Potentials of Cassava, Bambara Groundnut and Tigernut in Biscuit Production: A Review

ABSTRACT

Due to varying changes in lifestyle, economic level and urbanization in the developing countries, the consumption of biscuit and the development of food products using composite flour have increased and are attracting much attention from researchers in bakery and pastry productions. This work reviewed the potentials of cassava, bambara groundnut and tigernut composite flours in biscuit production. This study also includes studies on the use of flours from other tubers, legumes, cereals, and fruit sources in place of wheat flour to make a variety of food products in varying amounts. It was revealed that flour made from cassava, bambara groundnut and tigernut used to produce biscuit products has the capacity of maintaining similar characteristics to products made from full-wheat flour. The finished result demonstrates the cumulative impact of this option in terms of its functional and physicochemical features, as well as the health advantages of raw mixed flour and percentage blending.

In addition, composite flour is an excellent new strategy for employing unusual food products becaue its use produced goods with a range of qualities and features, depending on the types and proportions of wheat flour used in the formulation.

Also this review stated some possible challenges likely to be encountered in case Nigeria changes from use of wheat flour to composite flours and blends of non-wheat flours.

Keywords: Composite flour; products; challenges; potential; biscuit; cassava; bambara groundnut and tigernut.

1. INTRODUCTION

"Consumption of biscuit and other baked aerated wheat flour products has span in Nigeria and other developing countries of the globe" [1]. "Wheat which is common and unique among other cereals for making biscuit and other baked products can only be cultivated in very few developing countries" [2]. The government of Nigeria has supported the use of composite flours and mixtures of non-wheat flours for the production of aerated items such as bread, biscuits, cakes, and doughnuts in an effort to reduce the importation of wheat flour in Nigeria.

Reduced wheat imports by the use of locally accessible raw materials like cassava, maize, potato, millet, and other legume flours like soy bean, Bambara peanut, and pigeon pea are advantageous economically [1].

Robertson et al. [2] defined composite flour as a "mixture of flours, starches and other ingredients intended to replace wheat flour totally or partially in bakery and pastry products". "The usage of composite flours has advantages in terms of preserving hard currency, promoting native plant species with high yields, improving the supply of protein for human nutrition, and improving the use of domestic agricultural produce" [3].

In order to produce leavened or unleavened baked goods or snack foods that are traditionally manufactured from wheat flour and increase the vital elements in the human diet, composite flour is made by blending or mixing variable proportions of many non-wheat flours with or without wheat flour [2].

Composite flour is regarded as advantageous in developing nations since it increases the use of locally grown crops as flour and decreases the importation of wheat flour.

Due to the increase in demand for confectioneries, provincial raw materials are increasingly being used in place of wheat flour [4].

As a result, numerous nations with less developed industrial bases and lower human development indices have pushed for the start of programs to assess the viability of using alternative regional flours in place of wheat flour [5].

The Euphorbiaceous (Spurge) family includes the woody plant known as cassava or manioc.
At least 300 million people rely on the root crop as their main source of income.

Almost all of the cassava grown in Africa (90%) is used by humans as a staple crop, providing 500 people with enough energy and accounting for 37% of the population's dietary energy need [6].

The bambara groundnut, which is often spelled bambarra, is still a staple meal in Africa. It originated in West Africa. Nigerians cultivate bambara groundnut, an indigenous tropical crop.

It is grown in places like Enugu State, numerous northern states, and a few regions of South West Nigeria. Despite being the thirdmost significant legume in most of Africa after peanuts and cowpeas, bambara groundnut is not a particularly successful commercial crop.

The seed is a complete meal due to its high iron content and high lysine and methionine content and the protein when compared to most dietary legumes [7].

According to reports, "the underutilized crop tigernut (Cyperusesculentus) contains a high amount of dietary fiber, which may be effective in the treatment and prevention of a wide range of illnesses, including colon cancer, coronary heart disease, obesity, diabetes, and gastro-intestinal disorders" [8].
It has been shown that tigernut flour is a good source of high-quality oil and has a reasonable level of protein. Additionally, it is a fantastic source of several healthy elements like calcium and iron, which are crucial for body development and growth.

