academicJournals

Vol. 8(7), pp. 390-401, July 2014
DOI: 10.5897/AJFS2014.1179
Article Number: B109C0446554
ISSN 1996-0794

http://www.academicjournals.org/AJFS

African Journal of Food Science

Full Length Research Paper

Consumers' acceptance of composite cassava-maize-wheat breads using baking improvers

Maria Eduardo[1,2], Ulf Svanberg[2]* and Lilia Ahrné[2,3]

[1]Departamento de Engenharia Química, Faculdade de Engenharia, Universidade Eduardo Mondlane, Maputo, Moçambique.
[2]Department of Chemical and Biological Engineering/Food Science, Chalmers University of Technology, Gothenburg, Sweden.
[3]SIK, The Swedish Institute for Food and Biotechnology, Gothenburg, Sweden.

Received 22 May, 2014; Accepted 30 June, 2014

A consumer test of composite cassava: maize: wheat (40:10:50) breads prepared with improvers, 0.3% emulsifiers, either as lecithin (LC) or diacetyl tartaric acid ester of mono-diglycerides (DATEM), and 3% hydrocolloids, either as high-methylated pectin (HM pectin) or carboxymethyl cellulose (CMC), was carried out in supermarkets in Mozambique. Overall acceptance and sensory attributes such as appearance, texture, smell, flavour, and crumb and crust colour were evaluated, and the consumption pattern and purchase intent were determined using a structured questionnaire. Composite bread quality characteristics, such as specific volume, crust colour, moisture content and firmness, were assessed instrumentally. The consumers' overall acceptance of the composite bread with a mixture of roasted and sundried cassava flours and HM pectin added and LC had a score of 7.58, which was slightly higher than 7.28 for the composite bread with roasted cassava flour. The hedonic test showed that the perceived overall quality of the optimized composite bread based on roasted cassava flour with CMC and DATEM had a score of 7.47, which was significantly higher than the corresponding bread with HM pectin and LC (7.01), but not significantly different from commercial wheat bread (7.82). Crust colour and crumb colour and firmness correlated highly with their perceived sensorial counterpart properties.

Key words: Sensory evaluation, bread quality, composite flour, cassava, hydrocolloids, emulsifiers.

INTRODUCTION

The use of composite flours for breadmaking in order to utilize locally available food crops is promoted in Mozambique due to the high cost of imported wheat flour. Partial substitution of wheat flour by flour products from sorghum, millet, maize, yam and cassava is therefore being explored and evaluated in bread quality parameters such as specific volume, structure, texture and sensory qualities.

Although it is shown that substitution of wheat flour up to a level of 20% results in acceptable composite loaves of bread, an increased substitution level may adversely affect bread and sensory qualities (Khalil et al., 2000;

*Corresponding author. E-mail: ulf.svanberg@chalmers.se. Tel: +46 31 772 3823. Fax: +46 31 772 3830.

Table 1. Dough bread formulations selected from previous studies by Eduardo et al. (2013, 2014)[a].

Ingredient	Acceptance testing		Hedonic evaluation	
	Formula 1	Formula 2	Formula A	Formula B
Wheat flour (kg)	2.5	2.5	2.5	2.5
Maize flour (kg)	0.5	0.5	0.5	0.5
Roasted cassava flour (kg)	1.0	2.0	2.0	2.0
Sundried cassava flour (kg)	1.0	0.0	0.0	0.0
Yeast (%)	1.6[b]	1.6[b]	3.0[c]	3.0[c]
Margarine (%)	3.0	3.0	0.0	0.0
Oil (%)	0.0	0.0	3.0	3.0
DATEM (%)	0.0	0.0	0.3	0.0
LC (%)	0.4	0.4	0.0	0.3
HM pectin (%)	3.0	3.0	0.0	3.0
CMC (%)	0.0	0.0	3.0	0.0
Water (%)	85.0	85.0	85.0	85.0

Formulation used in the production of commercial wheat bread: 1.5% compressed yeast, 0.3% improver (soy flour, oxidant agent E300 and baking enzymes), 1.5% salt, 60-64% water. [a] based on flour weight; [b] dry; [c] compressed.

Hsu et al., 2004; Olaoye et al., 2006; Aboaba and Obakpolor, 2010; Nindjin et al., 2011; Udofia et al., 2013).

Only a few studies report the use of cassava in composite bread mixtures. According to Khalil et al. (2000) wheat breads with a 20% cassava flour substitution level and 1% malt has an overall acceptability score similar to that of wheat bread judged by a semi-trained sensory panel. Similar findings are reported by Eddy et al. (2007). Nindjin et al. (2011) found that 20% cassava or 30% yam starch substitution results in composite breads which meet consumer satisfaction with all the attributes as in the control wheat bread evaluated by an untrained consumer panel. Udofia et al. (2013) reports similar findings by a semi-trained sensory panel for composite bread of wheat:cassava:soybean (67:17:17 w/w ratio), however, higher substitution level on non-wheat flours results in bread with lower acceptability and bread quality parameters.

In addition, many other non-wheat flour products, such as rice flour (Rai et al., 2012; Sabanis and Tzia, 2009), yam flour (Hsu et al., 2004), maize flour (Păucean and Man, 2013) and sorghum flour (Keregero and Mtebe, 1994), have been tested as substitutes for wheat flour in composite bread formulations. All report that a level of 20% is the upper limit for substitution without there being an alteration in consumer acceptance of the composite bread as compared to wheat bread. The use of non-wheat flour products to partially substitute for wheat in products as bread, would help to reduce dependence on expensive wheat imports in South East Africa, including Mozambique where the production of wheat is difficult due to the climatic conditions.

