THE USE OF MALTED SORGHUM IN BISCUIT PRODUCTION

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Abstract

High cost of biscuit production is a critical concern in Nigeria. The reason mostly is the fact that wheat flour is imported for biscuit production. Sorghum is abundant in Nigeria and the use of sorghum flour in biscuit production will effectively bring down cost of biscuits in Nigerian markets. This study investigated the use of malted sorghum flour in biscuit production and also the microorganisms involved in the spoilage of these biscuits. Biscuits were produced from malted sorghum flour, wheat flour and a blend of malted sorghum flour and wheat flour in a 50:50 proportion. The spoilage microorganisms for the different produced biscuits were investigated; each of the biscuits produced was exposed for 7 days to initiate spoilage. Biscuits produced from absolute malted sorghum flour appeared brownish and had fishy taste. Biscuit produced from only wheat flour appeared yellowish after baking and tasted like cheese. Biscuit produced from 50:50 blend of malted sorghum flour and wheat flour appeared a little brownish after baking and had a fishy taste. All the biscuits had crispy texture.

The fungal analysis showed that *Aspergillus sp, Rhizopus sp, Penicillum sp, Candida sp* and *Saccharomyces sp* were associated with the spoilage of the different produced biscuits after 7 days. The study also showed that biscuits of acceptable quality can be produced using malted sorghum flour. Biscuits made from malted sorghum flour will be readily available in Nigerian markets at cheaper rates while utilising the abundance of sorghum in Nigeria.

Keywords: Biscuits, flour, sorghum, wheat

Introduction

Biscuits are baked snacks which are suitably ready-to-eat and taken by all age groups in several countries (Adebo, 2020). In some part of the world, biscuits are known to be a significant component of human snacks. It is an unleavened crispy, sweet pastry produced from wheat flour, shortening (hydrogenated fat) and sugar, with the addition of baking powder (a combination of sodium carbonate, sodium bi-phosphate and cereal flour) which makes the dough soft (Adebo, 2020). Wheat with additional ingredients for instance egg, fat, sugar, water, sweeteners in addition to sensory qualities improvers are the main ingredients for the production of biscuits (Uchenna and Omolayo, 2017). The key ingredient for production of biscuit is wheat flour for the reason it contains gluten proteins, which are not present in flour of

other cereals. During baking, gluten protein forms soft dough and gives high organoleptic value to the finished product.

Based on wheat and other cereals including minor millets in bakery foods, the use of composite flour is becoming widespread because of the economic and nutritional advantages of composite flour. Wheat as the major raw material in pastry and bakery industries is rarely grown in Nigeria and very expensive to import (Oyeyinka *et al.*, 2014). Health problems such as celiac disease which is been linked to the association of wheat consumption makes it appropriate to utilize composite flour in production of biscuits. Composite flour is a mixture of several flours obtained from roots, tubers, cereals and legumes with or with the addition of wheat flour (Arise *et al.*, 2917). Composite flour is desirable because it improves the nutritional value of bakery products, especially with the inclusion of legumes (Adeola and Ohizua, 2018).

Sorghum (*Sorghum bicolor*) is a recognized climate resistant crop which is widely used as food in Africa and other developing countries.

It is mostly used in the form of flour or paste formed into two key dishes “Tuwo” a thick porridge and “Ogi” a thin diet or porridge. Further dishes produced from sorghum consist of a number of deep-fried snacks, steamed dumplings and other boiled or roasted snack food.

Malting of grains involves soaking, germination and limiting cereals seedling growth by kilning. Throughout germination, enzymes are produced for the break down of starch and protein in the cereal grain. Malting yields higher proportions of hydrolytic enzymes such as α and β-amylases which maybe either completely soluble or largely insoluble depending on the variety. This study examined the possibility of using sorghum as an ingredient for making biscuit which is another type of food.

Materials and Methods

Collection of Materials

Sorghum grains were purchased from Eke-Awka market in Awka the capital city of Anambra state. Malted sorghum flour (Honey well flour mills), margarine (Becel company), sugar (Dangote sugar refinery plc), salt (Anapuna company), milk (Peak milk), ginger flavour, egg, baking powder (Royal company), ginger were also procured and moved to National Agency for Food and Drug Administration and Control (NAFDAC) laboratory, Awka for processing and for analysis.

Production of Malted Sorghum Flour

Sorghum grains were malted using the modified method described by Hallen *et al.* (2004) and Okpala and Okoli (2011). The grains were sorted and steeped in 600 ml of water with 0.6ml formaldehyde solution for 24 h (12 h steeping, 2 h air rest and 10 h steeping). After soaking, the hydrated grains were spread on a sieve and the grains were allowed to germinate for 5 days and adding 20 ml of water every 12 h after which the ones that failed to germinate were discarded. The germinated seeds were dried at 55ºC in a hot air oven for 24 h. Thereafter, the formed roots were manually rubbed off before milling and sieving through a sieve and packaged in an air tight container until it is used for malting analysis and production of biscuit.

