IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
November 2016 Vol.:5, Issue:1

Evaluation of Bread made from Livingstone Potato and Wheat Composite Flour

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

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Submission: 29 October 2016
Accepted: 7 November 2016
Published: 25 November 2016

HUMAN JOURNALS

www.ijsrm.humanjournals.com

Keywords: Bread, Livingstone potato, composite flour, sensory evaluation, microbial analysis

ABSTRACT

The effect of inclusion of Livingstone potato flour in bread making at different ratios was studied. Living stone potato flour was produced by washing, peeling, blanching, cutting, drying and milling of the freshly harvested Livingstone potato roots. Bread samples were produced from the blend of wheat and Livingstone potato at the following ratios: 95:5, 90:10, 85:15 and 80:20 respectively with bread from 100% wheat serving as control. Proximate analysis, sensory evaluation and microbial analysis were carried out on the bread samples. The results obtained show that the ash content of the bread samples was not significantly affected by the substitution, however, the protein, fat and moisture contents were significantly affected ($p<0.05$). The total aerobic count and total fungal count increased progressively with storage; however, bread samples with 20% substitution with Livingstone potato had the highest fungal count at the end of storage. The ratings for taste and texture for the different percentages of living stone potato flour substitution were not significantly different from that of the control (100% wheat flour bread). The scores obtained for overall acceptability of the breads ranged from like mildly to liked, indicating that the bread samples were generally liked by the panelists. The results of this study show that living stone potato flour could be used to substitute up to 15% of wheat flour in bread making without adversely affecting the sensory attributes of the bread.

INTRODUCTION

Bread is very important in an average Nigerian's everyday consumption due to its nutritional, sensory, textural characteristics, convenience and cost competitiveness. It is mainly produced from wheat as a major raw material (Oluwajoba, *et al*, 2012). There is limited production of wheat in Nigeria; hence wheat flour is usually imported to meet the demand. A large amount of foreign exchange is spent on wheat importation. Composite flours, in which flour from locally grown crops replaces a portion of wheat flour, have been developed for bread making, this is aimed at reducing the demand for imported wheat. It has been reported that composite flours made from tropical root and tubers such as cassava, yam and sweet potatoes gave good quality bread (Ijah *et al*, 2014). Recently, the emphasis is on bread with low glycemic index and low glutein. There is, therefore, the need for more research in the area of composite flour in order to prepare bread with the above-mentioned characteristics. One of the problems facing the baking industry is bread spoilage due to fungi, which shortens the shelf life (Samson *et al*, 2000).

Living stone potato (*Plectranthus esculentus*) is indigenous to Africa where it is grown for its finger-like edible tubers. The tubers are often used as a substitute for potato or sweet potato. The tubers are mostly boiled, but they can also be roasted, baked or fried. This crop is considered to be superior to other tuber crops in terms of its food value (Ben-Erik, 2005). It is rich in carbohydrate, Vitamin A, minerals and essential amino acids (Lukhoba *et al*, 2006). In spite of its nutritive potential, it is classified as an under-exploited species of food crops in Africa (Schippers, 2000).

The aim of this study was to evaluate the chemical, sensory and microbial acceptability of bread made from Livingstone potato and wheat composite flour.

MATERIALS AND METHODS

Freshly harvested livingstone potatoes were obtained from the experimental field of Minor Root Crops Programme of National Root Crops Research Institute, Umudike. Wheat flour was purchased from Ubani market in Umuahia, Abia State, Nigeria.

Production of Livingstone potato flour:

The livingstone potatoes were washed and manually peeled into warm water (60^{o}C for 15 mins) to minimize color changes. The blanched tubers were chopped into small pieces, sun dried at 36^{o}C and then milled with a hammer mill (Thomas Wiley Mill, Model ED-5). The resulting flour was packaged in a tight plastic container and stored at ambient temperature until required.