The quality of composite cassava-wheat-maize bread has recently been evaluated instrumentally for breads made with different types of cassava flour (sundried, roasted and fermented) in combination with pectin (1 or 3%) and lecithin (0.4%). Eduardo et al. (2013) reports that bread firmness and crust colour are similar to that of wheat bread with a high level (40%) of roasted cassava flour or a low level (20%) of sundried cassava flour. The composite bread with a high level (40%) of roasted cassava flour is further optimized by Eduardo et al. (2014) using different emulsifiers and hydrocolloids. Based on the results of these studies, three different composite cassava breads with added hydrocolloids (carboxymethyl cellulose (CMC) or high-methylated pectin (HM pectin)) and emulsifiers (diacetyl tartaric acid ester of mono-diglycerides (DATEM) or lecithin (LC)) are proposed to be selected for consumer field tests.

The aim of the present study was therefore to (i) assess the acceptability of improved composite cassava-maize-wheat bread among local consumers in Mozambique, (ii) hedonically evaluate sensorial bread properties in order to identify the most important ones for consumer acceptance and (iii) collect general information about the bread consumption pattern, purchase intention and attributes of composite breads.

MATERIALS AND METHODS

Two consumer studies were carried out in three supermarkets in Maputo, Mozambique. The first was a consumer acceptance test (overall liking) of two composite bread formulations (40% cassava: 10% maize: 50% wheat) with an addition of baking improvers, high methylated pectin (HM pectin) at 3% level and lecithin (LC) at 0.4% level. The two bread formulations selected were based on either roasted cassava flour (40%) – formula 1, in a previous study shown to have similar bread quality characteristics as wheat bread (Eduardo et al., 2013), or a mixture of roasted (20%) and sundried (20%) cassava flour – formula 2, (Table 1). Sundried cassava flour is selected because it is the major form (>80%) of cassava flour that

Name: ____

Zone: ( ) Rural ( ) Urban Date: ____ / _____ / 2010

Age: __________ Sex: (_____)Male (_____) Female

Please evaluate the sample using the scale below to describe how much you liked or disliked the product. Mark the position on the scale that best reflects your trial.

Sample code: _____________
( ) Like extremely
( ) Like very much
( ) Like moderately
( ) Like slightly
( ) Neither like nor dislike
( ) Dislike slightly
( ) Dislike moderately
( ) Dislike very much
( ) Dislike extremely

Figure 1. Sensory evaluation form used for the acceptance test.

is consumed in Mozambique (Dias, 2012).

In the second study, consumer acceptance and attitudes were further investigated for an optimized composite bread formulation containing 40% roasted cassava flour in compare-son with a composite bread similar to formula 1. The two formulations are based on the results of Eduardo et al. (2014), where quality aspects such as specific volume, texture, colour and moisture content were investigated when dough improvers were used. The formulations selected contained (formula A) carboxymethyl cellulose (CMC) with diacetyl tartaric acid ester of mono-diglycerides (DATEM) and (formula B) HM pectin with LC, which was similar to formula 1 in the first consumer study. Hydrocolloids were added at 3% level and emulsifiers at 0.3% level.

Materials

Commercial flours from common wheat and maize, sugar, salt, dry and compressed yeast (Anchor), baking margarine and vegetable oil were purchased from the Mozambican market. Other ingredients used were ascorbic acid (Hebei Welcome Pharmaceutical Company, China), diacetyl tartaric acid ester of mono-diglycerides (DATEM) (Panodan A2020, DANISCO, Denmark), sunflower lecithin (LC) (Sternchemie, Germany), carboxymethyl cellulose (CMC) (CEKOL® 50000 W, CP Kelco, Denmark) and high-methylated pectin (HM pectin) (GENU® pectin type BIG, CP Kelco, Denmark). Fresh roots of cassava were obtained from local producers in Mozambique and then processed into sundried and roasted cassava flour, respectively, as previously described (Eduardo et al., 2013).

Breadmaking procedure

Bread formulations are shown in Table 1. Other ingredients (based on flour weight) used were 1.5% salt, 2% sugar and 0.1% ascorbic acid. An industrial mixer (Felino, AF10.1, Portugal) was used to mix the ingredients with a simultaneous addition of water until a cohesive dough mass was obtained (~20 min). The resultant dough was left to rest at room temperature for approximately 10 min. The fermented dough was weighed and divided into portions of 200 g each, hand-rounded in "*cacete*" shapes (Figure 5), put on trays and fermented for approximately 60 min. Before baking, a cut was made with a blade in the surface of the rolled pieces of dough to orient dough expansion during the oven spring and to generate final scars on the surface, which are characteristic of this type of bread. The pieces were baked in an annular oven (Teimarmor, CE, Portugal) using wood fuel at a temperature of about 230 - 250°C for 12 min. The loaves were removed from the oven and cooled for 2 h at room temperature. The cooled loaves were packed in polyethylene bags until tested by the consumers on the same day.

Consumer acceptance test

The overall acceptability of two composite breads was evaluated by a consumer panel consisting of 79 Mozambican consumers (36 male and 43 female, aged between 16 and 65 years). The largest group of panel participants (46%) were between 21 and 30 years.

The consumer test describing the subjective quality of bread was a "hedonic" (affective) type of test and was conducted in three supermarkets in Maputo, Mozambique. The bread samples were marked with randomly chosen 3-digit numbers; they were sliced into pieces of uniform thickness and given to the consumers within 3 h after baking. Each consumer received an evaluation form (Figure 1) and one sample at the time to assess their degree of liking (Cordonnier and Delwiche, 2008). The consumers were provided with water at an ambient temperature of approximately 22°C to rinse their mouths before testing and between samples. A 9-point hedonic scale (9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much and, 1=dislike extremely) (Peryam and Pilgrim 1957; Lawless and Heymann 1999, 2010) was used for overall liking (Figure 1). The results were obtained by a calculation of the overall mean, and the acceptance index was determined as the acceptance percentage that considered 100% the score of 9. Bread was considered acceptable if the mean value was above 5 (neither like nor dislike).