Ginger processing

The ginger back was scraped off, washed with distilled water and drained off. It was cut into tiny bits using a sterile knife and dried in a Presto laboratory hot air oven (Model PSO-451) for 8 h at 65ºC.After cooling, it was ground and sieved into fine powder with a blender and stored in an aluminum foil.

Biscuit production

The baking recipe used was as described by Maohar and Rao (2002) (modified). Three samples of biscuits were produced using malted sorghum flour, wheat flour and 50:50 blend of both malted sorghum flour and wheat flour. Sugar (25 g), margarine (250 g), salt (1 g), milk (1 tin of liquid milk), egg (4) and ginger flavour (15 g) were creamed in a mixer with a flat beater for 2 mins. The baking powder (75 g) and malted sorghum flour (150 g) were added to the mixture and manually mixed for 3 mins. Water was carefully added to bits to form dough as described by Maohar and Rao (2002).

The dough was rolled to a thickness of 3.5 mm with the help of a flat rolling board and cut into circular shapes of 5 cm diameter. The cut out biscuit dough were carefully placed on lightly greased tray and baked at 180ºC for about 30 mins. Biscuit samples produced were cooled and stored in polyethylene bags. Biscuits were made with wheat flour and 50:50 blend of malted sorghum flour and wheat flour following these same procedures.

Microbial Spoilage of Produced Biscuits

The biscuits produced from malted sorghum flour and wheat flour were open contaminated and maintained at temperature of 25-270C for the fungi growth which took place in 7 days immediately after leaving the oven.

Isolation and Identification of Spoilage Fungi

The pure cultures of the fungal isolates were identified using cultural and morphological features such as colony growth pattern, conidial morphology and pigmentation by slide culture techniques (Oyeleke and Manga, 2008). A small portion of the aerial mycelia from the representative culture was picked using a sterile inoculating needle and inoculated on a slide containing a fraction of a prepared solidified sabouraud dextrose agar and incubated for 24-48 h, after which it was viewed under the light microscope first with x 10 and then with x 40 objectives lens to detect spore, hyphae and other special structures. The morphological characteristics and appearance of the fungi isolated from the spoiled biscuits were confirmed and authenticated with the help of Mycological Atlas.

Results

Tables 1 and 2 shows the results of the analysis carried out on the grains. From the analysis, it was observed that the moisture content of the sorghum grains was higher than that of the malted sorghum. The grains have a high germinative energy, high water sensitivity but low germinative capacity and low presence of tannins. It was also observed than the hot water extract and the cold-water extract of the grains and malted sorghum were different too.

Table 3 shows the spoilage fungi isolated from the different produced biscuits which

reveals *Aspergillus flavus, Penicillium, Aspergillus niger, Aspergillus niger, Rhizopus oryzae, Candida albicans, Saccharomyces cerevisiae.*

The study also showed that a total of five species were isolated and their colonial and microscopic characteristics as depicted in Tables 4 and 5. The fungi isolated from the spoilt biscuits were identified as *Aspergillus niger, Aspergillus flavus, Candida albicans, Penicillium chryosogenum, Saccharomyces cerevisiae and Rhizopus oryzae*.

Physical evaluation of the biscuit samples were carried out tasked for the following quality attributes; crispiness (firm but easily broken or crumbled), color, taste and dough formation as shown in Table 6.

Table 1: Grain Analysis in duplicate

Parameters	**Values**
Moisture Content (%)	6±0.00
Germinative Energy (%)	97±0.00
Germinative Capacity (%)	44±0.14
Water Sensitivity (%)	96±0.35
Presence of Tannins (%)	16±0.00
Cold Water Extract (Kg/ºL)	52.6±0.14
Hot Water Extract (Kg/ºL)	127.6±0.09

Table 2: Malt Analysis

Parameters	**Sample**
Moisture Content (%)	2±0.04
Cold Water Extract (Kg/ºL)	103.6±0.07
Hot Water Extract (Kg/ºL)	136.2±0.00
Reducing Sugar (Mg/mil)	0.35±0.01

Table 3: Spoilage Fungi isolated from the different produced biscuits

Biscuits produced	**Organisms**
Wheat Flour	*Aspergillus flavus*
	Penicillium sp
Sorghum and wheat flour	*Aspergillus niger*
	Rhizopus oryzae
Sorghum	*Candida albicans*
	Saccharomyces cerevisiae

Table 4: Colonial and Microscopic Features of the Spoilage Moulds identified after 7 days