Aphrodisiac, carminative, diuretic, emmenagogue, stimulant, and tonic properties are also attributed to its tubers [8].

One method of tackling the global food problem and insecurity will be the efficient processing and utilization of flour blends made from locally cultivated crops based on complementary nutrients. Additionally, this will aid in reducing the nation's high rate of post-harvest losses [9].

Composite flour is a creative flour that has generated a lot of interest in both food product creation and research [9]. It is described as a combination of flours made from starch-rich tubers like cassava, yam, and potatoes, as well as protein-rich flour and cereals, whether or not they contain wheat flour. Such combinations include wheat and cassava [11, 12], wheat and a variety of legumes [13], millet [14], or without wheat flour and other composites [15].

Composite flour is more nutrient-dense. According to some reports, it contains more minerals, vitamins, fibers, and proteins than flour made just from one type of grain [13].

According to [16], the composite flour mixture might offer a balanced nutrient in the years to come.
Composite flour has recently been the focus of sophisticated research. There is rising interest in functional gluten-free components as a replacement for traditional gluten-free formulations created from refined gluten-free flour, starch, and hydrocolloids [17].

If possible, using composite flour to make baked goods would help reduce total reliance on imported wheat.

The FAO (Food and Agriculture Organization of the United Nations) launched the Composite Flour Programme in 1964 with the goal of improving bread goods using ingredients that were readily available in the area.

In underdeveloped nations around the world, including Africa. The usage of composite flours offered numerous advantages in terms of saving money and promoting the high yielding of native plant species.

In addition, [23] said that the usage of mixed flour will promote better utilization of domestic agricultural goods. [18] asserts that blending wheat flour with other flours is beneficial for both economic and nutritional reasons.

"The most crucial factors to consider when choosing the raw material to create good flour blends in terms of preference, diversity, nutrition, and cheap cost in order to satisfy customer requests are the capability, availability, and cost at the point of use" [18].

Functional characteristics such foaming, emulsification, nitrogen solubility, oil solubility, and water absorption are thought to be primarily protein-dependent [19].

The molecular structure and size of the protein molecules as well as other external factors, such as the process used to separate or produce the protein, have an impact on these qualities [20]. Some composite flours' low protein content and lack of gluten are viewed as drawbacks for their exclusive usage in food products, particularly in those where the flexibility of the dough is crucial to the quality of the finished product.

The quantity and quality of wheat gluten as well as the nature of the product involved laboriously influence the percentage of wheat flour required to provide the desired impact in composite flours [21].

2. POTENTIALS OF CASSAVA FLOUR IN BAKING

As a promising way to improve the use of local crops, efforts are being made to partially substitute wheat flour in commercial food products with non-wheat flours. In order to maximize its industrial application, researchers have researched the physicochemical and functional characteristics of cassava flour (CF).

[24] investigated the cassava and soy flour mixtures' functional characteristics.

It was shown that soy flour (SF) had a greater ability to bind and retain water and oil than cassava flour (CF) alone.

The high protein composition of soybeans was thought to account for the high capacity of SF to absorb water and oil. [25] stated that compared to carbohydrates, soy protein can absorb up to 200% of its weight in water.[24] further stated that as the amount of SF was raised, so did the mixes' ability to absorb water and oil. The flour mixtures were more capable of absorbing oil and water than CF alone. When compared to CF, the blends may have an advantage in baked doughs where moisture is needed to improve handling characteristics. According to dough rheology tests, the dough development periods for blends of cassava and wheat flour were quicker than for 100% wheat flour (WF) and got shorter as the amount of CF replacement increased [24].