To determine how well composite bread is liked by consumers, the bread was compared with a commercial wheat bread (100% wheat flour) baked using the same procedure as in the case of the composite breads.

Evaluation of liking and consumption practices

In the second part, the consumer panelists hedonically evaluated sensory attributes of two composite bread types, 40% roasted cassava/HM pectin/LC and 40% roasted cassava/CMC/DATEM, in terms of appearance, texture, smell, flavour, crust and crumb colour, and overall quality. The overall quality was calculated as an average of the attributes evaluated. The sensory analysis was undertaken using 52 consumers (15 females, 37 males, aged 14-55 years). The hedonic evaluation was made for each of the properties using the same method and scale as described in Figure 1. An average response was calculated for each of the properties. Each consumer completed a structured questionnaire (Mcwatters et al., 2004) pertaining to bread consumption pattern, purchase intent and attitudes to composite breads.

Sample size estimation

The sample size of 52 persons was calculated according to Lawless and Heymann (1999, 2010):

$$N = \frac{(Z_\alpha + Z_\beta)^2 \cdot S^2}{(\mu_1 - \mu_2)^2} = [(1.96+1.65)^2.1^2]/(0.5)^2 = 52$$

where N = the number of consumers needed in the test; S = the anticipated standard deviation of the scores, 1.0, that was equal to the average standard deviation obtained in the first consumer study with 79 participants; $\mu_1 - \mu_2$ = the difference between means to be significantly detected ($p<0.05$); Z_α = 1.96 with a 95% confidence level; and Z_β = 1.65 with a 90% power of the study.

Instrumental analysis of bread quality attributes

Objective measurements of bread quality attributes were made only on the optimized breads with additives (second study).

Specific bread volume

Each bread loaf (n = 3) was weighed and the loaf volume was measured 8 h after the end of the baking process using the bread volume apparatus (TextVol Instruments BVM-L370, Sweden). The average specific loaf volume was expressed as cm^3/g.

Crumb structure

The bread crumb structure was evaluated from images captured using a flatbed scanner (HP ScanJet G2410, China). Images were scanned full scale at 300 dots per inch.

Crust and crumb colour

The colour analysis of the crust and crumb were evaluated using the Color Reader CR-10 (Minolta, Japan) and considered parameters L*, a* and b*. The L* scale ranges from 0 black to 100 white; the a* scale extends from a negative value (green hue) to a positive value (red hue); and the b* scale ranges from negative blue to positive yellow. The colour reader was calibrated with a white standard. The results were reported according to the brownness index (BI) (Maskan, 2001):

$$BI = \frac{[100 \cdot (x - 0.31)]}{0.17} \quad (1)$$

where,

$$x = \frac{a + 1.75L}{5.645L + a - 3.01b} \quad (2)$$

The measurements were carried out in triplicate.

Crumb moisture

The moisture content of bread crumb samples (n=3) was calculated by drying two to three grams of bread samples in an air oven (DigiTronic, Spain) at 105°C until constant weight was obtained (approved method Method 44-40, AACC 1995). Results were expressed on a wet weight basis.

Crumb firmness

The crumb firmness was measured 8 h after baking using an Instron Universal Testing Machine (UTM model 5542, USA). AACC standard method 74-09 was used (AACC, 1995). The measurements were carried out on 25-mm thick loaf slices taken from the centre part of the loaf of bread. Samples were compressed to approximately 10 mm (40% of the slice thickness) at a test speed of 1.7 mm/s. The measurements were carried out on three loaves from each batch, and the compression force (in Newton) was defined as crumb firmness.

Data analysis

Hedonic sensory scores of breads were subjected to analysis of variance (ANOVA) with the SPSS version 11.5 software. Differences between variables were tested for significance by Tukey's HSD multiple comparison range test. *P* values <0.05 were considered significant.

RESULTS AND DISCUSSION

Overall consumer acceptability

The overall acceptability of a food is an important factor that is influenced by the sensory quality of the product together with the consumer´s attitude towards the food (Mela, 2001). In the first part of this study, a consumer panel (n=79) evaluated the overall acceptability of two composite bread formulations containing 40% cassava flour from roasted or a mixture of roasted/sundried cassava with HM pectin and lecithin as baking improvers (Table 2). The bread with roasted/sundried had a score of 7.58, which was not significantly different from the score of 7.85 for the wheat reference bread and slightly higher

Table 2. Overall mean acceptability scores of bread samples evaluated by consumers (n=79).

