of 90:10 was used with the different bread improvers to produce bread samples. The improvers were added according to manufacturers' prescription. The levels of improvers used per 1,000 g of the composite flour were 100 ppm for ASA, 160 ppm ABT, 4,500 ppm for EDC and 80 ppm for PBT.

Bread was produced using the recipe shown in Table I. Bread was also produced without the addition of improver, to serve as the control. The straight dough method described by Eggleston *et al.* (1993) was adopted. The method involved mixing the flour samples with bakers' yeast, salt, sugar, water and each improver, which had been initially dissolved in a fraction of the water. After proper mixing, the dough was set aside for about 30 minutes. The dough was then kneaded, scaled, molded with hand into cylindrical shape, placed in bread pans and proofed at 40°C and 80 per cent relative humidity for about 3 hrs. Baking was carried out at 200°C for 35 minutes. Bread samples were allowed to cool and packed in polyethylene bags.

Analyses

Change in dough height during fermentation and oven spring. Change in the height of dough during fermentation was replicated four times at 45 minutes interval during the 3 hr of proofing. The method of Idowu (1988) was used to determine the oven spring; the initial height of the dough before baking was taken as h_i while the height after baking was taken as h_f:

$$oven\ \ spring = h_f - h_i$$

Specific volume. The specific volume of the bread was determined by using displacement method as described by Idowu *et al.* (1996). A known weight (w) of loaf was put in a measuring cylinder and covered with sorghum grain; the volume of this was noted as V_1. The bread was then removed and the volume of grain left in the measuring cylinder noted as V_2:

$$Specific\ \ volume = v_1 - v_2/w$$

Bread yield. This involved dividing the weight of bread samples obtained from a particular treatment by the total weight of flour used in producing the bread samples, and multiplying by 100.

Material	Quantity (%)
Wheat flour	90
Cassava flour	10
Sugar[a]	10
Fat[a]	2
Salt[a]	0.8
Yeast[a]	1
Water[a]	50

Note: [a]Percentage based on flour weight
Source: Osibanjo (2000)

Table I. Recipe used for bread production[a]

Sensory evaluation. A 30-member panel comprising of staff and students of the Department of Food Science and Technology, Federal University of Agriculture, Abeokuta were used to assess the bread samples for shape, crust colour, crumb colour, crumb firmness, texture, taste, aroma and overall acceptability, using the scoring and hedonic tests (Iwe, 2002). In the scoring test, panelists were asked to assess the bread samples based on a five-point scale where 1 is the highest degree of the attribute while 5 is the least. In the hedonic test, panelists rated the bread samples on a 9-point basis where 1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely. Responses of the panelists were subjected to statistical analysis of variance and means were separated by Duncan's multiple range test to establish significant differences among samples using SPSS 10.0 software package (Statistical Package for the Social Sciences, New York, USA).

Staling characteristics and shelf life of wheat-cassava (90:10) composite bread. The staling rate of bread was measured using the penetrometer by determining depth of penetration of the cone into the crumb within 12 seconds (Adeyemi and Omolayo, 1984). The bread samples were stored at ambient temperature (28 ± 2°C) and measurements were taken every 24 h for 7days. For each sample, penetrometer reading taken 2 h after baking was used as reference in calculating the index of freshness with storage period (Adeyemi and Idowu, 1990). Shelf life of bread was determined by looking for the first appearance of mould growth (Idowu *et al.*, 2002).

Results and discussion

Effect of improver on height of dough and leavening activity during fermentation

Height of dough and leavening activity during fermentation is presented in Table II. The height of dough increased gradually from an initial value of 3.55 to 20.20 cm after 3 h fermentation for samples prepared using ASA as improver. Other samples (ABT, EDC, PBT and control) also followed similar trends of changes in height of dough during fermentation. Significant differences ($p > 0.05$) were found in the leavening activity of dough due to inclusion of bread improver(s) as ingredient of formulation. ASA and PBT were superior (significantly different ($p > 0.05$)) in their leavening activity to other samples, while ABT and EDC were not significantly different ($p < 0.05$) from each other, but were superior and significantly different ($p > 0.05$) from the control. Height of dough and leavening activity during fermentation had earlier been reported to be a function of several factors including quality (viability) of yeast, composition (lean or rich) of dough and environmental (temperature and relative humidity) condition under which fermentation took place among other factors (Idowu *et al.*, 2010). In this investigation, quality of yeast and environmental condition of fermentation were kept constant, the differences in the height of dough and leavening