Isolates	Colonial Features	Microscopic Features	Organism
A	Colonies were black with white edges for	Non-branched conidiophores with bulb end that carries conidia	*Aspergillus spp* *A. niger* *A. flavus*
B	Colonies appear bluish-green to dark green in colour, having numerous spores and white borders.	Brush-like conidiophores bearing chains of conidia	*Penicillium sp*
C	Colonies were white cottony at first becoming brownish-grey to blackish-grey	Sporangia contained spores, have rhizoids.	*Rhizopus sp*

Table 5: Colony and Microscopic Features of the Spoilage Yeasts identified after 7 days

Isolates	Colonial Morphology	Gram Stain	Motility	Germ Tube	Sugar Fermentation						Urease	Organism
					Glucose		Sucrose		Fructose			
					G	A	G	A	G	A		
D	Flat, waxy, large colonies that appear creamy	+	-	-	-	-	-	-	+	+	+	*Candida sp*
E	Flat, smooth, tiny, cream to tarnish cream in colour	+	-	-	+	+	-	-	+	+	-	*Saccharomyces sp*

Keys: +: Positive
-: Negative
A: Acid Production
G: Gas Production

Table 6: Physical evaluations from the biscuits produced

Biscuits produced	Analysis

Sorghum	The biscuit appeared brownish after baking, has sweet flavour, tastes like fish, crispy texture and made soft dough before baking.
Wheat Flour	The biscuit appeared yellowish after baking, has sweet flavour, taste like cheese, crispy texture and made hard dough before baking.
Sorghum and flour	The biscuit appeared a little brownish after baking, sweet flavour, tastes like fish, crispy texture and also made soft dough before baking.

Discussion

The results of the experiments conducted in this study showed that biscuit of acceptable quality based on the physical evaluations can be produced with malted sorghum flour. In comparison, malted sorghum biscuits had almost same qualities as wheat biscuits with differences in color and taste. Malted sorghum flour biscuits tasted fishy and appeared brownish after baking while wheat flour biscuits tasted like cheese and appeared yellowish. Both biscuits were crispy and had good flavour. Their uniqueness in taste and color becomes their selling point. The biscuits produced with malted sorghum flour had an acceptable quality in terms of physical evaluations. The malted sorghum flour should be used to produce biscuits to improve on some nutrients such as protein in biscuits and also to manage the high cost of wheat flour in our country Nigeria.

Fungi were implicated in the test for spoilage microorganisms. Yeasts isolated from the spoilt biscuits included *Candida albicans* and *Saccharomyces cerevisiae* while moulds that were isolated included *Aspergillus flavus, Penicillium chrysogenum* and *Rhizopus oryzae.* Jarvis (2001) isolated similar molds when he analysed spoilt bakery products.

Generally, spoilage fungi are considered toxigenic or pathogenic(ref0. All the microorganisms isolated were confirmed to be pathogenic but in varying degrees and have been reported to produce secondary metabolites in plant tissues. These secondary metabolites are potentially harmful to humans and animals (Baiyewu *et al.*, 2007). A good example is aflatoxin which has been associated in cancer of the liver (heptatoma), aflatoxicosis and also with acute hepatitis in humans, especially in the developing world. Pathogenic fungi, on the other hand could cause infections or allergies (Monso, 2004). *Aspergillus sp* are known to produce several toxic metabolites such as malformins, naphthopyrones and they can produce ochratoxins, a mycotoxin which is a very important toxin worldwide because of the hazard it poses to human and animal health (Petzinger and Weidenbach, 2002), thus, extra care should be taken during production and handling of biscuits.

Microorganisms are naturally present on all food and can be brought in by outside elements (wind, water, insects, human handling). They can become contaminated during growing, harvesting, transport of raw materials and processing into finished products. It is therefore necessary and important that both manufacturers that produce the biscuit, the marketers and consumers take necessary and appropriate precautions in preventing the contamination of biscuits. These precautions will greatly reduce the risk of fungal contamination of biscuits and its consequent mycotoxins which are deleterious to human health.

Conclusion

A good quality biscuit can be described as one which is crispy, has good flavor and is soft enough to be masticated. The baking of biscuits with malted sorghum flour fortifies the biscuits with protein and carbohydrates and will greatly reduce the problem of malnutrition which is of high incidence in low income section of the populace.

In this work, it was discovered that the biscuit made from 50:50 blend of malted sorghum flour and wheat flour was the best when compared with the biscuit made with only malted sorghum and wheat flour in terms of crispiness, flavor, texture and overall acceptance. On the nutritional value, the biscuits produced were discovered to have different taste and different appearances.

This study also showed that fungi were involved in the spoilage of biscuits but bacteria were not due to the low moisture content of the biscuits caused by high temperature involved in the baking process. It is therefore important that both the manufacturer who produces the biscuit, the marketers and consumers take necessary precaution to avoid contamination. Eating contaminated biscuits exposes consumers to aflatoxin and other mycotoxins produced by these fungi which are deleterious to human health.

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Conflict of Interest

The authors declare no conflict of interest.

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