Bread samples	Cassava (%)	Overall acceptability[1)]	Acceptability Index (%)
Commercial wheat	0	7.85[a]	87.2
Roasted/sundried cassava (20:20)	40	7.58[ab]	84.2
Roasted cassava	40	7.28[b]	80.9

Mean values that are followed by a different letter differ significantly ($p<0.05$). [1)]Hedonic scale (9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much and, 1=dislike extremely)

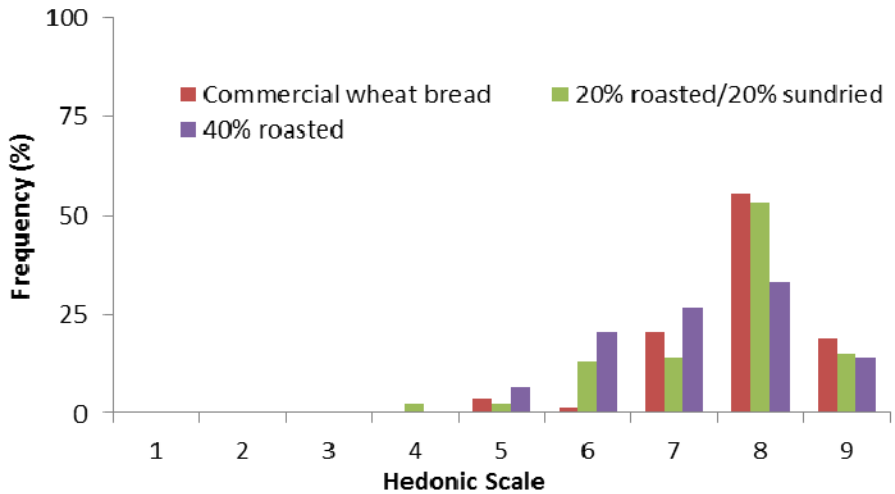

Figure 2. Frequency distribution of responses to overall consumer acceptance test of commercial wheat bread, bread with roasted/sundried cassava and roasted cassava bread.

as compared to that of composite bread with only roasted cassava (7.28). The results thus showed a good acceptability of the composite bread with 40% cassava, which is in agreement with the results reported by Eddy et al. (2007). They reported that bread with 30% cassava had an overall acceptability comparable to the mean score of wheat bread. The results are in contradiction to previous observations reported by Nindjin et al. (2011), however, who observe a decrease in the overall acceptability of composite bread made from wheat and 40% yam starch and wheat and 30% cassava starch. They explain their results by a decrease in taste, crumb appearance and texture. Aboaba and Obakpolor (2010) also reported a lower acceptability of composite bread containing 30 and 40% cassava flour due to size, crust colour, taste and texture. A possible reason for the high acceptability, similar to that of the wheat reference bread, found in the present study could be that improvers such as high-methylated pectin and lecithin were used in the formulation.

The distribution of the consumers' scores on the 9-point hedonic scale is shown in Figure 2. The majority of responses had a score of 8 (corresponding to "liked very much"), 53% for composite bread with roasted/sundried cassava and 33% for composite bread with roasted cassava, which indicates a high acceptance of both composite breads.

The acceptability index (AI), the percentage of scores above 5, was high (>80%) for both composite breads, including the commercial wheat control bread (Table 2), which means that these products are deemed by consumers as satisfactory (Dessimoni-Pinto et al., 2011). In conclusion, the two composite cassava breads with either roasted cassava or a mixture of roasted/sundried cassava flour were ranked similarly and like wheat bread, although there was a slight preference for bread formulated with a mixture of sundried/roasted cassava flour.

Sensory evaluation of quality attributes

The sensorial evaluation of quality attributes was made on the composite bread with 40% roasted cassava including an optimized formulation with respect to improvers (CMC/DATEM). Table 3 shows that the overall quality of the composite bread with CMC/DATEM was given a score of 7.47, significantly higher than HM

Table 3. Mean scores of hedonic sensory attributes and consumer attitudes towards purchasing composite cassava-maize-wheat breads with hydrocolloids and emulsifiers as compared to wheat bread (n=52).

Hedonic scale[1)]	Bread type		
	Commercial wheat	CBA	CBB
Appearance	8.33[a]	7.67[b]	6.80[c]
Texture	7.73[a]	7.40[ab]	6.98[b]
Smell	7.38[a]	7.35[a]	7.24[a]
Flavour	7.35[a]	7.50[a]	7.04[a]
Crust color	8.08[a]	7.38[b]	6.80[b]
Crumb color	8.08[a]	7.50[ab]	7.09[b]
Overall quality	7.82[a]	7.47[a]	7.01[b]
Intention of consumption[2)]	4.23[a]	4.08[a]	3.47[b]

Mean values in the same row followed by a different letter differ significantly ($p < 0.05$). CBA (composite bread with CMC/DATEM); CBB (composite bread with HM-pectin/LC). [1)]Hedonic scale (9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much and, 1=dislike extremely). [2)]Scale of attitudes of consumption (5 = consume whenever had the chance, 3 = would consume if it was accessible, but not strive for it; 1 = consume only if forced).

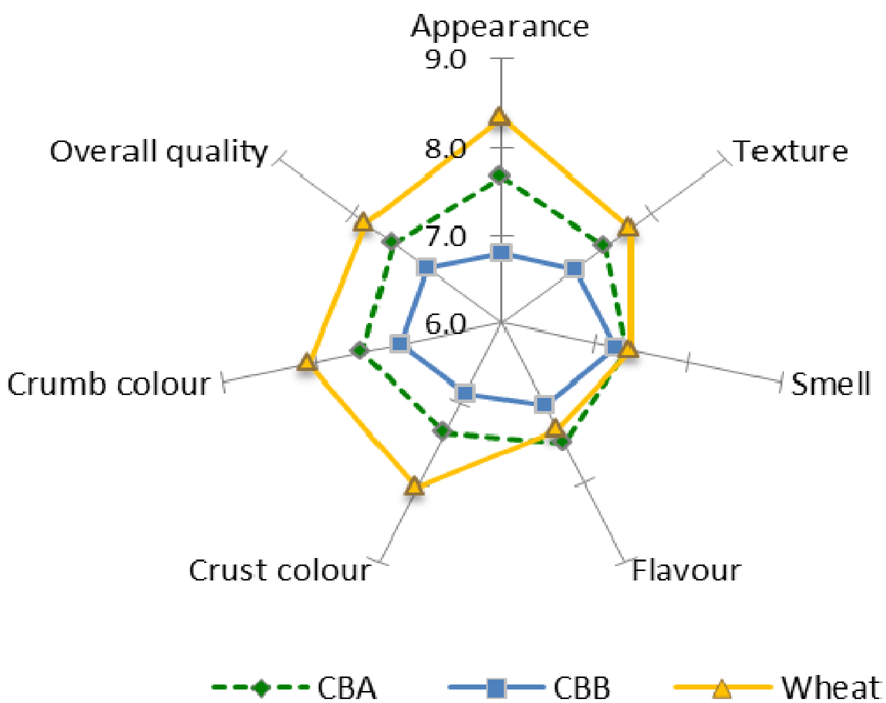

Figure 3. Radar plot of hedonic sensory evaluation of breads made from CBA (CMC/DATEM), CBB (HM pectin/LC) and wheat bread.