“This was related to the dilution of gluten brought on by the addition of the CF and also suggested a quicker water uptake by the various CF constituents. In comparison to 12 doughs made with 100% WF, dough stability, which measures how much more mixing can be applied to a dough sample before it starts to break down, was significantly lower for the flour blends, which may point to an overall weakening of the doughs with higher CF substitution” [24].
When the percentage of cassava flour (CF) was increased, the protein content of biscuits manufactured from blends of wheat and cassava flour decreased from 13.04% in 100% WF biscuits to 8.4% in 40% CF: 60% WF biscuits [25].

The low protein content of the CF (12%), which would have decreased the protein concentration of the wheat-cassava flour mixture, was blamed for this.

The nutritional value of the cassava cookies was improved by 10% soy flour (SF) added to corn flour (CF), which increased the cookies' protein and fat contents [24].

For instance, the 100% CF biscuits have 10.7% fat and 1.6% protein.

With the maximum amount of SF incorporation, the 20:80 (CF: SF) biscuits, these values climbed to 32.2% protein and 30.5% fat, respectively [24]. The color, crispiness, taste, and flavor of the biscuits were decreased when CF was added to SF, but when the cassava level was raised, the biscuits' diameter, spread ratio, and height rose [24].The cassava starch polymer's loosely bound molecules, which expand more when heated, are what caused the increase in diameter and spread ratio [26].

Notably, there was no discernible difference between biscuits prepared with 100% WF and those made with a wheat-cassava-soy flour combination in terms of overall acceptability. The results increase the likelihood that cassava flour can be used to make biscuits.

The amount of gluten in the wheat flour greatly influences the size of the loaf.

Because of this, wheat is the only type of raw material that can be used to make bread.

A viscoelastic network that emerges when gluten is soaked allows it to hold onto more gas during baking, increasing the volume of theloaf [22]. Additionally, using composite flour, such as a blend of wheat and cassava flour, has decreased the volume of loaves. The volume was decreased because the gluten protein was diluted as more cassava flour was added. Due to the fact that consumer preferences for wheat and composite flour biscuits did not differ significantly despite the volume reduction,

composite wheat-cassava flour can be used to make acceptable biscuits [28].
"Sadly, hydrogen cyanide is a dangerous chemical that is present in cassava roots, thus its presence in baked goods made from cassava must be checked to prevent food poisoning" [28].

According to [30], as the amount of cassava flour in the formulation increased, so did the biscuits' hydrocyanic acid content (HCN). The highest HCN measurement was 0.02 mg/kg of product in 70% CF cookies. The biscuits are safe for human consumption because the observed HCN content is less than the Codex Alimentarius Commission's recommended maximum allowed level of 1 mg/100 g of flour.

3. POTENTIALS OF BAMBARA GROUNDNUT FLOUR IN BAKING

"Different snack products have been produced from flour blends of bambara groundnut and other ingredients with bambara groundnut as the major source of protein".[32] produced *akpekpa* (similar to *okpa*) from flour blends of bambara groundnut, cassava, and soybean at different levels (100:0:0, 80:20:0, 80:0:20, and 70:15:15) and reported protein content varying between 14.25% and 16.25%; the high protein content of the product is as a result of bambara groundnut and soybean but more from bambara groundnut due to its high proportion in the product. Based on sensory scores, the most acceptable product (80:20:0) was that containing 80% bambara groundnut.

Balagopalan et a. [33] produced "snacks from composite flours of unripe plantain, bambara groundnut and turmeric. The ratio of bambara groundnut in the different formulations ranged from 35% to 100%. The protein content from the different formulations ranged from 4.23% to 14.81%. This implied that the increase in protein content was dependent on the quantity of bambara groundnut in the formulation".

Anderson et al.[34] prepared deep-fried snacks made from bambara groundnut paste and flour and reported that the products had respective protein contents of 23.41 and 19.35 g/100 g.

Heat and Maillard browning were blamed for the flour's decreased protein content after being used to make snacks. By replacing wheat flour with bambara groundnut flour, the snack known as the doughnut was created.

