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Technical Report

Chemical Composition Butternut Squash and Microbial Quality of Butternut Squash Flour

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Executive Summary

Butternut Squash (*Curcurbita moschata*) also known as butternut pumpkin is a fruit that is can be eaten in many forms. It can be roasted, toasted, pureed for soups or mashed and is used in casseroles, breads and muffins (Pinho *et al*., 2011). Butter nut squash (BNS) is packed with vitamins, nutrients and is a rich source of antioxidants.

In Ghana, BNS is not very popular but, it is grown locally for export to UK and Europe (ghananewsagency.org, 2011). In Kenya, BNS is an emerging economic crop with ready market and has a potential to promote food security, enhance incomes of small-holder farmers and alleviate poverty (Isaboke *et al*., 2012). Not much research has been done on BNS in Ghana. In 2013, Dari utilized it in the formulation of yoghurt to provide alternative source of nutrition for consumers and to reduce post harvest losses to farmers. He also proposed the extraction of the colour compounds from the fruit for use as a commercial food colour. Dari & Yaro (2017) conducted proximate analysis on BNS grown in Kukobila, Savelugu in the Northern Region of Ghana. Their results indicated the presence of crude protein, crude fat, crude fibre, ash, carbohydrate, moisture and Vitamin C in quantities that could be used to support nutritional status of consumers.

This study therefore sought to develop flour from BNS for possible use in the formulation of dry cereal mix, as composite flour as well as a fruit snack for consumers. Chemical analyses were conducted on the raw BNS and microbial and shelf life studies were conducted on the developed BNS flour over a period of eight weeks under room temperature (25°C) storage. Generally, there was a decline in bacterial population over the 8 week period. The BNS can therefore be processed for use as a snack or be milled into flour suitable for formulating cereal mixes, pastries, noodles, as composite flour or used in the formulation of juices.

Introduction

Butternut Squash (*Curcurbita moschata*) also known as butternut pumpkin is a fruit that can be roasted, toasted, pureed for soups or mashed and is used in casseroles, breads and muffins (Pinho *et al*., 2011). It has yellow skin, an orange fleshy pulp and has been described to have a sweet nutty taste. When it is ripe, the pulp turns increasingly deep orange and becomes sweeter. It is a good source of fibre, vitamin C, manganese, magnesium and potassium. It is also an excellent source of Vitamin A and E. Research has shown that it has a lot of natural antioxidants and carotenoid compounds like α and ß-carotenes, cryptoxanthin-ß, and lutein (Gonzales *et al*., 2001). Butternut squash is from the family Cucurbitaceae with other members being pumpkin, squash, cucumber and watermelon. The vegetable species of Cucurbitaceae have significant amounts of vitamins and minerals and BNS is highly appreciated for its nutritional quality (Lucera *et al*., 2012; Jacobo-Valenzuela *et al*., 2011).

Literature Review

Currently it is grown in Ghana for export to UK and Europe and the Export Development and Investment Fund (EDIF) believe that butternut squash has the potential to do better than cocoa (ghananewsagency.org, 2011). In Kenya, BNS is an emerging economic crop with ready market and has a potential to promote food security, enhance incomes of small-holder farmers and alleviate poverty (Isaboke *et al*., 2012). However, in Ghana, not much research has been done on butternut squash. Dari (2013) used butternut squash in developing yoghurt to reduce post harvest losses and provide alternative source of nutrition for consumers. He also proposed the extraction of the colour compounds from the fruit for use as a commercial food colour. Dari & Yaro (2017) conducted proximate analysis on BNS grown in Kukobila, Savelugu in the Northern Region of Ghana. Their results indicated the presence of crude protein, crude fat, crude fibre, ash, carbohydrate, moisture and Vitamin C in quantities that could be used to support nutritional status of consumers. They also determined the effect of storage on fresh BNS. Their findings indicate that the ideal storage conditions for BNS is on pallets at an average temperature of 30.7℃; and a relative humidity of 76% as these conditions could extend BNS shelf life over 5 months.

A pilot primary production of Butternut has been established with certified seeds from South Africa in Gomoa Fete Kakraba in the Central region, Nkoranza in the Brong Ahafo region and

in Somanya in the Eastern region (Source: GNA). It is also grown in Kukobila, Savelugu in the Northern region and in Keta in the Volta region.

Butternut squash are warm season crops and prefer high temperatures of 18 – 35℃ and well drained sandy-loams with pH of 6.0-6.5 (slightly acidic to nearly neutral) for optimum growth for development. A relatively dry period is required for fruits to mature. Fruits produced during the wet season tend to rot (HDU-DCS, MOFA 2013).

Suitable varieties of BNS are Butterboy, Pluto, Autumn Glow, Long White Bush, Bush Scallop, Atlas, Barbara and Avalon.