Baking

Five Blend formulations were baked using the straight dough method (Chuahan *et al*, 1992). The ingredients used include wheat flour (80%-100%), livingstone potato flour (5-20%), margarine (16.6%), sugar (8.3%), salt (0.9%), yeast (0.6%), nutmeg (0.2%), water (43.6%). Bread with 100% wheat flour was the control. All ingredients were mixed, the dough was kneaded manually for 20mins, molded and proofed for 90 mins at 30^{o}C and baked in a gas oven at 250^{o}C for 30mins. The baked breads were then allowed to cool at ambient temperature and packaged in polyethylene bags for further analysis.

Figure 1: Bread samples from different ratios of Wheat: Livingstone potato composite flours.

Sensory Evaluation of Bread

Sensory evaluation was performed 24 hours after baking, the bread loaves were cut into slices and kept in white plates and the samples were coded to evaluate the crust color, crumb color, taste, texture and general acceptability of the bread samples. Twenty semi-trained panelists composed of Staff of National Root Crops Research Institute and graduate Students of Michael Okpara University of Agriculture, Umudike who are familiar with the sensory attributes of bread, assessed the bread samples using a 9 point hedonic scale where 1= dislike extremely and 9- like extremely.

Microbial Examination

Total aerobic counts (TAC) of micro-organisms in the bread samples were done by pour plate techniques (Ezeama, 2007). Five grams of the bread samples were dissolved in 45ml sterilized water using a sterile forceps to obtain a dilution of 1:10, from which subsequent dilution were made and appropriate aliquot used to determine the total aerobic count (TAC) on Trypton soya agar plates incubated at 37^{o}C for 48hrs while Sabonrad agar plates used for the fungal counts were incubated at 25^{o}C for 48hrs. The dishes were moved gently five times clockwise, five times anti-clockwise, five times back and forth repeated with to and fro movement before incubation. After incubation period, the colony forming units (cfu/g) were counted for total aerobic and fungal count respectively. Colonies were purified by sub-culturing on fresh tryptone soya agar and gram stained for morphological examination and biochemical tests (catalase, coagulase, oxidase, citrate, glucose, sucrose, mannitol, lactose, maltose and inositol) were done for characterization and identification of the isolates, as described by Buchanan and Gibbons (1975). The colonies of the fungi emerging within 2-3 days of inoculation were identified under the light microscope (x40) and recorded using the scheme of Barnett and Hunter (1992). Each experiment was duplicated.

Statistical analysis

The data obtained from this work were analyzed using Analysis of Variance (ANOVA) with SAS package 2003 version. The means were compared using Duncan at 5% significance level.

RESULTS AND DISCUSSION

The result of the proximate analysis of the breads produced from the composite flours was shown in Table 1. Moisture was highest (9.32%) in the bread from 80% wheat: 20% Livingstone potato and lowest (7.10%) in bread from 90% wheat: 10% Livingstone potato. The moisture contents of the bread samples are suitable as high moisture content leads to spoilage of food products. Ash was highest (2.48%) in bread from 80% wheat: 20% Livingstone potato and lowest (1.83%) in 100% wheat bread and 95% wheat:5% Livingstone potato. There is no significant difference (P>0.05) in the ash content of all the bread samples. Ash gives an idea of the amount of mineral elements present in food sample (Eshun, 2009); this implies that substituting wheat flour with livingstone potato flour did not significantly affect the mineral composition. Fat was highest (18.0%) in bread samples with 90% wheat: 10% Livingstone potato. The high fat contents observed may be as a result of addition of fat during the making of the dough. Protein was highest (13.44%) in bread from 100% wheat flour and lowest (9.53%) in bread from 80% wheat: 20% Livingstone potato. The high protein content of bread with 100% wheat could be attributed to the gluten content of wheat which is a storage protein. The protein content decreased significantly with increase in the ratio of Livingstone potato flour.