Weickert et al. [35] prepared "doughnuts from composite flour blends of wheat and bambara groundnut mixed at different ratios (90:10, 80:20, 70:30, and 0:100) and reported a protein content of 10.88–11.78%. The protein content increased with the increase in the quantity of bambara groundnut flour. On sensory evaluation, the product with 10% bambara groundnut flour was most acceptable".

Bread is a commonly consumed staple food, which is produced from wheat flour. Many researchers have replaced wheat flour with bambara groundnut flour in bread production.

Masood et al. [36] produced "bread by replacing wheat flour with different proportions of *acha* and bambara groundnut sourdough flours (0, 5:5, 10:10, and 15:15) and reported protein content of 14.0–16.48%. Improvement of amino acids content compared with white bread was reported (contribution of dietary reference intakes of 50.29–71.65 for protein in male and female was also reported). The sourdough flours' substitution (10%) in bread significantly increased sensory properties (taste and flavour)". [37] incorporated "bambara groundnut flour at different levels (10%, 20%, and 30%) in *kissra* bread production. The control *kissra* (13.37 g/100 g) had lower protein content compared with the fortified *kissra* with the different levels (17.93%, 19.38%, and 20.23%, respectively) of bambara groundnut flour fortification, which could be associated with the high protein content (24.53 g/100 g) of the bambara groundnut flour used for the fortification". This result is in agreement [38] who found "significant improvement in the protein content of bread fortified with bambara groundnut". According to these authors, bread fortified with 15% of bambara groundnut flour inclusion was the most acceptable.

Baljeet et al. [39] also produced "bread from composite flour blends of whole wheat and bambara groundnut at different proportions (100:0, 90:10, 80:20, 70:30, and 60:40). The increase in protein content (8.65–18.41%) was attributed to the increase in the quantity of bambara groundnut flour in the blend. The sample with the highest quantity (40%) of bambara groundnut was least acceptable compared with the sample with the least quantity (10%) of bambara groundnut".

Best et al. [40] produced "extruded snacks from flours of bambara groundnut seeds that have been given different treatments (germination and roasting). The raw bambara groundnut had the least protein content (21.85%) compared with the roasted (23.09%) and germinated–roasted (23.20%). Roasting improved sensory properties such as taste and flavor".

Bambara groundnut has also been used in enriching breakfast cereal and extruded products.

Mongi et al. [41] prepared "pasta from composite flour blends of partially gelatinized wheat, cassava, and bambara groundnut in different proportions (100:0:0, 64:10:26, 60:12:28, 56:14:30, 52:16:32, and 48:18:34). The protein content (16.20–17.85%) of the pasta was found to increase with increasing quantity of bambara groundnut flour. Although the protein content increased, the sensory properties of the pasta containing high quantity (30%, 32%, and 34%) of bambara groundnut were less acceptable compared with blends containing low quantity (26% and 28%) of bambara groundnut". "The blends containing lesser quantity of bambara groundnut compared well with the blend containing 100% wheat flour (control). Bambara groundnut flour has also been reportedly used in enriching breakfast cereal produced from sorghum malt, which could be used in combating protein-energy malnutrition in children" [42].

Venho et al. [43] also produced "a protein-rich extruded product from the flour blend of sorghum and bambara groundnut in different proportions (90:10, 80:20, and 70:30) and reported that increase in quantity of bambara groundnut flour resulted in increase in protein content".

4. USE OF BAMBARA GROUNDNUT IN ENRICHING TRADITIONAL FOODS

Traditional dishes are greatly enjoyed by both rural and urban residents, particularly when they are prepared in hygienic settings. Many people now consume these dishes, and efforts have been undertaken to increase their nutritional content by adding protein-rich grains like bambara groundnut or by fermentation. For instance, fura, a diet made with millet flour and fortified with bambara groundnut, contained more lysine than the control sample and had appropriate levels of all the necessary amino acids [44]. Some authors claimed that fura fortified with 30% bambara groundnut had a slight (8%) increase in protein content [45].