Fig. 1: Butternut Squash ready for harvesting at a farm in Keta in the Volta Region.

In the Keta district of Ghana, an area predominantly made up of vegetable farmers, the Pluto variety of the butternut squash is currently being grown for the export market. Interaction with the farmers in Keta indicated that Butternut Squash is doing well. The yields are great with an average of 6-10 metric tonnes per hectare (HDU-DCS, MOFA 2013).

In packing BNS for export, the importing country or company has specific criteria that must be met by the exporter and farmers. Squash that do not meet these standards are rejected. The rejects could be utilized in other ways such as in meal formulations for the Governments' School Feeding Programme as well as in formulating other products such as weaning foods, juices, wines etc thus minimizing waste and providing local consumers with the much needed nutritional benefits derived from the squash and more importantly provide good income for

farmers, processors, exporters and foreign exchange for the nation. Considering the immense nutritional benefit of butternut squash and the potential revenue to be generated from growing them in Ghana, it is expedient to find ways of adding value to the squash for the Ghanaian consumer.

This study therefore sought to develop flour from the butternut squash which can be added to weaning food to provide babies, toddlers and consumers in general with nutritional cereal mixes to supplement their nutritional needs. There exists the possibility of developing custards, complement flours and fruit juices from the fruit. Butternut squash chips can possibly also be used as snacks providing alternative healthy foods to nibble on.

Furthermore, the study aimed at determining the chemical, microbial quality and shelf life of the butternut flour.

Methodology

Sampling

Two local BNS samples and one imported sample were used for this research. The local samples were obtained from randomly selected farms at Demawu in Keta at the Volta Region of Ghana. Samples were transported under ambient conditions to the Food Research Institute immediately after sampling. The imported sample was purchased from the market at Demawu.

Preparation of Butternut Squash Flour

Butternut Squash samples were washed, manually peeled and cut into small slices. They were then further treated with 1% sodium meta-bisulphite solution (which is100g per litre of potable water) and dried in an Apex drier (serial no. A27685, type B35E, London) for 15 hours at 55℃. The dried BNS slices were milled in laboratory milling machine (Panasonic mixer grinder, MX-AC 300) into a fine powder.

Butternut squash flour samples were stored at ambient temperature for 8 weeks. To determine the shelf life, microbial and chemical analysis were carried out on the flour samples weekly for the period of storage.

Fig. 2 Technologist cutting up Butternut Squash

Fig.3 Butternut Squash cut into 1cm slices for mechanical drying.

Fig. 4 Dried slices of Butternut Squash

Fig.5 Butternut Squash Flour

Microbiological and Chemical analysis of BNS Flour

Microbial Analysis conducted on the BNS flour were Aerobic Plate Count, Coliform, *E. coli*, *Salmonella* spp., *Staphylococcus aureus, Clostridium perfringens, Bacillus cereus,* Yeasts and Moulds. The test methods used were standard Nordic Committee on Food Analysis (NMKL) and International Organization for Standardization (ISO) methods.

For the chemical analysis, the parameters analysed on the butternut squash samples were Moisture, Ash, Phosphorus, Iron and Calcium and the following standard methods were used respectively; AOAC 925.10(1990) 15th Edition; AOAC 923.03; (2000) 17th Edition; Molybdenum Blue Colorimetric ; 2, 2 – bipyridyl Colorimetric and Permanganate Titrations.

Results and Discussion

Table 1 shows the average results obtained from triplicate chemical analysis of the butternut samples.

Table 1: Results of chemical analysis on the Butternut Squash Samples

Chemical Analysis on Butternut Squash					
Samples	**% Moisture**	**Ash (mg/100g)**	**Phosphorus (mg/100g)**	**Iron (mg/100g)**	**Calcium (mg/100g)**
Imported BNS	93.95	0.64	Trace	0.85	50.15
Local BNS 1	92.51	1.00	109.10	5.49	77.14
Local BNS 2	93.13	0.64	107.83	5.33	69.43

The moisture content of the fresh Butternut Squash ranged from 92.51 – 93.95%. Ash content was in the range of 0.64-1.00%. The level of Phosphorus in the imported BNS was in trace amounts whereas the locally grown BNS from Demawu had levels of up to 109.10mg/100g of BNS. The Iron content of the imported BNS was lowest at 0.85mg/100g whilst the locally grown variety recorded levels of up to 5.49mg/100g of BNS. For the Calcium levels, the Imported BNS contained the lowest level at 50.15 mg/100g.

Average Microbial Counts when the BNS flour was prepared was Log 2.9 for Aerobic Plate Count, Log 3.1 for *Bacillus cereus*, Log 2.5 for Coliforms, Log 4.03 for Yeasts and Log 4.05 for Moulds.