Table 1: Proximate Composite of the Bread samples

Sample	Moisture (%)	Ash (%)	Fibre (%)	Fat (%)	Protein (%)	CHO (%)
Z	$7.98^{b}\pm0.43$	$1.83^{a}\pm0.69$	$0.99^{a}\pm0.02$	$15.86^{b}\pm0.20$	$13.44^{a}\pm0.44$	$33.50^{c}\pm0.15$
O	$7.48^{b}\pm0.48$	$1.83^{a}\pm0.23$	$0.49^{b}\pm0.01$	$18.00^{a}\pm0.71$	$13.06^{a}\pm0.09$	$41.36^{a}\pm2.18$
Y	$7.10^{b}\pm0.23$	$2.15^{a}\pm0.23$	$0.98^{a}\pm0.03$	$18.03^{a}\pm0.04$	$11.16^{b}\pm0.31$	$37.98^{b}\pm0.40$
X	$9.02^{a}\pm0.06$	$2.47^{a}\pm0.32$	$0.99^{a}\pm0.02$	$15.98^{b}\pm0.04$	$10.84^{b}\pm0.75$	$24.04^{d}\pm0.39$
W	$9.32^{a}\pm0.45$	$2.48^{a}\pm0.18$	$0.49^{b}\pm0.01$	$13.93^{c}\pm0.11$	$9.53^{c}\pm0.13$	$41.74^{a}\pm0.97$

Means are $\pm$ standard deviation of duplicate determination. Means with the same superscript within the same column are not significantly different ($P>0.05$).

Where:

Z =100 (Wheat)

O = 95:5 (Wheat: Livingstone potato)

Y = 90:10 (Wheat: Livingstone potato)

X = 85:15 (Wheat: Livingstone potato)

W = 80:20 (Wheat: Livingstone potato)

Table 2 shows the mean scores by the panelists for crust color, crumb color, appearance, taste, texture and overall acceptability. Z (100% wheat flour) and X (15% living stone potato substitution) had the highest ratings for crust color. The bread crust is formed through the maillard reaction using the sugars and amino acids and intense heat at the bread surface. Crumb refers to the inside of the bread; crumb appearance is an important quality indicator of bread. The crumb color and appearance of bread samples with 20% living stone potato flour substitution was rated the lowest (4.8 and 4.76 respectively). This could be as a result of the relatively dark color of the living stone potato flour caused by enzymatic browning during flour preparation. The ratings for taste and texture for the different percentages of living stone potato flour substitution were not significantly different from that of the control (100% wheat flour bread). The scores obtained for overall acceptability of the breads ranged from liked mildly to liked, indicating that the bread samples were generally liked by the panelists.

Table 2: Sensory Evaluation of breads from the Livingstone potato/wheat composites

Sample	Crust colour	Crumb colour	Appearance	Taste	Texture	Overall acceptability
O	5.71^{ab}	6.095^{ab}	5.90^{ab}	5.95^{a}	6.05^{a}	6.05^{ab}
Y	5.19^{b}	5.86^{bc}	5.86^{ab}	5.75^{a}	6.05^{a}	6.00^{ab}
X	6.90^{a}	5.76^{bc}	5.33^{b}	5.75^{a}	5.81^{a}	6.00^{ab}
W	5.95^{ab}	$4.8b^{c}$	4.76^{b}	5.65^{a}	5.24^{a}	5.48^{b}
Z	6.95^{a}	6.95^{a}	6.71^{a}	6.55^{a}	6.43^{a}	7.00^{a}

Where O = Bread from 5% living stone potato and 95% wheat flour, Y = Bread from 10% living stone potato and 90% wheat flour, X = Bread from 15% living stone potato and 85% wheat flour, W = Bread from 20% living stone potato and 80% wheat flour, Z = Bread from 100% wheat flour.

