Effect of baking improvers on the quality of whole cassava biscuits

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Abstract Improving agents such as ascorbic acid, sodium metabisulphite, sorbic acid and soyflour were used in the production of whole cassava biscuits. Cassava flour and small amount of soyflour were produced. Bulk density, water binding capacity and amylograph viscosity of cassava flour were determined. Mixing and dough extrusion time were recorded for each sample of biscuit dough developed with addition of improvers. Length, width and thickness of cut-out dough were measured before and after baking to evaluate biscuits flow. Proximate and sensory analysis of the biscuits samples was also determined. The result showed that, there was a slight decrease in mixing time, extrusion time, length and width of the biscuits samples prepared with improvers. However, there was a considerable increase in biscuits thickness. Amylograph result showed an improvement in flour stability and low retrogradation tendency, most especially flour with inclusion of ascorbic acid. Crude protein and fat increased with sample contained soyflour. Sensory evaluation result indicated no significant difference among the samples except the texture of the biscuits.

Keywords Cassava flour · Improver · Ascorbic acid · Sodium metabisulphite · Soyflour · Sorbic acid

Introduction

Cassava has until recently been undervalued as a crop of importance in Africa, this is partly because cassava was argely processed for local traditional foods and its industrial

remain untapped (Hahn et al. 1989). This situation has changed with current efforts at utilizing cassava for the industrial production of food grade starch, glue, beer and alcohol (Eggleston et al. 1993) among others. One area in which cassava has been found very useful is in the utilization of cassava flour in a composite flour programme.

The composite flour programme initiated by Food and Agriculture Organisation of the United Nations in 1964 was conceived primarily to develop bakery products from locally available raw material particularly from locally available raw material particularly in the countries which could not meet their wheat requirements. Much attention has been focussed on the development of composite flour technology for confectionery production. Acceptable biscuits have been produced from mixture of wheat flour and cassava flour. Work done at the International Institute of Tropical Agriculture has led to the production of nutritious baked products such as cakes and biscuits using cassava flour, cassava starch, margarine and eggs (Bokanga 1995).

However, the major challenge in cassava flour utilization is dough handling, which lacks the functional viscoelastic properties which is the unique characteristics of wheat flour. To overcome this, some workers have worked on gluten substitute. John suggested that any ingredient capable of improving coherence between starch granules without impairing the capacity of dough/batter to rise will be a suitable binder. He used the surfaceactive emulsifier GMS (glycerol monostearate) to improve gas retention and bread qualities of starches. Almazan put forward the idea that starch obtained from cassava must be supplemented with an improver such as pentosan if used alone or at very high concentration.

These substances (improving agents) give a whitened appearance to baked products because of their beneficial effect on texture of the crumb. However, improving agents do not increase the carbon dioxide production in fermented dough, but they improve gas retention (because the dough is made

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more elastic) and this result in increased loaf volume (Kent 1984). Today, small amount of oxidising agents (improvers) are added to flour to accomplish the maturing process, and these oxidising agents are called flour improvers or sulfhydryl oxidising agents. The influence of improver on dough rheology and baking performance for the production of semi-sweet biscuits have been studied by Olive et al. (1995). The use of soy-flour as an improver in the baking industry is well known in improving dough handling characteristics particularly in products such as cookies. This study was designed to investigate the effect of baking improvers on the quality of whole cassava biscuits.

Materials and methods

All the materials for whole cassava biscuit production such as cassava flour, baking powder, sugar, salt, baking powder, egg, bakery fat, powdered milk and Soya bean flour except the baking improver were obtained from the retail market at kuto in Abeokuta, Ogun State, Nigeria. Baking improvers were collected from the Food Science and Technology laboratory in University of Agriculture, Abeokuta, Nigeria. These are sodium metabisulphite, ascorbic acid, sorbic acid and Soya flour. Soy flour was prepared in the laboratory.

Preparation of cassava flour

Manihot Palmata (low cyanide content) was used in the preparation of cassava flour. Cassava tubers were peeled, washed with portable water and chipped with chipping machine. The chips sizes from the machine are about 4 mm in thickness. After chipping, it was dried with cabinet drier operated at 45 °C for about 12 h and finally dried at 65 °C for moisture removal. It was then milled with disc attrition mill. The resultant product from milling was sieved using a sieve of size 70 mesh. The final product (cassava flour) was packed in polyethylene bags at ambient temperature until needed for biscuits production.