pectin/LC bread (7.01) but not significantly different from commercial wheat bread (7.82). The two composite breads may be regarded as highly acceptable products, where their mean scores were >6.8 for all attributes. As compared with wheat bread, the composite bread with CMC/DATEM had lower mean only for the attributes of appearance and crust colour. The mean scores for intention of consumption for the two breads were also similar.

Figure 3 shows the average results of the hedonic sensory evaluation on a radar plot for the composite breads. The attributes of appearance and crust colour

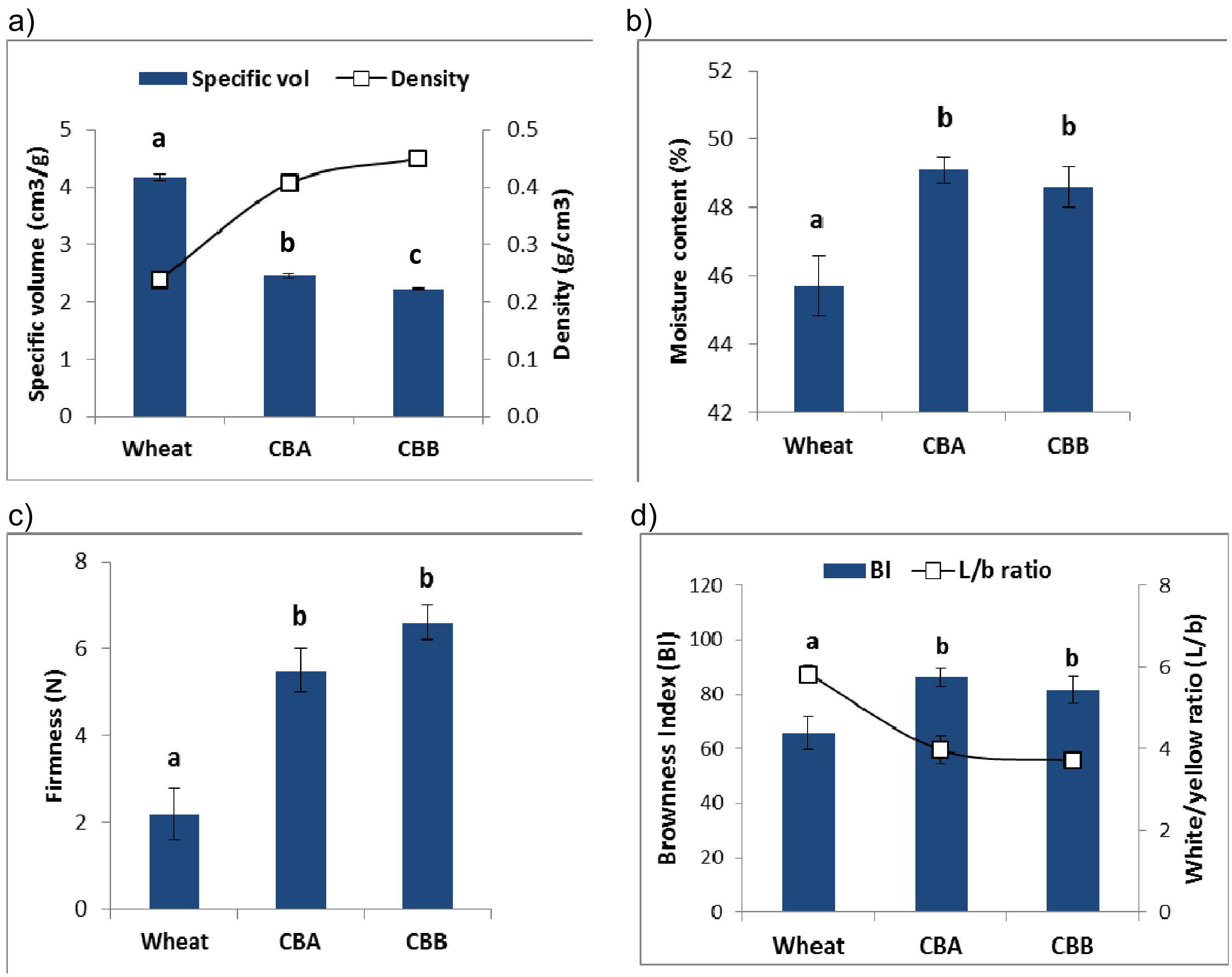

Figure 4. Bread characteristics of CBA (composite bread with CMC/DATEM), CBB (composite bread with HM pectin/LC) and wheat bread: a) specific bread volume b) moisture content c) firmness d) crust brownness index (BI) and crumb colour (L/b ratio). For each quality parameter, values with a different letter are significantly different from each other (p<0.05); n=3.

showed the most significant differences while smell and flavour showed statistically non-significant differences among the three evaluated breads. In general, all attributes for composite bread with CMC/DATEM had higher scores as compared with composite bread with HM pectin/LC, showing that results obtained instrumentally in Eduardo et al. (2014) agree well with the sensorial evaluation, as the results reported in the next section.