Fufu is a significant traditional fermented meal that is widely consumed in Africa.A fermented cassava product known as fufu is a staple item that is often boiled before consumption [46,47,48]When bambara groundnut flour was added to fufu at various quantities (10%, 20%, 30%, 40%, and 50%), [28] found that the protein content rose (13.35-18.87%). As the amount of bambara groundnut flour increased, so did the protein content.

However, the sample with a 10% substitution of bambara groundnut was the most favored according to sensory analysis.

Kweon et al. [50] prepared meat mimic made from flour blends with various amounts of African yam bean and bambara groundnut protein isolate (50:50, 60:40, and 40:60).African yam bean, bambara groundnut protein isolate, and 100% bambara groundnut flour were also used to create a meat-analog. While other samples' protein contents ranged from 20.0% to 34.3%, the sample with 100% bambara groundnut protein isolate had the highest protein level (36.4%). The samples that contained bambara groundnut flour, as opposed to those that contained bambara groundnut protein isolate, received higher mean scores during the sensory evaluation.

Faridi and Faubion [51] enhanced an acha-based biscuit with unripe plantains and bambara groundnut (100:0:0, 80:10:10, 70:20:10, 60:30:10, and 50:40:10) and stated that the product's sensory qualities (color, flavor, texture, and crispness) were acceptable.

The protein level varied from 5.30 to 7.51 percent. Additionally suitable for diabetic people.

Perez et al. [52] used Rhizopus oligosporus and Rhizopus nigricans to ferment bambara groundnut flour and found that three days of fermentation boosted the nutritional content (the protein increased from 18.66-22.60%). The addition of bambara groundnut flour to the diet was advised. It was asserted that it might help reduce obesity and cardiovascular problems.

Composite flour blends made from wheat, cocoyam, and bambara groundnut were created by [52]. (60:30:10 and 72:19:9). Protein concentrations ranged from 11.11 to 20.35 percent.

The protein content of the composite flour blends was boosted with the addition of bambara groundnut. [54] created an extruded food product using an 80:20 mixture of white yam meal and bambara groundnut meal.[54] developed an extruded snack with a protein level of 3.26–17.62% that was attributed to bambara groundnut. The snack was made from composite flour mixes of bambara groundnut, corn bran, and cassava starch. Because it produced a product that was high in protein, it was asserted that bambara groundnut is a nutrient-rich legume.

Orange-fleshed sweet potatoes and bambara groundnuts were used to make extruded products, and [55] found that adding more bambara groundnut increased the product's protein content (4.08–15.03%).

[56] manufactured biscuits with varying flour blends of wheat, bambara groundnut, and aerial yam (100:0:0, 0:100:0, 40:30:30, 30:30:40, and 50:40:10), reporting a protein level of 7.90-17.08%. As the amount of bambara groundnut flour increased, so did the protein content.

The sample with the ratio 40:30:30 was moderately accepted.

5. POTENTIALS OF TIGERNUT FLOUR IN BAKING

Tigernut flour has a distinct sweet flavor that is great for a variety of applications. Given that it is gluten-free and suitable for those who must avoid gluten in their diets, it is a good substitute for many other flours, including wheat flour. Additionally, the confectionery sector makes use of it [23, 38]. Due to its natural sugar content, which is fairly high and prevents the need for excessive additional sugar, it is regarded as a good flour or additive for the bread industry [38].

Additionally, it can be used to flavor ice cream and biscuits [38]. The sun-dried tubers are pounded into a fine powder in the Keta region of Ghana and can be combined with sugar to be preserved until needed.Roasted tubers can be pulverized into a powder called fiedzowe in Vhe (Awlan). You can consume these meals on their own or with water to form a beverage [31].

Tigernut has also been shown to have higher essential amino acid content than the levels suggested in the protein standard by the FAO/WHO [28] for meeting adult demands.

Tigernut could thus be a useful substitute for cassava in the baking sector due to its inherent nutritional and medicinal benefits [32].
Furthermore, during the milling process, tigernut flour retains all of its nutritive qualities. The finely ground tigernut flour lends baits a creamy, smooth texture and a distinct flavor. It can be used as a basis component in any combination to help baits keep moisture [43].In addition, removing some or all of the skins from tigernut hook baits increases their potency.

