The production of Bamcorn, a maize-bambara groundnut product

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SUMMARY

Diets based on Ablemamu, a roasted maize or corn meal, alone are of low protein content. In Ghana, some maize diets such as Akplidzii are supplemented in various ways with grain legumes. Experiments were, therefore, conducted to develop a simple but cheap and effective method for producing an enriched Ablemamu called Bamcorn using bambara groundnut (*Voandzeia substerranea*). Proximate analysis of the Bamcorn shows that it has a protein content of 62 per cent more than Ablemamu. However, Bamcorn contains 60 per cent less calcium than Ablemamu. Results of organoleptic tests show that the Bamcorn has an acceptable taste and flavour. A pilot technology involving cleaning, weighing, roasting, cooling, grinding, weighing, mixing and packaging the Bamcorn in polyethylene bags is briefly described.

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RÉSUMÉ

LARTEY, B. L.: *La production de 'bamcorn', un produit à base de maïs et de voandzu.*

Les régimes alimentaires basés sur l' 'ablemamu' (grains de maïs rôtis) sont trop pauvres en protéines. Au Ghana, quelques uns des mets à base de maïs comme l' 'akplidzii' sont enrichis en proteines de différentes manières par l'adjonction de graines de légumineuses. C'est dans cette voie que des expériences ont été faites par l'auteur afin de mettre au point une méthode simple, efficace et bon marché, pour l'obtention d'un 'ablemamu' amélioré, appelé 'bamcorn', composé de grains de maïs et de voandzu (*Voandzeia subterranea*). Une analyse approximative de ce 'bamcorn' montre qu'il a une teneur en protéines de 62% supérieure à celle de l' 'ablemamu', mais qu'il contient 60% de moins de calcium. Les résultats d'essais organoleptiques prouvent que le 'bamcorn' a un gôut et une saveur acceptables. L'auteur décrit brièvement une technique pilote comprenant successivement le nettoyage des matériaux, le pesage, le rôtissage, le refroidissement, la mouture, le pesage, le mélange et l'emballage du 'bamcorn' dans des sachets de polyethylène.

Introduction

Maize or corn (*Zea mays* L.) is one of the most popular staple food crops in Ghana. It is traditionally prepared for consumption in a number of ways such as a roasted meal called *Ablemamu* in Ga.

Ablemamu is liked by both children and adults because it appears to be bulkier and easier to digest than corn gruel, *Akasa*. However, diets based mainly on *Ablemamu* may be low in protein.

In Ghana, some traditional maize diets like *Akplidzii* or *Aprapransa* include liberal amounts of grain legumes, especially cowpea (*Vigna* spp.). Legumes contain as much as 17–36 per cent protein and, therefore, have a protein supplementary effect on such maize diets. Diets based on a mixture of maize and legumes, therefore, possess a protein value significantly higher than those based on maize alone (FAO, 1974).

Laboratory experiments were, therefore, undertaken to determine how *Ablemamu* could best be fortified with a suitable legume, changing the colour and taste as little as possible.

The aim was to find the simplest and cheapest method, keeping capital outlay to a minimum and to enable the new product to be marketed at a competitive price. However, it was not possible to evaluate in meaningful terms, the economics of the technology because the detailed work was outside the scope of the laboratory-based experimentation. It may be possible, nevertheless, that such

an evaluation can be undertaken in the future, in addition to carrying out experiments to find out the net protein utilization (NPU) and protein efficiency ratio (PER) of the Bamcorn.

Materials and methods

Local maize, of 15–18 per cent moisture content, was used in these experiments. It was first winnowed to remove all extraneous material.

A 2 kg sample of the maize was roasted in a shallow stainless steel pan over a low heat until the colour changed from yellowish white to golden brown. A 2 kg sample of bambara groundnut (*Voandzeia subterranea*) was similarly roasted until the colour changed from light to deep brown.

The roasted maize and bambara groundnut samples were separately ground on a Christy and Norris Laboratory mill (No. 8, Screen aperture 0·008 mm), mixed in equal proportions and then packed in $7{\cdot}62\times10^{-5}$m gauge polyethylene bags.

Organoleptic tests

A number of acceptability tests were carried out with members of staff of the Food Research Institute, Accra, during the course of these experiments. The method chosen for these tests was the paired-comparison test in combination with the hedonic-rating scale as described by Kramer & Twigg (1962) and Amerine, Pangborn & Roessler (1965).

Porridges were made from the Ablemamu-Bambara groundnut mixture (Bamcorn) and were compared with Ablemamu akasa. The proportions of Bamcorn to boiling water as well as Ablemamu to boiling water used for making the porridges were 1 : 9.

Chemical analysis

To compare the proximate composition of the Bamcorn with the Ablemamu, an analysis of both samples as well as the original maize was undertaken.

Moisture. Determined on 5 g sample heated in an air oven at 105 ± 1°C to a constant weight.

Protein. Nitrogen content (N) determined on 2 g sample of macro-Kjeldahl procedure and percentage protein calculated by multiplying N with the factor 6·25.

Fat. Extracted from 5 g sample by Soxhlet continuous extraction method for about 6 h.

Ash. 5 g sample heated in a silica crucible on a burner in a fume cupboard and later ashed in an electric muffle furnace at 550°C.

Crude fibre. Determined according to the standard procedure described by AOAC (1970).

Calcium. Determined by the standard method by AOAC (1970).

Phosphorus. Determined in accordance with the method described by Fogg & Wilkinson (1958).

Iron. Determined by 2-2′ dipyridyl method as described by AOAC (1970).

Results and discussion

Bambara groundnut was used because it is employed more frequently than other legumes in traditional maize diets. It is also the most draught resistant pulse and produces a crop under conditions of higher temperature and less rainfall than other pulses like cowpeas. It is also one of the most pest and disease-free legumes (Karikari, 1971) and is less prone to lose its nutritive constituents on storage.

The organoleptic tests had a two-fold purpose: to determine the quality of individual samples of Bamcorn with respect to their taste, colour, flavour and consistency and to compare this quality with that of Ablemamu.

Sample of Bamcorn prepared by the laboratory method were rated higher than the Ablemamu in taste, flavour and consistency. Similarly, the majority of the panelists preferred the flavour and taste of the Bamcorn porridge to those of the Albemamu akasa.

As a result of the experiments, a laboratory method for the production of Bamcorn was worked out as follows:

1. The maize is winnowed to remove light extraneous material;
2. Heavy extraneous materials in the maize and in the bambara groundnut are removed by hand;
3. The maize is then roasted over a low heat (85–110°C) for 20–25 min until the colour changed from yellowish white to light brown.
4. The bambara groundnut is roasted in the same way until the colour changed from light brown or cream to deep or dark brown.

5. Both are allowed to cool for 5 min.
6. Equal weights of roasted maize and roasted bambara groundnut are each ground twice in a laboratory mill.
7. The quantities are subsequently mixed in a rotomixer.
8. The mixture is packed in $7{\cdot}62 \times 10^{-5}$m gauge polyethylene bags.
9. The bags are stored at room temperature.

The analytical results in Table 1 show that Bamcorn contains 62 per cent more protein than Ablemamu. However, it contains 60 per cent less calcium.

TABLE 1
Proximate Composition of Samples

Composition	*Bam-corn*	*Able-mamu*	*Roasted bambara ground-nut*	*Local maize*
Moisture (per cent)	3·1	2·9	3·3	11·1
Protein (per cent)	14·4	8·9	18·2	8·8
Ash (per cent)	2·8	1·5	2·0	1·3
Fat (per cent)	5·6	4·1	8·4	3·9
Crude fibre (per cent)	1·6	0·6	4·1	1·2
Calcium (mg/100 g)	20	50	25	45
Phosphorus (mg/100 g)	362·5	475	312·5	253
Iron (mg/100 g)	4·3	4·7	4·2	8·4

As a result of the exploratory experiments and the subsequent acceptance of the product, a pilot plant technology was designed for pre-industrial production. This scale of production is necessary to enable the marketing of the product to be tested before full industrial-scale production is commenced. This plant is planned to produce 1 ton of Bamcorn a day.

The requirements of machinery, materials, site area etc. can be deduced from the following data and the operational phases shown in Fig. 1.

Raw materials storage. A storage space for 2500 kg of bambara groundnut and 2500 kg of maize is necessary. This quantity is sufficient for 5 days production. Both the bambara groundnut and the maize are packed in jute bags which are sealed with suitable thread. The bags are stacked on pallets with enough passageway between stacks. The storage room is separated from the processing area by a wall and a sliding door.

Cleaning. The light extraneous materials are removed by winnowing, the heavier materials by hand-picking, and the resulting raw materials are washed with water in plastic containers.

Weighing. The cleaned material (Bambara groundnut or maize) is weighed in suitable containers on a floor-mounted balance with a capacity of up to 100 kg, accurate to 0·5 kg.

Roasting. An electrically-heated roaster capable of roasting 1 t in 8 h is necessary. The roaster is thermostatically controlled at 85–110°C for 20–25 min in batches of 50 kg.

Cooling. The roasted material is emptied on to aluminium trolleys which are transferred to a cooling chamber which should be air-conditioned if possible.

Grinding. The roasted, cooled materials are

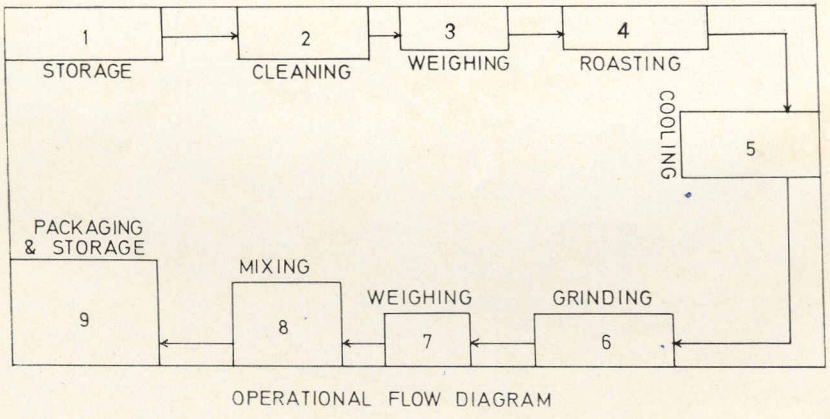

Fig. 1. Operational flow chart.

ground separately in an electrically driven beater mill with suitable screens attached. The ground materials are collected in plastic vats.

Weighing. The same quantity of each material is weighed into a bigger plastic vat.

Mixing. The mixture is poured slowly into a horizontal trough mixer capable of mixing 100 kg at a time.

In the absence of a horizontal trough mixer, a tumbler mixer with baffles may be used. After 15 min mixing, the resulting Bamcorn is collected into plastic vats.

Packaging. 1 kg of Bamcorn is then measured into $7{\cdot}62\times10^{-5}$m thick polyethylene pouches which are then sealed with a heat-sealing machine. Batches of 20 sealed pouches are packed into cardboard boxes.

Quality control checks are carried out at phases (1), (2), (4) and (8) by visual examination.

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