Instrumental evaluation of bread properties

Figure 4 (a-d) shows the values for bread specific volume and density, moisture content, firmness and colour of the wheat bread (control) and the composite breads with CMC/DATEM and HM pectin/LC at levels of 3% and 0.3% of hydrocolloids and emulsifiers, respectively.

The specific volume of the composite breads ranged from 2.2 to 2.5 cm^3/g, which was significantly lower than that of the wheat reference bread (4.2 cm^3/g). The lower specific volume of the composite breads can be explained by a lower gluten level as a result of the addition of cassava flour (40%). The gluten fraction is responsible for the elasticity of the dough by causing it to extend and trap the carbon dioxide generated by yeast during fermentation. The percentage of wheat flour required in composite flours to achieve acceptable bread qualities depends largely on the quality and quantity of wheat gluten and the nature of the product involved (Mepba et al., 2007).

The moisture content of the composite breads ranged from 48.6 to 49.1% (Figure 4b), which was significantly higher than in wheat bread (45.7%) although the same amount of water was added in the preparation of the dough. The difference can be explained by the high water binding capacity of the hydrocolloids (CMC and HM pectin) used in the composite breads (Bárcenas and Rosell, 2005; Sivam et al., 2011), preventing moisture losses during baking.

The texture analysis showed a higher firmness in bread made with HM pectin/LC (6.6 N) when compared with CMC/DATEM (5.5 N) ($p<0.05$), and both values were significantly higher than the firmness of wheat bread (2.2 N).

The brownness index (BI) of the loaf crust was significantly higher ($p<0.05$) in the composite breads, 86.4 in bread with CMC/DATEM and 81.6 in bread with HM pectin/LC, when compared with wheat bread (65.9). These results are in line with the findings of Raidi and Klein (1983), who showed that when the level of non-wheat flour in a dough mixture is higher, the crust colour of the breads changes from creamy white to dull brown or dark. The change in crust colour may be attributed to Maillard reactions, which are influenced by the distribution of water and the reaction of reducing sugars and proteins (Raidi and Klein, 1983; Kent and Evers, 1994). The presence of partly gelatinized starch in the roasted cassava flour may contribute to an increased content of reducing sugars (Tivana et al., 2010). Esteller and Lannes (2008) further observe that, during baking, the amount of water on the dough surface quickly decreases, providing favourable conditions for Maillard reactions and thus resulting in a darker brown colour.

Relationship between the sensory evaluation and instrumental analysis

The relationships between three physical properties of the composite cassava-maize-wheat breads, crumb colour (L/b ratio), brownness index and bread firmness and their sensory counterparts, are shown in Figure 6.

There was a good correlation between the sensorial evaluation and the instrumental analysis results obtained for crumb colour and firmness, as shown by the values of the coefficient of determination (R^2 >0.8). However, a lower correlation was observed for sensorially perceived and the instrumentally measured crust colour (R^2=0.64), which is probably due to the fact that the bread crust had a central area with a more light colour while analytical measurements were done on the darker crust (Figure 5). The bread firmness was inversely correlated to the bread texture score, that is, the consumers prefer bread with a softer texture. In the case of bread crumbs, the consumers seemed to prefer bread with a lighter colour, that is, bread with a higher white-to-yellow ratio.

General information of bread consumption pattern and purchase intention

It was found in the general consumer survey that 25% of the respondents (n=52) spent less than 0.33 USD/week, 35% between 0.33 and 0.67, 19% between 0.67 and 1.34, 12% between 1.34 and 1.67, and only 10% more than 1.67 USD/week in the purchase of wheat bread, which corresponds to 1, 2-4, 4-8, 8-9 and more than 10 loaves of 200 g/week, respectively.

The results showed that most respondents buy bread more than 3 times a week (about 83%) while about 17% purchase between 1 and 3 times a week (Table 4).

Concerning the bread consumption pattern (Table 5), it was found that 33% of the respondents consume bread 5-7 times a week while 21% ate bread more than once a day. Most of the consumers, 54%, do not keep bread before eating it but 46% keep bread between 1 and 3 days before consumption. Over 60% of the respondents use appearance as a criterion to decide whether the bread is no longer edible, followed by texture (15%), length of storage (14%) and odour (only 6%). A majority of the respondents (92%) purchase their bread for consumption.

Respondents revealed their attitudes to composite breads, (Table 6). About 94% of the respondents would accept composite bread, and 92% showed interest in buying bread made with two or more flours but were not ready to buy a mixture of two or more flours to produce bread (85%).

In general, composite bread was viewed as more nutritious (50%) and as providing variety (29%), and a few respondents (15%) referred to it as an inexpensive product.

Conclusions

In the present consumer study, we found that the use of cassava flour in breadmaking is feasible and that incorporation of 40% roasted cassava in composite flour mixtures in combination with baking improvers produced highly acceptable breads in all sensory attributes including overall quality on a 9-point hedonic scale. Composite cassava bread with 20% sundried and 20% roasted cassava flour had an overall acceptability similar to commercial wheat bread.

The general information on the bread consumption pattern indicated a high acceptability and willingness to purchase composite cassava bread.

These results suggest that cassava and maize, the two major food crops produced in Mozambique, could be commercialized to be used in bread making and thus contribute to a reduced import of wheat flour.

ACKNOWLEDGEMENT

Financial support from the Swedish International Development Agency (SIDA) programme under the Project “Energy science and Technology research” is gratefully acknowledged.