Table II. Height (cm) of dough and leavening activity during fermentation

Bread improver	Fermentation time (min) 0	45	90	135	180	Leavening activity (cm/h)[d]
ASA	3.55	7.30	11.25	15.60	20.20	5.03[a]
ABT	3.55	7.25	11.15	15.40	20.05	4.95[b]
EDC	3.55	7.25	11.15	15.35	19.90	4.95[b]
PBT	3.55	7.30	11.30	15.60	20.25	5.03[a]
Control	3.55	7.15	11.00	15.15	19.65	4.90[c]

Notes: Means in the same column with same superscripts are not significantly different ($p \leqslant 0.05$); [d]leavening activity is defined as change in dough height (cm) during fermentation per unit time (h) activity therefore, could only be explained by the differences in the dough composition as illustrated in the different bread improvers included in the bread recipe. Bread improvers have also been reported to contain vitamins and enzymes which could influence oxidation and gas retention during fermentation (Moreira *et al.*, 2011), hence the differences in the height of dough due to differences in the type of improver used.

Effect of improver on oven spring, bread yield and specific volume

Except for the control (Table III), there was no significant difference ($p \leqslant 0.05$) in the oven spring of the bread samples, but bread yield and specific volume were significantly different ($p > 0.05$). Bread prepared with ASA, PBT and EDC (as improvers) had higher bread yield and were not significantly different ($p < 0.05$) from each other but were significantly different from ABT and the control samples. All the bread samples on the other hand were significantly different ($p > 0.05$) from each other in their specific volumes. Bread samples baked with EDC had the highest specific volume (3.57 ml/g), followed by ASA, PBT, ABT and the control in descending order of specific volume. ASA and PBT were, however, not significantly different from each other in their specific volume. It is noteworthy that ASA and PBT that showed the highest leavening activity (Table II) also had specific volumes which were not significantly different ($p < 0.05$). The dough sample(s) (ASA and PBT) with the highest leavening activity did not produce bread with the highest specific volume. High bread yield (loaf count) and specific volume are desirable indices recognized by bakers and consumers of bread. Specific volume and loaf count, however, are dependent not only on the leavening activity, but also on the ability of the dough to retain gas (carbon-dioxide) generated (as a result of fermentation) during baking and this in turn is a function of the visco-elasticity power of the dough (Moreira *et al.*, 2011).

Effect of improver on the sensory quality of fresh bread samples

The result of the ranking (difference) test revealed that there was no significant difference ($p \leqslant 0.05$) in the crumb colour, crumb firmness, taste and aroma of the bread baked using different improvers (Table IV). On the other hand, bread shape, crust colour and texture of bread samples were significantly different ($p > 0.05$) due to inclusion of bread improvers. The control sample, however, had the best mean ranking scores for shape (1.77) and crust colour (2.07). Also bread samples baked with ASA and PBT as improvers were not significantly different ($p < 0.05$) in their mean ranking scores for shape, crust colour and texture. A similar trend of result (as for difference test) was obtained for the preference test (Table V). Preference of tasters for bread samples baked with different improvers was not significantly different ($p < 0.05$) for crust colour, crumb colour, crumb firmness, texture, and aroma. Significant differences ($p > 0.05$), however, exist in the preferences of tasters for bread shape, taste and overall

Table III. Oven spring, yield and specific volume of fresh bread

Bread improver	Oven spring (cm)	Bread yield (%)	Specific volume (ml/g)
ASA	2.94^{b}	134.00^{b}	3.43^{c}
ABT	3.04^{b}	126.75^{a}	3.31^{b}
EDC	3.09^{b}	132.50^{b}	3.57^{d}
PBT	3.04^{b}	133.00^{b}	3.44^{c}
Control	2.79^{a}	123.50^{a}	3.14^{a}

Note: Means in the same column with same letters are not significantly different ($p \leqslant 0.05$)

acceptability. The shape of the control sample was the most preferred although it was not significantly different ($p \leqslant 0.05$) from ABT. Also, control sample had the highest mean preference scores for crust colour, aroma and overall acceptability among the different bread samples, it was not significantly different ($p < 0.05$) from ABT and EDC in terms of these attributes. However, both the control and all bread samples baked with improvers were acceptable to the panelist in all the attributes tested except crumb firmness of EDC and crumb texture of PBT.