Preparation of soy flour

Cleaned soybean was washed and soaks for 6 h in water containing 0.2 % NaOHCO₃, to remove beany flavour. After this, it was decorticated and steamed for 20 min. After steaming, it was drained, spread out inside a tray and placed in cabinet drier to dry at a temperature of about 45–50 °C. It was dried mill into flour and sifted.

Production of cassava biscuit

Bakery fat (Breaden) produced by Lever Brother Nigeria Plc was weighed, and all other ingredients according to the recipe.

Bakery fat and sugar was weighed into a mixing bowl and mixed until it becomes fluffy. Egg and baking improver dissolved in 40 ml of water were added and mixed at medium speed, when thorough mixing was achieved. Cassava flour, salt, milk powder, flavouring agent and baking powder were finally added into the mixing bowl. The mixer was first operated at low speed to prevent splashing of ingredients after which it was turned into high speed for thorough mixing to form dough. The dough was rolled into a thin sheet, cut into shapes manually and quickly baked at a temperature of 160 °C for 30 min in a forced air convection oven.

Physico-chemical analysis

Bulk density of the flour

The bulk density was determined by weighing 20 g of dried cassava into a 100 ml measuring cylinder and drop the cylinder 150 mm onto a 80 ft pad 10 times, level off powder and measure the bulk density in g/ml (Kirk and Ronald 1991).

Water binding capacity

The method of Medcalf was used for determining the water binding capacity.

$$\text{Calculation} = \frac{\text{Different in weight}}{2.5} \times 100$$

Dough extrusion time and mixing time

A sample of the bulk dough (60 g) was rolled into a cylindrical shape (12 mm diameter) and pressed firmly into a simple extruder. After 10 min a plunger with a weight (2,370 g) was placed on top of the dough piece. The time taken for the plunger to travel 1 cm was recorded with stop watch (Olive et al. 1995). The mixing time during dough development was determined by using stop clock.

Biscuit flow and break strength

The biscuit flow which is the increase in volume of unbaked stamped-out dough after baking was determined by measuring the diameter and thickness of the cut-out biscuit baked biscuit. Determination was carried out in duplicate and average values were recorded.

For the biscuit strength, biscuit of known thickness (0.41 cm–0.51 cm) was placed centrally between two parallel metal bars 5 cm apart. A wooden bar of thickness 2 cm (0.368 kg) was then placed on the biscuit and weight added on the bar in increment of 0.20 kg until the biscuit snapped. The least weight that caused the breaking of the biscuits was regarded as break strength of biscuit.

Biscuit hardness

Biscuit hardness was determined by using needle penetrometer, the speed of the needle travelling in biscuit per seconds show the extent of hardness of the biscuits. The tests were conducted in duplicate and the average was recorded.

Proximate analysis

The moisture, ash, crude fat, crude protein, crude fibre contents of the fortified tapioca samples was determined by the method described by Association of Official Analytical Chemists (AOAC) 1990.

Carbohydrate content

The carbohydrate content was determined by difference in food composition i.e. $100 - (\% \text{ moisture} + \% \text{ Ash} + \% \text{ Fat} + \% \text{ Protein} + \% \text{ Crude fibre})$

Cooking characteristics of cassava flour with improver

The cooking characteristics of the flour with improvers were evaluated using Barbender Amylograph.

Sensory evaluation

The cassava biscuits prepared from the sample of cassava flour with different improvers were subjected to sensory evaluation test based on colour, taste, texture and overall acceptability. Twelve member consumer sensory panels were selected from the University environment to evaluate the biscuits according to their likeness, using 9-points hedonic scale, where 9 = like extremely and 1 = dislike extremely.

Statistical analysis

The experiments were carried out in triplicate and the statistical package for social scientist (SPSS) version 17.0 was used in the analysis of data. Duncan Multiple Range Test was used to separate the experimental data.

Results and discussion

Chemical composition of cassava biscuit

Table 1 shows the chemical composition of cassava biscuit with different improvers added to each sample at the point of dough development. Moisture contents of the biscuit samples ranged from 6.39 % to 7.43 %, protein 1.91 % to 2.65 %, fat 20.2 % to 23.3 %, carbohydrate 63.1 % to 65.9 % and ash 2.35 to 2.9 %. Holland et al. (1991) reported

Table 1 Physical, chemical and sensory quality characteristics of whole cassava biscuits of different recipe