The fact that tigernuts are high in lysine, a significant fish feeding stimulant, contributes to their appeal. Tigernuts also contain a variety of other crucial and stimulating amino acids for fish, such as methionine, cystine, arginine, and histidine [34,35].Tigernuts' composition is distinguished by their high insoluble fiber and unsaturated fat concentrations as well as their relatively low starch percentage [57]. [58] employed a mixture of tigernut and chickpea flour to partially or completely replace emulsifier and/or shortening in the formulations of gluten-free batters, doughs, and breads. They observed that the GF goods had adequate specific volume and a darker crust.According to [59], tigernut flour added up to 25% to rice flour raised the gelatinization temperatures in GF bread, but tigernut flour added to corn-based biscuits significantly decreased the peak and onset gelatinization temperatures. [60] discussed the impact of various hydrocolloids on the rheology of the dough, the textural characteristics, and the cooking abilities of GF noodles prepared using tigernut. Tigernut use as an extrudate component has only been documented in one study.

The high quantity of insoluble fiber and fat in tigernuts made the mixes of TN-cassava utilized in the authors' study difficult to extrude as the TN concentration grew in the mixes, which led to a pressure reduction in the extruder barrel and lessened expansion. Additionally, TN inclusion (20%) produced the highest overall acceptance scores of corn-made biscuits, emphasizing on the sensory quality of GF cereal-based meals.

It is well known that soluble fiber tends to increase expansion while insoluble fiber tends to decrease it, and that fat content can lead to melt sliding into the barrel and a resulting low pressure at the die exit [61].

6. RELATIONSHIP BETWEEN FLOUR QUALITY AND BAKED-PRODUCT QUALITY

Dough rheology techniques (farinography, mixography, extensography, and alveography) and baking tests (bread, cookies, and cakes) have been widely and traditionally used to examine the relationship between flour quality and baked-product quality. Farinography and mixography are two common dough rheology techniques used to gather data on a flour's water absorption and the amount of time a dough is mixed, both of which are related to the production of gluten [62].To maintain dough consistency, varying amounts of water were added in these two ways. Contrarily, a fixed amount of water is provided in extensography and traditional alveography, regardless of the actual water absorption of a given wheat, to acquire data on the flour's dough-forming and gluten strength [63]Cookie-baking analyses are frequently employed to assess the biscuitbaking abilities of soft wheat flours. Although the majority of previously published research studies on cookie baking employed benchtop standard sugar-snap cookie baking procedures [AACC Methods 10-50D and 10-52].

According to [54], compared to sugar-snap cookie-baking, wire-cut cookie-baking shown a significantly more sensitive response to changing ingredients (such as trans-fat and zero-trans-fat shortening). In other words, the wire-cut cookie method is better equipped to distinguish between various flours as they react to the cookie dough's operating environment and to show the effects of non-flour elements' contributions to that environment.Regarding sugar concentration [%S = formula level of sugar/(sugar + water), baker's% (100 parts-by-weight flour) basis] and amount of total solvent [TS = formula levels of sugar + water, baker's% basis], the AACC sugar-snap and wire-cut cookie formulations differ greatly and significantly.

The formula for sugar cookies typically comprises 73% S and 82 TS, whereas the formula for wire-cut cookies typically has 66% S and 64 TS [64].

A benchtop cracker baking method has not been widely investigated or adopted as an Official Method in comparison to the cookie baking techniques mentioned above because of obstacles such the challenge of locating ideal diagnostic flours and the lack of adequate benchtop equipment (e.g., powerful dough mixer, dough sheeter, multizone oven).

Saltine, chemically leavened, and savory crackers are the three main categories of crackers [65].

The majority of earlier studies on crackers focused on saltine and soda crackers, which are commonly made using a sponge and dough method [54].