Table 3 shows the total aerobic count of the bread samples during storage for six days. The total aerobic count of the bread samples ranged from 0.5 to 39 x 10^3. The total aerobic count increased progressively with storage days. At day 0, there was no growth in all the bread samples. At the end of the storage period (day 6), bread with 20% living stone potato flour substitution had the highest total aerobic count while the 100% wheat bread had the lowest total aerobic count. The fungi counts of the bread samples at day 0 had no growth due to the lethal effect of the baking temperature on micro-organisms. This is in agreement with the findings of Knight and Monlove (2006) which states that mold spores are generally killed by the baking process in fresh bread. The bread with 5% living stone potato flour substitution had the highest count at 6^{th} day of storage while the 100% wheat bread had the least count (as shown in table 3). The counts show variation in the microbiological status of the stored bread samples. Although microbial count increased progressively with storage days in all samples, it was observed that the counts in the bread sample substituted with living stone potato were higher than the 100% wheat bread. The trend of the fungal count is similar to that of the total aerobic count which is in line with the claim that most microbiological spoilage of bread is attributed to fungal growth (Cauvain and Young, 2007). Some of the micro-organisms isolated during the period of the storage include *Rhizopus stolonifer*, *Aspergillus niger*, *Aspergillus flavus* while the bacteria that were identified include *Staphylococcus aureus* and *Bacillus cereus*. The microorganisms present in the bread samples were a reflection of the sanitary quality of the source of raw materials, processing and storage of the samples (Ray and Bhunia, 2007). The values obtained for the bread samples were within the acceptable International commission on microbiological specification (ICMSF) limits and recommendation for products of this nature (10^5cfu/g) in good manufactured practice (ICMSF, 2009) for total plate count. The fungal counts were within acceptable limits for bread by ICMSF for good manufacturing practice (10^3cfu/g) (ICMSF, 2009).

Table 3: Total aerobic count (cfu/g) in stored wheat/living stone potato composite flour bread.

Sample	Day 0	Day 2	Day 4	Day 6
O	0.0±0.0	0.5±0.7	10.5±0.7	35.0±2.8
Y	0.0±0.0	1.5±0.7	12.0±0.7	33.0±1.4
X	0.0±0.0	1.0±0.0	15.0±2.8	33.0±1.4
W	0.0±0.0	1.5±0.7	15.0±1.4	39.0±1.4
Z	0.0±0.0	0.5±0.7	14.0±1.4	30.0±5.6

Mean ± standard deviation of two replicates. Where O = Bread from 5% living stone potato and 95% wheat flour, Y = Bread from 10% living stone potato and 90% wheat flour, X = Bread from 15% living stone potato and 85% wheat flour, W = Bread from 20% living stone potato and 80% wheat flour, Z = Bread from 100% wheat flour.

Table 4: Fungal count in stored bread from wheat/living stone potato composite flour

Samples	Day 0	Day 2	Day 4	Day 6
O	0.0±0.0	1.5±0.7	3.0±0.0	17.0±0.9
Y	0.0±0.0	1.0±0.0	1.5±0.7	8.0±0.0
X	0.0±0.0	1.5±0.7	3.0±1.4	6.5±0.7
W	0.0±0.0	2.0±0.0	2.5±0.7	5.5±0.7
Z	0.0±0.0	0.5±0.7	2.0±0.7	5.0±0.0

Mean ± standard deviation of two replicates. Where O = Bread from 5% living stone potato and 95% wheat flour, Y = Bread from 10% living stone potato and 90% wheat flour, X = Bread from 15% living stone potato and 85% wheat flour, W = Bread from 20% living stone potato and 80% wheat flour, Z = Bread from 100% wheat flour.

CONCLUSION

The results of sensory evaluation and microbial stability of bread samples produced from wheat/living stone potato composite flour blends show that living stone potato flour could be used to substitute up to 15% of wheat flour in bread making without adversely affecting the sensory and microbial stability of the bread. Beyond this level, the color and appearance of the bread were not acceptable to the panelists. Based on the findings, breads made from living stone potato/wheat composite flour contained higher amounts of bacteria and fungi than 100% wheat bread, hence the need for approved preservatives to extend their shelf life. The physical properties (such as loaf weight and loaf volume) of the bread produced from wheat/living stone potato flour composites should be further investigated to determine if they are within the acceptable range.

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