Recipe	Physical			Chemical							Sensory								
	Level of addition of improvers (kg ⁻¹)	Water (ml)	Dough mixing time (Min)	Dough extrusion time (S)	Biscuit flow or spread ratio (%)	Biscuits break strength (g)	Texture (mm/s)	Length (mm)	Width (mm)	Thickness (mm)	Moisture (%)	Crude fiber (%)	Protein (%)	Crude fat (%)	Ash (%)	Colour	Taste	Crispiness	Texture
CF + AC	0.2	40.0	7.0 ^a	10.0 ^a	69.9 ^c	246.7 ^c	2.1 ^a	64.0 ^c	41.4 ^c	5.0 ^a	7.4 ^e	1.5 ^a	2.5 ^c	22.7 ^d	2.3 ^a	7.3 ^a	7.3 ^c	7.3 ^b	6.8 ^d
CF + SMB	0.2	40.0	8.0 ^a	10.0 ^a	78.0 ^d	246.6 ^c	2.7 ^b	39.1 ^a	39.1 ^a	5.0 ^a	7.3 ^c	1.6 ^a	1.9 ^a	20.2 ^a	2.7 ^b	6.9 ^a	6.3 ^c	6.8 ^b	6.8 ^{de}
CF + SA	0.1	40.0	10.0 ^b	10.0 ^a	64.9 ^a	240.0 ^b	2.9 ^c	39.7 ^{ab}	39.0 ^a	5.0 ^a	7.3 ^c	1.5 ^a	2.2 ^b	21.1 ^b	2.3 ^a	6.7 ^a	6.8 ^c	6.7 ^b	6.7 ^c
CF + SF	0.05	40.0	11.0 ^b	10.0 ^a	69.6 ^c	186.7 ^a	2.7 ^b	40.0 ^{ab}	40.0 ^{ab}	6.0 ^a	6.3 ^a	1.7 ^b	2.7 ^d	23.2 ^d	2.9 ^d	6.4 ^a	6.5 ^c	6.2 ^b	6.6 ^e
CF	Nil	40.0	13.0 ^c	10.0 ^a	66.9 ^b	333.3 ^d	2.7 ^b	40.1 ^b	40.9 ^{bc}	6.0 ^a	6.9 ^b	1.5 ^a	2.2 ^b	21.2 ^c	2.8 ^c	6.8 ^a	7.2 ^c	6.6 ^b	6.6 ^e

Values with different superscript on the same column are significantly different ($p < 0.05$). ($n = 3$)

CF Cassava Flour, AC Ascorbic Acid, SMB Sodium metabisulphite, SA Sorbic acid, SF Soya flour, CF Cassava flour

that 100 % wheat flour biscuits contained protein (6.2 %), carbohydrate (62.0 %), fat (23.4 %) and moisture (2.6 %). The variation in chemical composition of cassava biscuit from that of whole wheat biscuit may be traced to the raw materials. High moisture content of cassava biscuit is due to excessive moisture contained in the raw material. Low protein content of cassava biscuits as observed may also be ascribed to the low protein content of cassava which is the principal raw material for cassava biscuit production.

The sample that contain Soya bean flour has the highest protein content of 2.65 % due to the protein contributed to the biscuit sample by the Soya bean flour which is very rich in protein. The fat content was also high due to the addition of fat during processing. The total carbohydrate content calculated by difference showed a slight decrease in values. The crude fibre of the samples is within the same range with the exception of the sample containing soy flour which shows highest percentage of crude fibre. The difference may be caused by fractional amount of fibre contributed by soy flour to the biscuit sample.

It was observed that mixing time of dough produced with addition of ascorbic acid was lower than the mixing time of the other recipe formulation. Cassava biscuit dough produced without improving agent had longer mixing time than the other recipe formulations. These variations in the mixing time among the dough developed from different improvers may be due to the improving action of each improver which varies considerably. The mixing temperature was used to determine when the mixing should be stopped (i.e. 35°C) during the dough development. The variations in mixing time between dough developed from improvers and the one developed without improver was also observed by Olive et al. (1995). Although, they reported longer mixing time for dough prepared from wheat flour.

Variation in extrusion time of cassava dough prepared with the addition of improvers is not so much. However, this is not in agreement with findings of Olive et al. (1995). The reason is that the raw material used for the biscuit production is not the same because cassava flour completely lacks gluten which is the unique functional characteristics of wheat flour. The slight variations that were observed may be due to the effects of different improving actions of each improver used in the dough development.

