Bambara groundnut: An underutilized crop with potential for improving food security

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Bambara groundnut, *Vigna subterranean*.
(Photo courtesy of Kwekwe Photography, provided by Grow Further)

Bambara groundnut (BGN) is relatively easy to grow in West Africa and well known as a traditional food. Drawbacks to including it in the diet are difficulty to mill and its "hard to cook" trait. As a result, this highly nutritious legume is considered an underutilized crop. Research is ongoing to understand the composition of the nut and its nutritional advantages, as well as looking for new opportunities to incorporate BGN in the diet. Agricultural research is working toward increasing the availability and quality of the seed. Food science research has led to BGN incorporation into unique food products sold internationally. These efforts have promoted awareness of BGN nutrition values and provided the opportunity to increase the BGN supply in Ghana. It is especially beneficial for the farming communities in which they work by improving financial and food security.

Food Science in Action:

- ✓ Food Engineering
- ✓ Nutrition
- ✓ Product Development
- ✓ Sensory Science

Introduction

Ghana, located in West Africa, has had high inflation in 2023 of key crops (maize, sorghum, and rice).[1] Of the analyzed population, 11% in West Africa and the Sahel (14 countries including Niger, Mali, and Burkina Faso) suffered from high levels of acute food insecurity in 2023.[1] The majority of the households (80%) farm the land and have high rates of food insecurity.[2] A number of factors are contributing to the problem: the combined effects of conflict, climate shocks, the COVID-19 pandemic, and high food prices, which continue to drive up hunger and malnutrition in the region.[3]

Africa has several indigenous crops designated as "underutilized crops." These crops provide viable alternatives to food insecurity and malnutrition issues in the region. Based on their climate-resistance and their nutritional content,

these crops have the potential to end hunger and poverty. Bambara groundnut (BGN) is one of these underutilized crops in Africa.[4]

Bambara groundnut (Figure 1), *Vigna subterranea*, is native to Africa and the third most important legume after peanut and cowpea.[5] The plant grows well in many soil conditions with little assistance.[6] BGN is considered a "complete food" with balanced macronutrients and many micronutrients.[6] Minerals such as potassium, magnesium, phosphorus, zinc, and iron are higher in BGN than other legumes such as chickpea and mungbean. BGN also has a low glycemic index, making it valuable for diabetics.[6] Representative nutrition data (Table 1) shows the nut is mostly carbohydrate with protein as the second highest nutrient.[7] Other published results differ from Table 1 due to environmental factors or cultivar grown.[6] Evaluation of the physical properties of the nut have been determined in Ghana to provide data for handling equipment.[8]

In Ghana, BGN is prepared by boiling until tender and adding seasoning. This traditional dish, called Aboboi, is eaten with fried plantains or Tatale (plantain pancakes). It is also eaten as a street food, dry roasted for a snack, or put in various stews Consumption of BGN is limited due to its hard-to-cook property.[7]

Table 1. *Nutritional composition of Bambara groundnut*[7]

Component	Amount
Carbohydrate	49 - 63.5% (of dry weight)
Fiber	5.2 - 6.4%
Protein	15 - 25%
Fat	4.5 - 7.4%
Minerals	2%
Calcium	95.5 - 99.0 mg/100 g
Iron	5.1 - 9.0 mg/100 g
Potassium	11.45 - 14.36 mg/100 g
Sodium	2.9 - 10.6 mg/100 g

Figure 1. *Bambara plant growing in Ghana. (Photo credit: Kwekwe Photography, provided by Grow Further)*

Project Overview

In Africa, research is being done to find applications that include BGN flour. At IFT's annual meeting ("FIRST") in July 2024, Dr. Victoria Jideani, professor at Cape Peninsula University of Technology in South Africa, presented data from her systematic review on the incorporation of BGN flour in wheat bread. Her study showed that BGN flour significantly increases the protein and fiber content of wheat bread, with no significant difference on carbohydrate or moisture content. The sensory attributes, however, decrease when BGN flour is used and currently is acceptable only when used at not more than 10% of the flour component. Further research is needed to address the balance between the nutritional content vs. the sensory attributes.

Other research suggests that BGN has potential for use in flour, snacks, pastries, breakfast cereal, pasta, milk, yogurt, infant foods, and as fortification for other foods.[6] BGN has also been added to noodles, along with Moringa, to improve the nutritional content.[7]

Improved farm practices and more convenient cooking methods were explored as part of the Innofood Africa Project, a four-year project (2020–2024) funded by the European Horizon 2020 research and innovation program. In one work package, researchers at the University of Pretoria, South Africa, studied small-holder farming practices of seed production. This project

Figure 2. *Women farmers growing Bambara groundnut in Ghana. (Photo credit of Kwekwe Photography, provided by Grow Further)*

resulted in the development of training manuals and videos on good agricultural production practices that will lead to increased sustainable seed production.