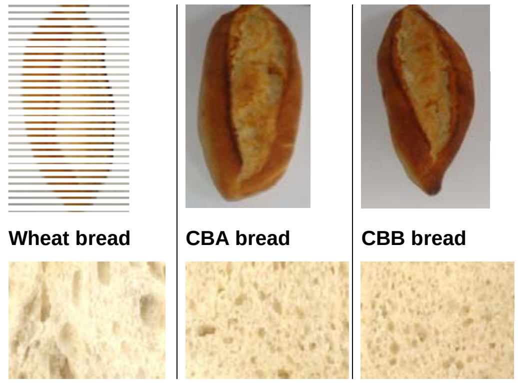

Figure 5. Photographs of composite cassava-maize-wheat breads baked with CMC/DATEM (CBA) and HM pectin/LC (CBB).

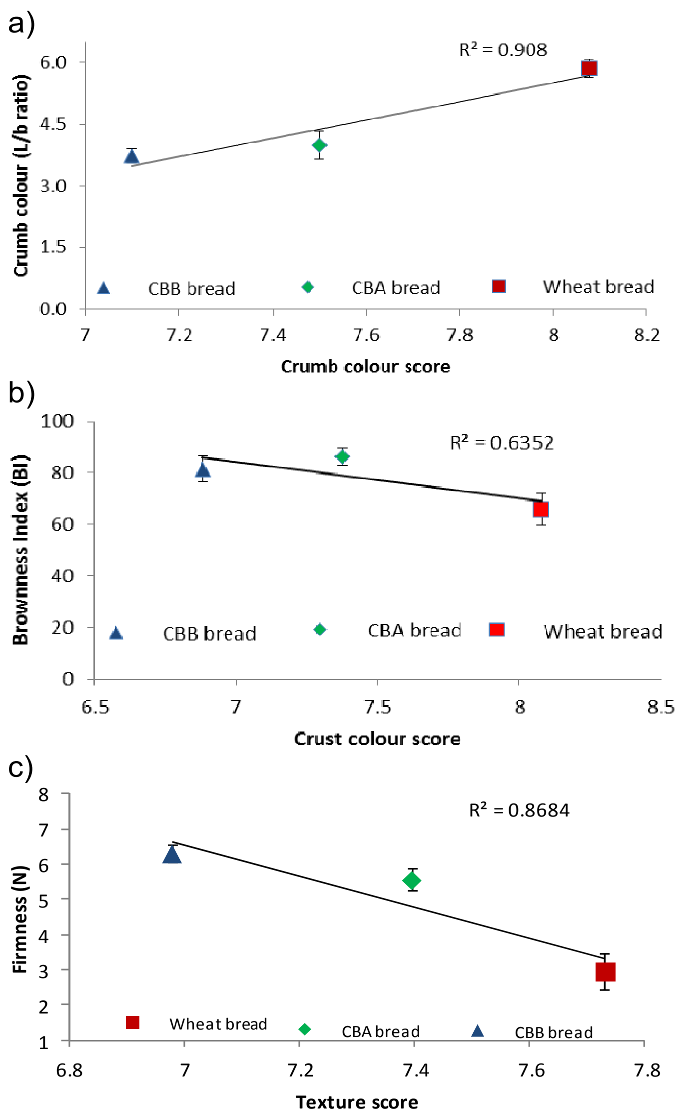

Figure 6. Relationship between the instrumental analysis and sensorial evaluation of bread properties. Wheat bread, CBA (composite bread with CMC/DATEM) and CBB (composite bread with HM pectin/LC).

Table 4. Wheat bread purchase pattern.

Parameter	Frequency	Percentage
How much do you normally pay for the bread (a loaf of bread of 200 g):		
Less than USD 0.33	13	25.0
USD 0.33-0.67	18	34.6
USD 0.67-1.34	10	19.2
USD 1.34-1.67	6	11.5
Greater than USD 1.67	5	9.6
How often do you buy bread:		
Less than once a week	0	0.0
Once a week	3	5.8
Twice a week	3	5.8
Three times a week	3	5.8
More than three times a week	43	82.7

1USD=29.91 MT (source: Banco de Moçambique, 17th of February 2013).

Table 5. Pattern of consumption of wheat bread among the study population.

Parameter	Frequency	Percentage
Bread consumption:		
Once a day	12	23.1
More than once a day	11	21.2
1-2 times a week	4	7.7
3-4 times a week	8	15.4
5-7 times a week	17	32.7
Bake bread at home:		
Yes	4	7.7
No	48	92.3
Keeping before eating:		
Yes	24	46.2
No	28	53.8
Where:		
Not keep	28	53.8
Plastic bag	23	44.2
Fridge	1	1.9
How long (day):		
0	28	53.8
1	20	38.5
2	3	5.8
3	1	1.9
more than 3	0	0.0
How do you decide when your bread is no longer edible:		
Appearance (mould, colour)	34	65.4
Texture (too hard)	8	15.4
Length of storage	7	13.5
Odour	3	5.8

Table 6. Consumer attitudes to composite cassava bread.

Parameter	Frequency	Percentage
Acceptance of composite bread:		
Accepted	49	94.2
Rejected	3	5.8
Why it is accepted:		
More nutritious	26	50.0
Provides variety	15	28.8
Pay less	8	15.4
Why it is rejected:		
Not good enough	1	1.9
Less nutritious	1	1.9
Pay more	1	1.9
Would you buy a mixture of flours:		
Yes	8	15.4
No	44	84.6
Purchase bread made of a mixture of two or more flours:		
Yes	48	92.3
No	4	7.7
Which other products do you prefer to bread:		
Rice	11	21.2
Potatoes	14	26.9
Cassava and rale	15	28.8
Maize flour	5	9.6
Cake	7	13.5

Conflict of Interest

The author(s) have not declared any conflict of interests.