Cassava biscuits flow (spread) and break strength

The data of biscuit flow or increase in volume of biscuit dough after baking were presented in Table 1. Cassava biscuit with improver increased in volume as follows: Ascorbic acid 69.95, sodium metabisulphite 78 %, soy flour 69.6 % and ascorbic acid 64.9 %, while biscuit without improver (reference sample) had 66.9 %. The best improving action was

shown with biscuit that contains sodium metabisulphite as shown above. Addo also observed similar spread or increase in volume in the biscuit production, but the reason that was attributed to this is that has sugar content contributes to increase in volume which in molten state flows within the biscuit matrix, and on cooling, sets within the biscuit matrix and thus conferring rigidity to the much expanded biscuit. Although, sugar contributes its own fractional increase in volume, the increased volume in cassava biscuit as shown Table 1 could be due to the improvers added to some samples because the same amount of sugar was used in the cassava biscuits production which is considered to have similar effect throughout the biscuits samples.

Biscuit break strength is the weight required to break the biscuits and it shown in Table 1. Cassava biscuit without improving agent exhibited the highest break strength (333.30 g) while those with improvers showed a slight decrease from this value with the exception of that contained soy flour. Action of soy flour in bakery products has been described by Wetanbe et al., which improve dough handling and bleaching action.

Cassava biscuit hardness, thickness, length and width

The results of these parameters were presented in Table 1. Biscuits hardness (texture) was determined by needle penetrometer, the texture that were presented on this table shows that, the higher the value the softer the biscuit. Sorbic acid produced biscuit that is softest in texture compared to other samples. Sodium metabisulphite exhibited similar variation with soy containing biscuits and reference sample (sample without improver). For all recipe formulations produced in this study, biscuits were shorter in length and width but the thickness increased considerably compared to the cut dough piece. The initial dough piece length (65 mm), width (42 mm) and thickness (4 mm) were altered by the inclusion of improving agents. Olive et al. (1995) in their finding reported similar contraction in dough piece length on processing, which results in a small increase in width and increase in dough piece thickness. They also confirmed that an increase in dough piece thickness occurs more readily than increase in dough piece width. The result showed in Table 1 agreed with these findings, except the contraction in dough pieces width that was observed in cassava biscuits. The reason for this occurrence may be due to the raw materials used in biscuits production (i.e. cassava flour). However, there is considerable increase in thickness of biscuits produced.

Sensory evaluation

Table 1 all shows the result of sensory evaluation by a panel of 12 judges carried out on cassava biscuits prepared with different improving agents i.e. Ascorbic acid, sodium

metabisulphite, sorbic acid, soyflour (full fat soy flour) and one reference sample without improving agent.

It showed that all samples presented for the sensory evaluation were not significantly different in terms of colour, taste, crispiness, and overall acceptability. However, significant difference were observed among the sample texture, in which biscuit prepared from ascorbic acid differs in texture from other samples, but all other samples are insignificantly different.

Kaputto and Chalwa, observed no significant difference in flavour and texture of biscuits prepared from 40 % substitution with fermented cassava flour. The result of sensory evaluation above is not in line with this and the differences may be ascribed to the improving agents used in this research work in which different improving actions were exercised on the texture of the biscuit which subsequently result in slight variation.

Bulk density and water binding capacity of cassava flour

The bulk density and water binding capacity of the cassava flour used in the production of biscuits is given overleaf in Table 1. It was observed that the water binding capacity is a room temperature measurement and does not indicate the behaviour of the starch when heated. It increases as soon as heat starts disrupting the intragranular bonds during the gelatinization process. Low water binding is attributed to a close association of starch polymer in the native granule. While higher water binding capacity may be attributed to a loose association of amylase and amylopectin molecules in the native granule. According to Lorenz and Collins (1990), starches with low amylase content had low water binding capacities.

Pasting characteristics of cassava flour with improving agents

Pasting temperature

The brabender amylograph of flour sample with addition of different improvers are shown on Table 2. Swinkles (1985) express pasting temperature as the temperature at which the viscosity of stirred starch suspension begin to rise. Pasting temperature increase from 63 °C to 64.5 °C. Reference sample flour (flour without improver) and flour with sodium metabisulphite inclusion showed the same pasting temperature or gelatinization temperature. Although high pasting temperatures are associated with low viscosities, the difference in pasting temperatures of the flour samples were not significant enough to conclude on viscosity variations.

Peak viscosity

The maximum viscosity is obtained when the increase in the structural viscosity caused by swollen starch aggregate is

counter balanced by the decrease in viscosity resulting from the disintegration of starch. When the heating is continued, the viscosity of the starch increases from almost zero to a peak value.