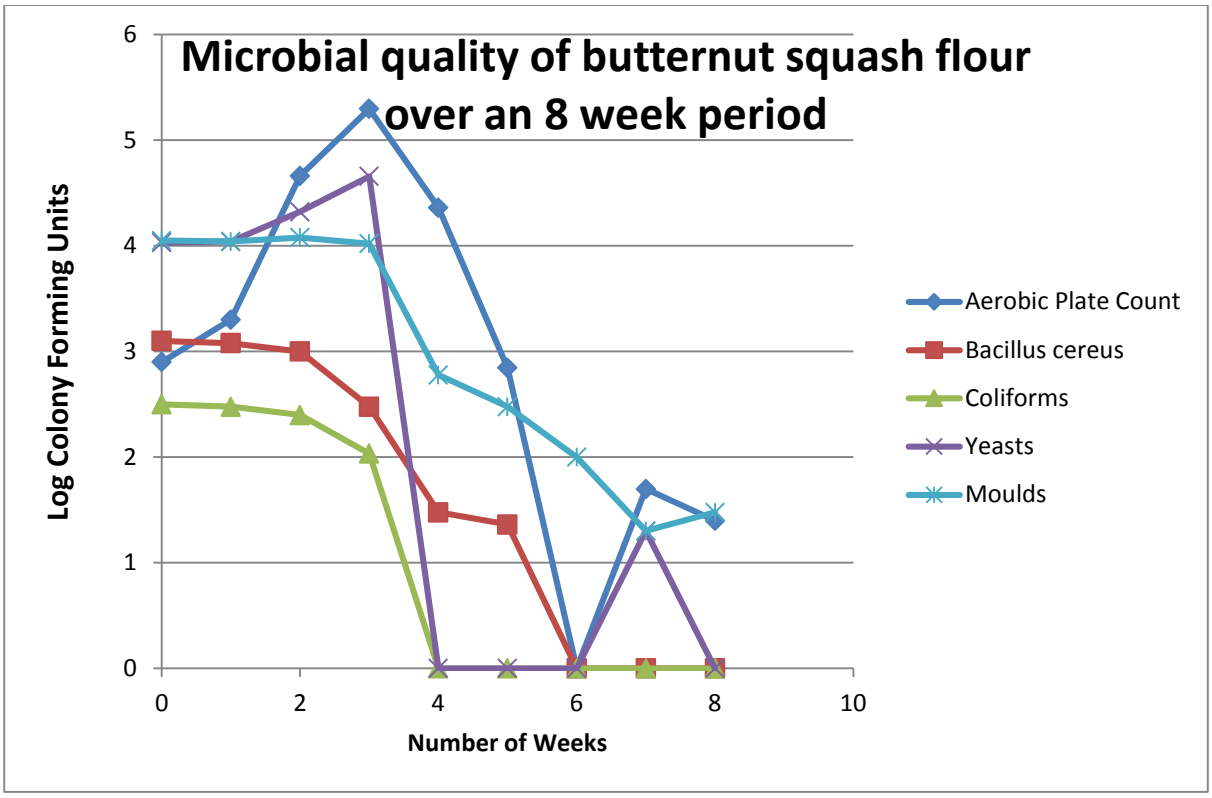

Fig. 6 A graph showing the Microbial Quality of BNS Squash Flour over an 8 week period.

From Fig.6 it is observed that Aerobic Plate count increased in the sample till the 5th week of storage when a decline was observed. This decline in levels of aerobic microorganisms continued till the 7th week of storage when there was an increase. However, after 8 weeks of storage, the level of aerobic microorganisms was lower than that of the sample when it was freshly prepared. This trend was similar to that of Yeasts in the BNS flour. For Bacillus spp and coliforms, there was a steady decline of their levels in the BNS flour during the period of storage. For coliforms, none were isolated from the sample after 4 weeks of storage. For Bacillus spp, none were isolated after 6 weeks of storage. The level of moulds also declined steadily until the 8th week of storage when there was an increase. However, the level at the end of the 8 week storage period was still lesser than that after immediate preparation.

Conclusion

The BNS flour has been found to be microbiologically stable over an 8 week storage period. Its nutritional levels also make it a great source of alternative diet. BNS Flour therefore has a potential to be used as an ingredient in formulating cereal mixes, noodles and pastries, as fruit drinks, in custards to mention a few. It can also be eaten as a snack to provide nutrition and

fibre to the consumer. Due to the high moisture content of the butternut squash, the yield of dried flour obtained was not enough considering the energy utilized in preparation of the flour. The fruit pulp could therefore be used directly in food and drink product development. Extensive work could not be carried out on this project due to limited funds. However, butternut squash is a good source of nutrients that could complement the nutritional needs of the Ghanaian consumer.

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