Effect of improver on storage stability and shelf life of bread

Freshness of bread samples decreased as expected during storage, with ASA and control samples having the highest and lowest freshness respectively after 24 h of storage (Table VI). Except for ABT and EDC, other bread samples were significantly

Table IV. Mean sensory scores for bread samples (difference test)

Attribute	ASA	ABT	Bread improver EDC	PBT	Control
Shape	3.63^{b}	2.03^{a}	2.97^{b}	2.97^{b}	1.77^{a}
Crust colour	$2.77^{a,b}$	2.33^{a}	3.50^{b}	2.50^{a}	2.07^{a}
Crumb colour	2.37^{a}	2.40^{a}	2.40^{a}	2.37^{a}	2.30^{a}
Crumb firmness	2.60^{a}	2.43^{a}	2.67^{a}	3.13^{a}	2.63^{a}
Texture	$2.93^{a,b}$	2.70^{a}	2.00^{c}	3.27^{b}	2.80^{a}
Taste	3.13^{a}	2.30^{a}	2.70^{a}	2.63^{a}	2.57^{a}
Aroma	2.80^{a}	2.57^{a}	2.50^{a}	2.53^{a}	2.67^{a}

Note: Means in the same row with same letters are not significantly different ($p \leqslant 0.05$)

Table V. Mean sensory scores for bread samples (preference test)

Attribute	ASA	ABT	Bread improver EDC	PBT	Control
Shape	6.33^{a}	$7.57^{a,c}$	$6.50^{a,b}$	6.37^{a}	7.60^{c}
Crust colour	6.43^{a}	7.00^{a}	6.10^{a}	6.80^{a}	7.17^{a}
Crumb colour	7.07^{a}	7.07^{a}	6.87^{a}	7.13^{a}	6.67^{a}
Crumb firmness	6.43^{a}	6.40^{a}	5.97^{a}	6.07^{a}	6.17^{a}
Texture	6.37^{a}	6.77^{a}	6.33^{a}	5.57^{a}	6.60^{a}
Taste	6.13^{a}	7.23^{b}	$6.80^{a,b}$	$6.97^{a,b}$	$7.07^{a,b}$
Aroma	6.30^{a}	6.27^{a}	6.53^{a}	6.47^{a}	6.67^{a}
Overall acceptability	6.27^{a}	$6.83^{a,b}$	$6.73^{a,b}$	6.43^{a}	7.50^{b}

Note: Means in the same row with same letters are not significantly different ($p \leqslant 0.05$)

Table VI. Staling characteristics and shelf life of bread

Bread improver	2 h	24 h	Staling rate (% freshness) 48 h	72 h	96 h	Shelf life (days)
ASA	100	98.75^{d}	84.75^{c}	82.00^{d}	$70.00^{b,c}$	5
ABT	100	$84.00^{a,b}$	75.00^{a}	$70.50^{a,b}$	61.75^{a}	4
EDC	100	86.75^{b}	$78.00^{a,b}$	67.50^{a}	62.25^{a}	5
PBT	100	92.75^{c}	82.75^{c}	78.25^{c}	73.00^{c}	6
Control	100	82.75^{a}	79.25^{b}	73.25^{b}	67.75^{b}	4

Note: Means in the same column with same letters are not significantly different ($p \leqslant 0.05$)

different ($p \leqslant 0.05$) in terms of freshness. At the end of the storage period (96 h), PBT had the highest per cent freshness, followed by ASA, control, EDC and ABT. In terms of shelf stability, bread prepared using PBT was the most shelf stable, followed by ASA/EDC, control/ ABT as indicated by the first appearance of mould on the bread samples (Table VI).

Conclusion

The quality attribute improvements observed with the use of the different bread improvers varied from one improver to the other. EDC gave the best oven spring and specific volume while ABT gave the best improvement in terms of shape and firmness of bread loaves. ASA, EDC and PBT resulted in the highest bread yield. Bread improvers should therefore be selected based on the type of improvements that are desired in the final products. Bread improvers commonly used for wheat (100 per cent) bread in Nigeria could be used without adverse effect on quality of wheat-cassava (90:10) composite bread.

References

Abd Elmoneim, O.E., Ashwag, M.M., Mayada, A.M. and Abdullahi, H.El.T. (2007), "Use of guar gum and gum Arabic as bread improvers for the production of bakery products from sorghum flour", *Food Science and Technology Research*, Vol. 13, pp. 327-331.

Adeyemi, I.A. and Idowu, M.A. (1990), "Evaluation of pre-gelatinized maize flour in the development of 'Maissa' – a baked product", *Nigerian Food Journal*, Vol. 8, pp. 63-73.

Adeyemi, I.A. and Omolayo, O. (1984), "Utilization of cocoyam flour and starch for biscuits and cake making", *Nigerian Journal of Science*, Vol. 18 Nos 1/2, pp. 34-37.