The peak viscosity recorded for the samples were 480B.U. 485.U. 505B.U, 480B.u and 470B.U. From these peak viscosity sodium metabisulphite and Ascorbic acid had the highest peak viscosity. This result is in contrary of what Faboya and Asagbra (1990) had reported, that higher pasting temperature is associated with low viscosities. However, sorbic acid addition and reference sample showed similar variation in peak viscosity, while flour sample containing soyflour showed a significant different in peak viscosity. The lower pasting temperature and reduced peak viscosity of “soyflour” containint flour compared to others might be due to effect of fractional lipoxxygenase present in soy-flour.

But Numfor and Noubi (1995), has reported similar decrease in Brabender viscosity of the composite flour with soyflour addition. However, the reason attributed to such increase is that the decrease in viscosity of composite flour is due more to the decrease in proportion of cassava flour than to the increase in proportion of soya bean flour.

With this finding, where composite flour is not used, the improving action of soyflour is conceived to be the causes of such occurrence in the viscosity of the flour used for biscuit production.

Ease of cooking

The difference between the time taken for the flour to reach pasting temperature during heating and the time taken to reach the peak viscosity is described as the ease of cooking of the flour, Adeyemi et al. (1986). The smaller the time taken, the greater is the ease of cooking. The ease of cooking of the flour with addition of improvers are as presented in Table 2. From the table, ascorbic acid, sodium metabisulphite and sorbic acid addition give the greatest ease of cooking, while reference sample (sample without improver) and “soy flour” containing flour showed similar ease of cooking.

Stability if the flour

Stability of the flour is the difference between the peak viscosity on heating and viscosity on heating, and viscosity on holding at 95 °C for 15 min, Mazurus et al. (1957). The lower the value, the stable the flour and vice-versa. The samples stabilities were shown on Table 2. “Soyflour” contained flour has the highest stability (360 B.U) Ascorbic acid and sodium metabisulphite and similar stability (405 B.U) while sorbic acid contained flour had stability of 390 B.U., this implies that, it is the next stable to “soyflour” contained flour that is used in biscuits production.

Table 2 Brabender amylograph pasting viscosity of cassava flour plus improvers

	CF + AC	CF + SMB	CF + SA	CF + SF	CF
Pasting temperature (TP) °C	63.0	64.5	63.8	63.0	64.5
Gelatinization time (mg) minutes	22.0	23.0	22.5	22.0	23.0
Temperature at peak viscosity (TPV)°C	71.3	72.8	71.2	72.0	73.5
Peak viscosity during heating (Vp) B.U.	485.0	505.0	480.0	470.0	480.0
Time to reach peak viscosity (mn) minutes	27.5	28.5	27.5	28.0	29.0
Viscosity at 95 °C B.U.	265.0	328.0	310.0	290.0	300.0
Viscosity after 30 min holding at 95 °C B.U.	80.0	100.0	90.0	110.0	110.0
Viscosity on cooling to 50 °C (Ve) B.U.	150.0	210.0	200.0	180.0	180.0
Ease of cooking (mn-Mg)	5.5	5.5	5.0	6.0	6.0
Stability of flour (Vp-Vr) B.U	405.0	405.0	390.0	360.0	370.0
Setback value (Ve-Vp) B.U	−335.0	−295.0	−280.0	−290.0	−300.0

(n=3)

CF Cassava Flour, AC Ascorbic Acid, SMB Sodium metabisulphite, SA Sorbic acid, SF Soya flour, CF Cassava flour

Set back value

The set back value of the flour is the difference between the viscosity of the paste on cooling to 50 °C, and the maximum viscosity of the paste during heating. The extent of increase viscosity on cooling reflects the retrogradation tendency of the flour, Rasper (1969).

It has been reported by Halick and Kelly (1959) that the increase in viscosity on cooling to 50 °C reflects the retrogradation tendency of the starch product. It also follows that high amylase starches would show maximal set back on cooling. From the Table 2, when all the samples cooled to 50 °C, all the samples showed maximum decrease in viscosity, even the samples exhibited decrease in viscosity beyond their corresponding peak viscosities recorded by the hot paste. From the result from the table it shows that all of them have low tendency for retrogradation.

The flour sample with addition of ascorbic acid has the lowest tendency to retrograde followed by the reference sample. The reason for this is that ascorbic contained flour has the lowest set back value of −335B.U., and −300 B.U for reference sample (sample without improver).

Conclusion

The improvers caused slight increase in mixing time, extrusion time, length, width of the biscuits and considerable thickness in the biscuits. The flour with the inclusion of ascorbic acid resulted in the improvement in flour stability and low retrogradation tendency while crude protein and fat increased in the sample with the addition of soyflour. The samples with the addition of all the improvers were liked by the consumers in terms of colour, taste and crispiness but not for the texture. There is need for extra studies on the storage stability of the biscuits.

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