In a separate Innofood Africa Project work package, researchers utilized infrared and microwave technologies to produce a quicker-cooking BGN. Cooking time was reduced from three hours to 25 minutes. The goal was to increase the potential for future commercialization of Bambara groundnut.[4]

When food scientist and WhatIF Foods co-founder Chris Langwallner learned of the composition of BGN, he was intrigued. BGN's excellent macronutrient balance, and the specific amino acids, glutamic acid and aspartic acid, which would give a pleasant flavor with minimal masking required, were motivation to investigate this food that he was not familiar with.[9] He tried to pitch this "new" nut to the established food industry, but there was no interest. His science incubator group at the time started looking for ideas of applications with BGN as primary ingredient, that could be delivered straight to the consumer. BGN milk was developed through a multi-step process, which led to a patent application by WhatIF Foods.[10] Another product by WhatIF is an air-fried noodle (rather than deep-fried) which includes the unique ingredient of BGN flour, and the air-frying prevents any nutrient loss.[11]

Once a viable product was developed, a consistent supply of raw material was needed for WhatIF Foods. Part of this effort was to provide the farmers with seed. Seeds come from the growing regions (e.g., Burkina Faso and Nigeria). As well, a community of farmers needed to be created that would grow the nut. Exact numbers are not published, but the crop is thousands of tons. Using the established system of moving a crop from the farmer to export had about seven middlemen, which was causing practices that were not fair to the farmer. Given his farming background, Langwallner was keen to ensure that those who are doing the work should get maximum benefit. WhatIF has established better relationships with the farmers and cut out the middlemen. No one had ever shipped BGN internationally, which was critical for WhatIF's business plan, so all the steps had to be completed to allow for transport (i.e., shipping and customs codes), which took nearly 6 years for completion.[9]

Another group assisting the efforts to improve BGN availability is Grow Further.[2] This not-for-profit organization, based in Seattle, WA, is providing a grant to develop a commercial variety of BGN in three years. This is important because there is now no way for farmers to purchase quality seeds.[12] Currently seeds are shared between farmers, which often have low yield[13] (with the exception of seed supplied by WhatIF). Research will be done at the Council for Scientific and Industrial Research–Savannah Agricultural Research Institute (CSIR-SARI) in northern Ghana. The traits to focus on during the breeding efforts were determined through interviews of the women who are growing the crop (Figure 2). Desirable traits are earlier maturity and increased

yield.[12] Other BGN characteristics are larger seeds suitable for milk or flour production as well as maintenance of drought tolerance and nitrogen fixation. Culinary aspects of the bean are also being considered, especially the cook time.[2]

Successes

BGN milk from WhatIF Foods is available in many countries, including the US, Australia, New Zealand, Singapore, and Taiwan. Geographically convenient co-manufacturers produce the milk, and this product uses the majority of the nut. Noodles with BGN can be found in the US (in stores and online) that are produced in Malaysia, which has limited capacity and uses a smaller percent of nut grown. After a lengthy process, BGN has been approved in the European Union which will allow for sale of the BGN- containing products to a bigger market. WhatIF has 3000 farmers that they supply with seed to grow BGN for them. By supplying the seed, quality is maintained, plus there is a steady supply, unlike previously where most seed would be consumed to meet immediate hunger demands.[9] Farmers decide how much of each crop they want to sell and keep whatever they choose; profits and income are maximized when a greater proportion is sold. WhatIF has quality standards and rejects some of the crop for various defects (e.g., color and moisture level), and this portion of the crop can be consumed as part of the diet of the farmer and their families. The cash paid to the farmers (primarily the women, given land from the local chief) is benefiting the society through education of the children.

Grow Further has completed the survey of farmers and has made progress in breeding a seed with desired characteristics and identified 38 varieties that have traits the farmers want.

Looking Ahead

WhatIF continues to expand the market for milk and increase the number of farmers who grow BGN for export.

Grow Further is planning for release of the commercial seed after two more years of lab work. About a year will then be needed for government approval with the Ministry of Agriculture in Ghana. The Ministry will also be helping with multiplication of seed (so there is seed that can be available for use). This will be an improvement of the current method of sharing seed between farmers, where quality is not always the best.[12] It is expected that 1.6 million farms will adopt the improved BGN within 5 years of release, which will give improved income and better nutrition.[2]

The importance of this pulse in the western world is evident by the increasing availability of Bambara groundnut in new products. According to Innova Market Insights there was a CAGR of 52% in the last 5 years (from a small base of less than 50 launches in 2023).[14]

Bambara groundnut, as an underutilized crop, has the potential to increase the nutrition and food security of the people in the countries where it is grown. Currently, the research is mainly at the agricultural level, so that more–and better quality–seed is available to increase BGN production. The efforts of organizations such as WhatIF Foods and Grow Further (among others) are paving the way toward that goal. As the seed yields increase, there will be opportunities for BGN to be used in many additional food products and available as a good source of nutrition to help with food security for all and not just the smallholder farmers who grow the crop.

"Bambara groundnut is often regarded as a "complete food" because of its well-balanced nutritional profile. It's a fantastic source of protein, carbohydrates, fibre and minerals, making it a wholesome choice! It (also) plays a wonderful role in crop rotation and intercropping systems, helping to boost soil fertility. This plant contributes to nitrogen fixation in soils, making it even more special!"

Dr. Victoria Jideani, professor at Cape Peninsula University of Technology in South Africa

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