REFERENCES

Aboaba OO, Obakpolor EA (2010). The leavening ability of baker´s yeast on dough prepared with composite flour (wheat/cassava). Afr. J. Food Sci. 4:325-329.

American Association of Cereal Chemist (AACC) (1995). Approved methods of the AACC (9th ed.). St Paul: The Association.

Bárcenas ME, Rosell CM (2005). Effect of HPMC addition on the microstructure, quality and aging of wheat bread. Food Hydrocolloid. 19:1037-1043.

Cordonnier SM, Delwiche JF (2008). An alternative method for assessing liking: positional relative rating versus the 9-point hedonic scale. J. Sens. Stud. 23:284-292.

Dessimoni-Pinto NAV, Moreira WA, Cardoso L de M, Pantoja LA (2011). Jaboticaba peel for jelly preparation: an alternative technology. Ciênc. Tecnol. Aliment. 31(4):864-869.

Dias P (2012). Analysis of incentives and disincentives for cassava in Mozambique. Technical notes series, MAFAP, FAO, Rome

Eddy NO, Udofia PG, Eyo D (2007). Sensory evaluation of wheat/cassava composite bread and effect of label information on acceptance and preference. Afr. J. Biotechnol. 6:2415-2418.

Eduardo M, Svanberg U, Ahrné L (2014). Effect of hydrocolloids and emulsifiers on baking quality of composite cassava-maize-wheat reads. (In press, Int. J. Food Sci.).

Eduardo M, Svanberg U, Oliveira J, Ahrné L (2013). Effect of cassava flour characteristics on properties of cassava-wheat-maize composite bread types. Int. J. Food Sci. 2013:1-10.

Esteller MS, Lannes SCS (2008). Production and characterization of sponge dough bread using scalded rye. J. Texture Stud. 39:56-67.

Hsu CL, Hurang SL, Chen W, Weng YM, Tseng CY (2004). Qualities and antioxidant properties of bread as affected by the incorporation of yam flour in the formulation. Int. J. Food Sci. Technol. 39:231-238.

Kent NL, Evers AD (1994). Bread made with gluten substitutes. Technology of Cereals. Oxoford: Pergamon, Press, p. 215.

Keregero MM, Mtebe K (1994). Acceptability of wheat-sorghum composite flour products: an assessment. Plant Food Hum. Nutr. 46(4):305-312.

Khalil AH, Mansour EH, Dawoud FM (2000). Influence of malt on rheological and baking property of wheat-cassava composite flours. Lebensm. Wiss Technol. 33:159-164.

Lawless HT, Heymann H (2010). Sensory evaluation of food: Principles and practices, 2nd ed., London: Springer New York Dordrecht Heidelberg, 587 p.

Lawless NT, Heymann H (1999). Sensory evaluation of food: Principles and practices. Gaithersburg, Maryland: Aspen publishers, Inc. 819 p.

Maskan M (2001). Kinetics of colour change of kiwifruits during hot air and microwave drying. J. Food Eng. 48:169-175.

Mcwatters KH, Phillips RD, Walker SL, Mccullough SE, Mensa-Wilmot Y, Saalia FK, Hung Y-C, Patterson SP (2004). Baking performance and consumer acceptability of raw and extruded cowpea flour breads. J. Food Qual. 27:337-351.

Mela JD (2001). Development and acquisition of food likes. In “Food, people and society”, eds. Frewer, L. J., Risvik, E. and Schiffersteins,

H. (pp. 9-19). Springer, Berlin Heidelberg.
Mepba HD, Eboh L, Nwaojigwa SU (2007). Chemical composition, functional and baking properties of wheat-plantain composite flours. Afr. J. Food Agr. Nutr. Dev. 7:1-22.
Nindjin C, Amani GN, Sindic M (2011). Effect of blend levels on composite wheat doughs performance made from yam and cassava native starches and bread quality. Carbohydrate Polymers 86:1637-1645.
Olaoye OA, Onilude AA, Idowu OA (2006). Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. Afr. J. Biotechnol. 5:1102-1106.
Păucean A, Man S (2013). Influence of defatted maize germ flour addition in wheat:maize bread formulations. J. Agroaliment. Proc. Technol. 19(3):298-304.
Peryam DR, Pilgrim FJ (1957). Hedonic Scale method of measuring food preferences. Food Technol. 11:9-14.
Rai S, Kaur A, Singh B, Minhas KS (2012). Quality characteristics of bread produced from wheat, rice and maize flours. J. Food Sci. Technol. 49:786-789.
Raidi MA, Klein BP (1983). Effect of soy or field pea flour substitution on physical and sensory characteristics of chemically leavened quick breads. Cereal Chem. 60:367–370.
Sabanis D, Tzia C (2009). Effect of rice, corn and soy flour addition on characteristics of bread produced from different wheat cultivars. Food Bioprocess Tech. 2:68-79.
Sivam AS, Sun-Waterhouse D, Waterhouse GIN, Quek SY, Perera CO (2011). Physicochemical properties of bread dough and finished bread with added pectin fiber and phenolic antioxidants. J. Food Sci. 76(3):H97-H107.
Tivana LD, Dejmek P, Bergenståhl B (2010). Characterization of the agglomeration of roasted shredded cassava (*Manihot esculenta* Crantz) roots, Starch/Staerke, 62(12):637-646.
Udofia PG, Udoudo PJ, Eyen NO (2013). Sensory evaluation of wheat-cassava-soybean composite flour (WCS) bread by the mixture experiment design. Afr. J. Food Sci. 7(10):368-374.