Dendy, D.A.V. (1993), "Review of composite flour technology in the context of Tanzania", a paper presented at a conference on Sorghum and Millets Marketing and Utilization Held in Arusha, 3-5 May, available at: www.dfid.gov.uk/r4d/pdf/outputs/R5128b.pdf (accessed 12 December 2012).

Eggleston, G., Omoaka, P.E. and Arowosegbe, A.U. (1993), "Flour starch and composite breadmaking quality of various cassava clones", *Journal of the Science of Food and Agriculture*, Vol. 62, pp. 49-59.

Ekop, A.S., Obot, I.B. and Ikpatt, E.N. (2008), "Anti-nutritional factors and potassium bromate content in bread and flour samples in Uyo Metropolis, Nigeria", *E-Journal of Chemistry*, Vol. 5 No. 4, pp. 736-741.

Idowu, M.A. (1988), "The use of pre-gelatinized maize flour in baking", MSc thesis, Department of Food Science and Technology, Obafemi Awolowo university, Ile-Ife.

Idowu, M.A., Ojo, M.R. and Shittu, T.A. (2010), "Quality evaluation of some baker's yeasts in Nigeria", *Nigerian Food Journal*, Vol. 28 No. 1, pp. 164-172.

Idowu, M.A., Oni, A. and Amusa, B.M. (1996), "Bread and biscuit making potentials of some Nigerian cocoyam cultivars", *Nigerian Food Journal*, Vol. 14, pp. 1-12.

Idowu, M.A., Atanda, O.O., Bankole, M.O., Uzochukwu, S.V.A. and Olaewe, O.O. (2002), "An assessment of the status and product quality of some bread-making industries in Abeokuta", *Asset Series B*, Vol. 1 No. 1, pp. 61-66.

Iwe, M.O. (2002), *A Handbook of Sensory Methods and Analysis*, Rojoint Communication Services Ltd, Enugu.

Moreira, R., Chenlo, F. and Torres, M.D. (2011), "Rheological properties of commercial chestnut flour doughs with different gums", *International Journal of Food Science and Technology*, Vol. 46, pp. 2085-2095.

Ojeka, E.O., Obidiaku, M.C. and Enukorah, C. (2006), "Spectrophotometeric determination of bromate in bread by the oxidation of dyes", *Journal of Applied Science and Environmental Management*, Vol. 10 No. 3, pp. 43-46.

Ogunsua, A.O. (1987), "Process modifications in the production of bread and biscuit from composite or non-wheat flour", *The Use of Non-Wheat Flour for Bread and Biscuit Production 1987 Proceedings of the Conference in Obafemi Awolowo University, Ile-Ife, The Nigerian Institute of Food Science and Technology, Lagos*, pp. 84-91.

Osibanjo, A.A. (2000), *Annual Research Report*, Federal Institute of Industrial Research, Oshodi.

About the authors

Dr Michael Ayodele Idowu is an Associate Professor of Food Science in the Department of Food Science and Technology of the Federal University of Agriculture, Abeokuta and Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria. He is also the former Acting Programme Leader of the Food and Nutrition Research Programme of the Institute of Food Security, Environmental Resources and Agricultural Research of the Federal University of Agriculture, Abeokuta, Nigeria. Dr Michael Ayodele Idowu is the corresponding author and can be contacted at: idowumchl@yahoo.com

Kazeem Iroko holds a Bachelor's Degree in Food Science and Technology of the University of Agriculture, Abeokuta, Nigeria.

Dr Abiodun Aderoju Adeola holds a PhD in Food Technology from the University of Ibadan and is a Research Fellow attached to the Food and Nutrition Research Programme of the Institute of Food Security, Environmental Resources and Agricultural Research of the Federal University of Agriculture, Abeokuta, Nigeria.

Dr Isaac Babatunde Oluwalana holds a PhD in Food Science and Technology of the Obafemi Awolowo University, Ile-Ife Nigeria and he is a Senior Lecturer in the Department of Food Science and Technology of the Federal University of Technology, Akure. He is also a Visiting Lecturer in the Department of Food Science and Technology of Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria.

Dr Jerome Ayokunle Ayo is an Associate Professor of Food Science and Technology in the Department of Food Science and Technology of the Joseph Ayo Babalola University, Ikeji-Arakeji and a Chief Lecturer in the Department of Food Technology, Federal Polytechnic, Bauchi, Nigeria.

Damilola Shayo Ikuomola holds a Master's Degree in Food Science and Technology of the Federal University of Agriculture Abeokuta and is a Lecturer in the Department of Food Science and Technology of Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria.