Improved Nutrition and National Development
Through the Utilization of Cassava in Baked Foods

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ABSTRACT

Cassava (Manihot spp.) has become an important crop in many parts of the world for processing into several human foods and industrial commodities. Increased utilization of cassava and its products has been a catalyst for industrial development, creating sources of income for farmers, processors and traders. In poorer developing countries of the tropical and semi-tropical climates where wheat cannot be, or is not, cultivated, cassava has become a major source of revenue, contributing significantly to the improvement of food and livelihood security by directly or indirectly helping to reduce the huge foreign exchange expended on wheat, a major raw material in the production of bread, biscuits and pastry products. This chapter highlights the importance and use of cassava in the bakery industry. The benefits of including cassava, partly or wholly, are highlighted. Also discussed are the problems involved in the conversion of cassava into products on an industrial basis, e.g. the large amounts of material required for industrial processing, pre-process storage of cassava roots and flour and the influence of pre-process root storage, root maturity and flour storage on the physicochemical and sensory attributes of cassava biscuit; possible solutions are highlighted. Nutritional improvement of cassava flour products is also discussed.

INTRODUCTION

Cassava is a short-lived perennial shrub which is grown anywhere between the latitudes 30°N and 30°S, an area which is encompasses some of the poorest countries of the world (Bokanga, 1995). It is a dicotyledonous perennial plant belonging to the family Euphorbiaceae grown only in the hotter lowland tropics mainly for its starchy roots, though its leaves are also used as vegetable. It has been reported that cassava is an important staple for over 500 million people in the developing world (Cock, 1985). As a crop, cassava is hardy, contributing to feeding the populace in areas that are marginal to other crops such as marginal, unproductive or depleted lands where other crops yield essentially nothing (Cock, 1985; Bokanga, 1995) or in areas that experience long dry seasons and uncertain rainfall (Cock, 1985).

The two common botanical forms of cassava are Manihot esculenta Cranz and Manihot utilissima Phol. This classification is based on the cyanoglucoside content of the tubers, which also classify the tubers as “sweet” or “bitter” cassava, the sweet form have low (<140ppm) cyanoglucoside content while the bitter cassava contains greater than 140 ppm cyanoglucosides (linamarine and luteoseltraline) on dry weight basis. A further distinction is that while the cyanoglucosides are evenly distributed throughout the sweet, low cyanide cassava tuber, they are majorly located in the peel in the “bitter” high cyanide cassava and are removed with peeling during processing of the tubers.
Most of the total world production of cassava is processed for direct human consumption, also for livestock and as starch. Cassava is often castigated as an “inferior food crop”, “poor people crop” (Hahn and Keyser, 1985) and as a “dangerous crop”. These labels on cassava were due to some limitations of the crop including low quality and quantity of protein, the presence of cyanogenic glucoisides (Cooke and Coursey, 1981) and poor storage of the tubers (Akingbala et al., 2005). Table 1 shows the strengths, weaknesses, opportunities and threats (SWOT) analysis of the traditional cassava processing techniques. Consequently, the challenges associated with cassava processing are multifaceted and efforts required to address them would require similar dimensions (Falade and Akingbala, 2009).

Table 1. Appraisal of the traditional processing of cassava into different products

<table>
<thead>
<tr>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Highly perishable and toxic cassava is being converted to a more stable and edible form by fermentation process</td>
<td>• Poor hygienic condition</td>
</tr>
<tr>
<td>• No requirement specialized processing equipment</td>
<td>• No specific processing condition temperature</td>
</tr>
<tr>
<td>• Amenable to small scale operation</td>
<td>• No specification of variety</td>
</tr>
<tr>
<td>• Provision of rural employments</td>
<td>• “Chance” inoculation with reduced action</td>
</tr>
<tr>
<td>• Supplementation of the small income in the rural households</td>
<td>• Poor dewatering/fermentation facilities</td>
</tr>
<tr>
<td>• Provision of personal security and small capital investment from the scarce cash resource for rural women</td>
<td>• Variable flavour, e.g. gari</td>
</tr>
<tr>
<td>• Enhancement of food and livelihood security</td>
<td>• Use of grater with variable apertures</td>
</tr>
<tr>
<td>• Specification of variety (to enable appropriate machine design in terms of shape and sizes)</td>
<td>• Poor packaging and distribution practices</td>
</tr>
<tr>
<td>• Consume cassava on a daily basis without any obvious sign of intoxication</td>
<td>• Low shelf life of cassava</td>
</tr>
<tr>
<td>• Provision of variety in diets</td>
<td>• High labour requirement for processing</td>
</tr>
<tr>
<td>• Specification of variety (to enable appropriate machine design in terms of shape and sizes)</td>
<td>• Long processing times</td>
</tr>
<tr>
<td>• Consume cassava on a daily basis without any obvious sign of intoxication</td>
<td>• Low energy density of cassava and cassava products</td>
</tr>
</tbody>
</table>

Opportunity

• Specification of variety (to enable appropriate machine design in terms of shape and sizes)
• Consume cassava on a daily basis without any obvious sign of intoxication
• Provision of variety in diets

Threat

• Presence in cassava of the cyanogenic glucoisides linamarin and lotaustralin
• Cassava toxicity
• Competing uses of cassava
• Malnutrition due to low quantity and quality of protein of cassava

Source: Falade and Akingbala, (2009)

CASSAVA STORAGE

Cassava roots when left attached to the main stem can remain in the ground for several months without becoming inedible and farmers often leave cassava plants in the field as a security against drought, famine or other unforeseen food shortages (Bokanga, 2007). However, incipient quality deterioration starts after the roots have reached maturity, e.g. starch content decreases while fibre increases. The roots after harvesting start actively deteriorating within 2-3 days and rapidly become of little value for consumption or industrial application (Bokanga, 2007; Hahn, 2007). This initial physiological deterioration is followed by microbial deterioration 3–5 days after (Rickard & Coursey, 1981). Because of the large amounts of material required for industrial processing, two to three days of pre-process storage of cassava root is inevitable, during which time physiological changes that reduce starch yield and the quality of processed cassava products occur in the raw material (Akingbala et al., 1989; Ihedioha et al., 1996), thus making pre-process storage the main problem of cassava utilization on an industrial scale.

Several methods of storage have been proposed for cassava roots. However, most of the methods are not economically viable for storing the roots prior to processing on an industrial scale, considering the low prices of cassava products. Storage methods, which result in a reduction of moisture loss from the roots, have good potential for pre-process storage on an industrial scale. Rickard & Coursey (1981)
reported that cassava roots were stored in moist sawdust for up to 8 weeks with minimum deterioration. Storage of cassava roots in trenches also reduced spoilage (Agboola, 1985; CIAT, 1983). Roots pre-treated with a microbial protectant (CIAT, 1993) and sealed in polyethylene bags have exhibited reduced moisture loss (Rickard, 1985), reduced oxygen tension (Oudit, 1976) and maintained excellent storage quality. However, storage quality may be very different from utilization quality. Ihedioha et al., (1996) and Akingbala et al., (1989) reported that cassava food utilization properties change long before physical deterioration is observed in stored roots. Therefore it is expedient to process cassava roots promptly, or store for a minimal period prior to processing.

PROCESSING OF CASSAVA

Raw cassava roots and uncooked leaves are not palatable; they also contain varying amounts of cyanide which is toxic to man and animals. Due to their bulkiness and high moisture content (~70%), transportation of the roots to urban markets is difficult and expensive. Consequently, cassava must be processed to increase the shelf life of the products, facilitate transportation and marketing, reduce cyanide content and improve palatability. Processing of cassava helps to reduce postharvest losses and stabilizes seasonal fluctuations in the supply of the crop (Hahn, 2007). Processing methods developed in Africa to convert raw cassava into food have been described by Hahn (1989). The unit operations involved in cassava processing include washing, peeling, soaking in water or holding in air for different times to permit fermentation of the root, drying, grinding/milling, roasting (garification), steaming, pounding, sieving and mixing in cold or hot water. Specific combinations of these unit operations lead to a myriad of different cassava products appealing to a wide range of consumers (Bokanga, 1995).

Figure 1: Peeling of harvested cassava roots.

Processing and Nutrition

Processing of cassava often results in nutritional improvement even in the most toxic (highest concentration of cyanogenic glucoside) cultivars. Detoxification of cassava, to a large extent, occurs during the processing of the roots when the cell structural integrity is usually lost. The cyanogenic glucosides come into contact with the hydrolytic enzyme linamarase, thus initiating the formation of HCN. Akingbala et al., (2005) reported about a 95% decrease in cyanoglucoside content after grating and nearly 98% after fermentation of cassava during gari manufacture. Since food processing usually includes heating, the HCN produced is likely to evaporate completely (Bokanga, 1995). However, boiling whole bitter cassava root can result in toxicity as the hydrolytic enzymes are denatured by heat without hydrolysing the cyanoglucosides.

Fermentation and product nutritional quality

Lactic acid fermentation which is generally employed in processing cassava products also assists in hydrolysis of the cyanogenic glucosides to sugar and volatile HCN which is removed during further
processing by heating. Apart from the detoxifying effect on cassava, it is safe to presume that lactic acid fermentation also confers on cassava products such as fufu and fermented flours the same advantages it confers on milk, nuts and other proteinous products, e.g. increased digestibility, increased protein content, improved protein quality and increased vitamin content. Increased protein contents have also been reported in the conversion of cassava into gari (Akingbala et al., 2005).

**Processing of Cassava into unfermented flour**

One of the emerging non-traditional uses of cassava in Nigeria is the use of high quality cassava flour (HQCF) for baking applications. Cassava flour is produced by different methods depending on the locality. In West Africa, particularly in Nigeria, cassava flour is made from freshly harvested roots. The roots are peeled, washed and cut into chips. The cassava chips are sun-dried, milled into a fine powder and packaged in moisture proof materials. The process of production of HQCF suitable for baking was developed by the International Institute of Tropical Agriculture (IITA) and has been described by Onabolu and Bokanga (1995) and Abass et al., (1998). Actually, IITA developed two methods for cassava flour production: grating and chipping. The grating method uses machines and processes similar to those widely used for gari production in Nigeria. It is more flexible and adaptable to cassava of low and high cyanogenic potential. The chipping method is faster and requires the use of only the chipping machine before drying; however, its use is limited to cassava of low cyanogenic potential. This technology for unfermented flour production has been disseminated in Nigeria through training of farmers, women’s groups, staff of national agricultural extension agencies and NGOs (Abass et al., 1998). The use of HQCF for baking, pastry production and other catering purposes has also been developed (Onabolu et al., 1998) and demonstrated to home caterers, bakers and industrial food processors who have adopted the technologies (Abass et al., 1998).

![Figure 2: Sieving of dried and milled cassava flour.](image)

Despite the benefits of the HQCF technology to all producers and users, Abass et al., (1998) enumerated some problems that hinder high quality cassava flour production and continuous availability and utilization. Some of the problems include high cost and inadequate supply of fresh cassava, lack of working capital, dependence on weather for drying, labour (intensive, shortage, expansiveness and seasonality), and transportation (high cost, bad roads) (Abass et al., 1998). Others include insufficient drying space, low and unstable selling price of HQCF (users dictate prices), low demand for HQCF and lack of access to market (Abass et al., 1998). These problems could be location specific (Mlingi et al., 1998) and time dependent, and could be due to the effect of the vicious cycle associated with cassava production (Abass et al., 1998). The location effect was shown in an economic analysis of cassava flour production in Masaki and Dar es Salaam for use in biscuit factories, which indicate that cassava flour can only be processed economically in the farms located outside Dar es
Salaam city due to the great difference between the comparative costs of fresh cassava at the two locations (Mlingi et al., 1998).

**CASSAVA FLOUR UTILIZATION**

Cassava flour is used in a number of ways in South India, South East Asia and Africa. It can be made into a type of porridge by mixing with water or rice before cooking (Balagopalan et al., 1988). Traditional Indian foods such as chappathis, uppuma, puttu, iddlies, and dosa can be made from cassava flour. In the Philippines, cassava flour is used in delicacies such as bibingka, seeman and kalanay (Balagopalan et al., 1988). Cutlets are made by mincing the grated roots and mixing with fried onions, cashew nuts, black gram and coriander leaves. The mixture is then made into balls dusted with maida flour and lightly fried. The flour can also be used for making breads, biscuits and salad dressings, custard powder, ice cream powder, flakes, vermicelli, etc. Cassava flour can also be used for making other delicacies such as cassava dumplings, cassava fruit cake, cassava cakes, cassava banana fritters, cassava puttu, cassava uppuma, cassava masala poori, cassava porotta, cassava vattayappam, cassava idiappam, cassava iddli and cassa dosai (Balagopalan et al., 1988).

Among the popular cassava products in Nigeria such as gari, fufu and lafun, cassava flour is the easiest and cheapest to make and the highest income generator (Abass et al., 1998). The use of cassava flour in food rations has clear advantages. The inclusion of cassava in composite flour for the production of fast foods would reduce cost and enhance the production of noodles, breakfast cereals, and pastries among others (Falade and Akingbala, 2009). Apart from the industries, bakers and caterers, individuals also produce and purchase cassava flour for home use for the preparation of chin-chin, pie (meat and fish), buns and cake among others. Inclusion of cassava flour at between 10-50% and 10% in wheat flour has been used for producing acceptable biscuits and noodles respectively (Table 2).

**Table 2. Products made by processors from cassava roots, and from cassava flour at home, ease of production and income generation rating**

<table>
<thead>
<tr>
<th>Product</th>
<th>Number of commercial processors making the products</th>
<th>Frequency of responses by processors</th>
<th>Easiest to make</th>
<th>Cheapest to make</th>
<th>Highest income generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>From cassava root:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassava flour</td>
<td>24</td>
<td>13</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Gari</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fufu</td>
<td>12</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lafun</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Starch</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Tapioca</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>From cassava flour:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinchin</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other pastries, akara, burns, etc.</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Fish or meat pie</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Doughnut</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Amala</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cake</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Semo (HQCF mixed with maize or rice)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Source: Abass et al., (1998)

For the production of different pastry and baked goods, caterers and bakers have substituted cassava flour for wheat at different levels of 10-100% and 5-20%, respectively. Figure 3 shows the pastries that can be made from composite flour. Research at IITA has also shown that cassava flour (100%) can be used to prepare bakery products such as cakes, cookies and doughnuts (Onabolu and Bokanga, 1995). The resulting products are readily available and sold in Nigeria, thus helping to improve food
and livelihood security. The benefits of the use of HQCF include increased profit as a result of the lower cost of HQCF compared to wheat, and increased yield of products, particularly biscuits. Users noted that the quality of pastry products, biscuits and noodles improved when good quality flour and the right processing method for their manufacture was used. The highlighted benefits of flour indicate good prospects for commercial production and utilization of cassava (Abass et al., 1998).

![Figure 3: Pastries made from composite flour.](image)

In order to facilitate the production of consistent quality products, a number of criteria for screening HQCF prior to purchase have been specified and are shown in Table 3 (Abass et al., 1998). Utilization of cassava flour would help promote cassava production, increase farmer’s income, create more jobs, reduce dependence and consequently the foreign exchange expended on wheat importation. These would add up to an improvement of food and livelihood security for the vast majority of the citizenry.

<table>
<thead>
<tr>
<th>Quality criteria</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.0-8.0</td>
</tr>
<tr>
<td>Moisture content (%)</td>
<td>10-12</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>&lt;0.9</td>
</tr>
<tr>
<td>Colour</td>
<td>White</td>
</tr>
<tr>
<td>Odour</td>
<td>Not detectable</td>
</tr>
<tr>
<td>Taste</td>
<td>None or sweet</td>
</tr>
<tr>
<td>Sand or any other contaminants</td>
<td>Not present</td>
</tr>
<tr>
<td>Particle size</td>
<td>Same as for wheat</td>
</tr>
<tr>
<td>Cyanogenic potential (CNP)</td>
<td>National (Nigeria) limit (10ppm)</td>
</tr>
</tbody>
</table>

Source: Abass et al., (1998)

In Tanzania production of bakery and confectionery products such as bread, biscuits, cakes and noodles is limited to wheat flour and the total annual needs of wheat flour in the country was 127000 t (Food Security Bulletin, 1998). Domestic output of wheat was 61000 t in 1996/97 with the rest (42000 t) being imported at a cost of USD 6 million (Mlingi et al., 1998). By substituting cassava flour for only 20% of the wheat in the country for biscuit manufacture, Tanzania could save about USD 1.2 million of foreign exchange annually (Mlingi et al., 1998). Based on experiences from other countries such as Nigeria, Cameroon, Cote d’Ivoire and Ghana, Tanzania has initiated a research program geared towards diversifying cassava use (Mlingi et al., 1998). According to Kapinga et al., (1998) trials by the Ministry of Agriculture and the Tanzania Food and Nutrition Centre showed that cassava could economically substitute wheat flour to produce biscuits, cakes, bread, doughnuts and noodles.

**Cassava bread**

There is a great increase in the consumption of bread and other wheat-based products worldwide because of changing food habits, increasing population, urbanization, and the convenience of these
ready-made foods (Akingbala et al., 2009). This has created unnecessary financial problems for many poor tropical countries which are naturally unsuitable for growing wheat and therefore have to import wheat to sustain their new wheat-based diets. Also, for the many that suffer from celiac disease, a chronic enteropathy characterized by an inadequate immune response to ingested gluten from wheat, rye, barley, and triticale (Sciarini et al., 2008), reduction in the consumption or outright elimination of gluten-free foods would be desirable (Turabi et al., 2008). Wheat importation and celiac disease could be tremendously reduced by partial or complete substitution of wheat flour with flour or starch from tropical crops such as cassava, yam, and sweet potato, and cereals such as maize, rice, sorghum, and millet. For some products, attempts have been made to completely eliminate wheat flour by substituting other flours and changing the recipe for the products. Generally such moves require government support. In Nigeria, there is a regulation that all wheat flour should contain 10% non-wheat flour inclusion, which in the 1980s required about 200,000 tonnes per year of cassava flour of which only about 10,000 tonnes could be supplied (Mkpong et al., 1990). Figure 4 shows bread made from wheat and composite flours on display for sale in Nigeria.

In South America, cassava bread “Cazabe” is an important traditional fermented food made by the Tukanoan Indians from bitter cassava (Balagopalan et al., 1988). To prepare the flour/starch extract used for the bread, freshly harvested roots are washed, peeled and then pulped. The wet pulp is strained in a large basket, rinsed with water, squeezed, kneaded and pressed against the strainer to dewater. The extracted starch suspension is collected in a large clay pot, the starch is allowed to settle and the liquids decanted off the top to make juice. Once separated, the starch and fiber are relatively stable and can be left in pots or leaf-lined baskets for several days or buried in leaf-lined pits and stored for longer periods (Balagopalan et al., 1988). This mash is used for breadmaking.

Research and development activity for the preparation of bread based on cassava have been taken up by many international and national organizations throughout the world. In the composite flour program development of bakery products and paste goods from cereal and non-cereal flours, starches, and protein concentrates, the Food and Agriculture Organization (FAO) of the United Nations has given a description of two innovations being tested to employ larger quantities of cassava, corn or sorghum flours in bread making: (a) In bread without gluten programme, substances that agglutinate starch (glyceryl monostearate (GMS), 10% emulsion) are used to substitute for wheat gluten. In order to compensate for the nutritional inferiority of an all-starch bread, considerable amounts of plant proteins are added in the form of peanut or soy flours producing a bread that is more nutritious than traditional ones; (b) Attempts have been made to increase the proportion of non-wheat flour inclusion in wheat flour to more than 10% (Balagopalan et al., 1988).

Attempts have been made by several workers and organizations to improve the traditional bread preparations or develop composite flour technology for cassava based preparations by mixing other starches with cassava flour (Balagopalan et al., 1988). Different wheat flours have been diluted with various proportions of cassava starch and flour (Shittu et al., 2007, Shittu et al., 2008) and cassava mash (Crabtree et al., 1978a,b). Defloor et al., (1995) and Khalil et al., (2000) specifically reported that
inclusion of cassava flour into wheat flour up to about 30% could still give an acceptable fresh loaf depending on the source of wheat flour. Bread containing 20% fresh minced cassava showed higher sensory evaluation ratings (Crabtree et al., 1978a). To cut expenses on wheat importation and find wider utilization for the increasingly produced cassava roots, the Nigerian government mandated the use of composite cassava-wheat flour for baking by adding minimum of 10% cassava flour to wheat for a start. In spite of the small amount of cassava flour (10%) included into wheat flour (90%), the breadmaking characteristics of the composite flours from different cassava genotype grown with or without fertilizer application differed significantly (Shittu et al., 2008). The greatest effect of cassava genotype was realized on crumb moisture while fertilizer application had the greatest effect on the bread crumb texture (Shittu et al., 2008). Flour from unfertilized roots also showed significant differences in performance in making composite cassava-wheat bread loaf, which resulted in Shittu et al. (2008) concluding that careful selection of cassava root variety and application of fertilizer are important factors that should be considered in optimizing composite cassava–wheat bread quality.

The production of dried products of cassava is wasteful in terms of the energy required for drying, particularly since the dried products will be rehydrated during the bread making process. The incorporation of fresh minced cassava into bread has been described by Crabtree et al., (1978b). This technique has the advantage of eliminating the need for an energy-consuming drying stage and should be of special interest to bakeries in rural areas of the developing world where fresh cassava is readily available. Bread containing 20% fresh minced cassava rated higher than products from higher levels of cassava substitution in all assessments except sensory evaluation. If cassava is to be processed into dried flour before incorporation into bread, low temperature drying at around 50°C is recommended to ensure that the flour is light in colour. The longer storage life of dried cassava products may alternatively be advantageous in urban situations remote from cassava-producing districts and for the export market. The use of composite flours will enable developing countries to save some scarce foreign exchange expended on importing wheat flours (Ogunsua, 1989). Studies on improving nutritional quality of cassava bread by incorporation of flours rich in proteins have been investigated as early as in the 1960s. Kim and De Ruiter (1961) reported the suitability of flours derived from cassava, yam, sago and arrowroot in breadmaking when combined with protein concentrates obtained from soybean, peanut, cottonseed and fish meal. De Ruiter (1970) studied the mixture of cassava starch with soybean or groundnut flours using a GMS emulsion as improving agent for breadmaking. To ensure the commercial success of this composite cassava wheat flour technology, systematic studies need to be conducted to fully understand the best way to formulate product and to determine the optimal processing conditions required to realize high quality baked products. Shittu et al., (2007) reported complex polymeric changes caused by the changing temperature–time combinations in baking, which may be peculiar to the use of composite cassava wheat flour in breadmaking. The influence of baking temperature was specifically more significant on loaf volume and crumb moisture while baking time had a more significant influence on loaf weight, crumb dryness, hardness and density. Literature reports of studies relating cassava flour properties to food uses are presently few. An example of such a study conducted by Eggleston et al., (1993), observed that cassava flour's diastatic activity and maximum paste viscosity influenced the specific volume of gluten free bread loaf from soy-cassava flour.

**Cassava biscuits**

Wheat is the major ingredient in the Nigerian biscuit baking industry, and it was the only source of flour for biscuit production prior to the reduction in wheat importation in 1996. In a swift move to remedy the problem, the industry sought cheaper and readily available raw materials. Cassava and corn flours have now found important places in the Nigerian biscuit industry. Cassava is particularly used due to its good baking qualities. As at 1998, there were 18 brands of biscuits and a brand of noodles in which cassava flour was used in Nigeria (Abass et al., 1998). Other flours have been used in biscuit manufacture. Figure 5 shows the biscuits made from composite flour. Tyagi et al., (2007) studied the nutritional, sensory, and textural characteristics of defatted mustard flour fortified biscuits, and Eneche (1999) reported the manufacture of biscuits from blends of millet flour and pigeon pea flour in different proportions. However, among the possible roots and tuber flours...
Substitutes, cassava is the best choice to replace wheat partially or completely because of its high yield and low cost of production (Morton, 1988).

![Figure 5: Biscuits made from composite (cassava/wheat) flour.](image)

It has been reported that 20% cassava substitution for wheat could be used for biscuit production without affecting the flavour, texture and colour of the products (Mlingi et al., 1998). Partial substitution of wheat flour with cassava flour up to 40% has been reported to be satisfactory for the production of biscuits (Eggleston et al., 1992; Omoaka and Bokanga, 1994). Oyewole et al., (1996) were able to produce acceptable biscuits by completely substituting wheat flour with cassava flour. Quality of cassava flour or starch for biscuit manufacture would be affected by the cultivar, the pre-process storage of the tubers, storage of the flour/starch (Akingbala et al., 2005), and crop maturity (Akingbala et al., 2009). Most research investigations are centred on the production of flour from freshly harvested cassava roots at the village farm level and in many urban centres. Production of cassava flour for biscuit manufacture would be affected by delays in processing of roots due to collection and transportation problems between the farm sites and the processing centres, and delays in processing caused by the slow manual peeling process that is often employed. Moreover, the large amount of tubers required for industrial application takes time to harvest and gather and the highly perishable tubers may lose some of their utilization quality, including reduced flour/starch yield, increased enzymatic activity, and increased difficulty of peeling among others (Akingbala et al., 1989), which affect the final flour and product quality.

Biscuits are a more robust product without the overriding effects of gluten on texture. A recent report by Akingbala et al., (2009) indicated that neither age of tuber nor length of preprocess storage of flour affected biscuit spread, colour, taste or aroma significantly, though root maturity tended to favour biscuits made from flour from 12 month old as against that from 23 month old roots. Akingbala et al., (ibid.) reported that the average diameter (5.6 cm), height (0.50–0.51 cm), and spread ratio (11.0–11.2) of biscuits manufactured from both cassava and wheat flour, which was used as the reference sample, were not significantly (p<0.05) different. However, average weight of the cassava biscuits (13.4 g) was significantly (p<0.05) greater than that observed for wheat flour biscuits (11.9 g). This may be due to differences in the moisture contents of the biscuits which was 8.7–8.8% for cassava flour biscuit and 8.3% for biscuit made from wheat flour.

Fat and protein contents of the cassava biscuits were lower than those of wheat biscuits due to the higher fat and protein contents of wheat flour compared to cassava flour (Akingbala et al., ibid.). Apart from a probable reduction in the nutritional value of the cassava flour biscuits, the low protein content would be of little significance since biscuits are structurally and texturally different from a loaf of bread. Gluten is important for bread and the quantity and quality of the proteins present in flour have a major influence on the rheological behaviour of the dough, particularly when flour is the major constituent of the formula (Maache-Rezzoug et al., 1998). Ash and fiber contents of biscuits made of
flour from 12-month-old cassava roots were similar to that of wheat biscuits but lower than observed for biscuits made of flour from the 23-month-old roots (Akingbala et al., 2009). This was probably due to increased lignification of the roots during further growth which was reflected in flour composition (Akingbala et al., 2009). Generally, proximate composition of the biscuits in this study was in conformity with the standard specification (Wills et al., 1984) for biscuits.

CONCLUSION

The uniqueness of cassava in improving nutrition and bringing about national development in the food industry cannot be overemphasized. While other commodities such as corn, millet and soybean have been suggested and used as substitutes in the production of composite flours, the use of cassava has been shown to outweigh their benefits. The inclusion of cassava flour and starch in wheat flour for the preparation of biscuits, cakes, bread, doughnuts, noodles and other baked goods has several socio-economic advantages. Utilization of cassava would resolve the vicious cyclic effect associated with its production, increase stakeholders’ income, create more jobs, solve some health problems and reduce dependence on wheat importation. These benefits can be summed up as improvements in food and livelihood security for the vast majority of citizens.

References