Due to the requirement for a lengthy (19-hour sponge) fermentation time, typical sponge- and-dough methods for making saltine and savory crackers typically take about 24 hours.

Contrarily, chemically leavened crackers often don't need a fermentation stage, and their preparation is rather straightforward.

The ability to employ such a method as a forerunner for assessing gluten functionality in cracker flours would be made possible by the development of a tabletop process for chemically leavened crackers. The need for a tabletop baking method to forecast the contribution of gluten functionality/performance to overall flour performance for cracker baking has so long been felt by academia and industry.

A tabletop method for making chemically leavened crackers was recently developed and described by [66], who also verified the approach using various flours. This method will hopefully be adopted as an Official AACC Method through next scheduled joint studies by the Soft Wheat Flour and Product Technical Committee of American Association for Clinical Chemistry International. Despite the fact that empirical rheological and baking tests are so frequently used, they all, in one way or another, only measure the sum of the functional contributions of the main flour constituents, which include damaged starch, gluten proteins, and arabinoxylans (also known as "pentosans"), rather than the specific functional contributions of each of those constituents. Through a deeper understanding of dough mixing and cookie/cracker-baking mechanisms, end-users would be better able to forecast flour functionality and improve biscuit quality with the ability to examine the individual functional contributions of each functional component of flour [68].

The solvent retention capacity (SRC) method was created and developed by [58] and subsequently adopted as an Official AACC Method as a useful instrument for evaluating flour functionality for soft wheat applications.

The SRC test is a solvation assay for flours that relies on the improved swelling behavior of individual polymer networks in particular single diagnostic solvents, such as water, 5% weight/weight lactic acid in water (for gluten), 5% w/w sodium carbonate in water (for damaged starch), and 50% weight/weight sucrose in water (for pentosans)—which are used to predict the functional contribution of each individual flour component. Wheat breeders, millers, and bakers are using the SRC method more frequently, and there has recently been a lot of press about the connections between flour SRC profiles and cookie and cracker quality [67].

7. COMPOSITIONAL EFFECT ON QUALITY CHARACTERISTICS OF BISCUIT

Ali et al. [68] investigated the impact of baking on the protein content of high protein cookies manufactured using lysine-rich flours such soybean, wheat germ, and pea. They discovered that baking reduced the protein efficiency ratio (PER) of several types of biscuits from 13.3% to 35.3%. They created high protein biscuits employing a ratio of 55:20:25 of wheat, peanut, and soybean flour.

Reducing sugar, crude fiber, ash, protein (N 6.25) and moisture percentages were determined to be 7.5, 3.33, 5.58, and 0.52 respectively.

The biscuit had a calcium and phosphorus level of 439 and 228 grams per 100 grams, respectively. There were 4.8 and 4.8 grams of calcium and phosphorus per 100 grams of protein in baked and unbaked biscuits, respectively. In contrast, 3.44g/100g of lysine were accessible in the biscuit [69].

"Scientist also evaluated the high protein cookies prepared by adding 33% defatted soy flour and 27% peanut butter. The proximate composition of protein was 1.5%, fat 22.4%, moisture 4.7%, ash 2.4%, fibres 1.5% and carbohydrates 54.21%. The calculated energy content of cookies was 48 kcal/100g. Addition of soy and peanut butter substantially improved the micronutrient except thiamine, which were 5.25 times higher than those in wheat flour. The Ca, P and Fe, content of cookies were 49.1, 1.82 and 2.76mg/100g, respectively" [60].

Andrae and Beckman [61] prepared "biscuits containing wheat, breadfruit flour, soy protein, whey and found that biscuits containing 10% breadfruit flour, soy protein were judged more acceptable in flavor, color and texture".[62] in the study "on biscuit baking properties of composite flours containing varying levels of 0, 5, 10, 15, 20 and 25% untreated, heat-treated and germinated black gram flour (BGF) separately indicated that the diameter and thickness of biscuits gradually reduced with increasing quantity of BGFs. The hardness values significantly increased on incorporation of 25% of all the three differently processed BGFs".

"The organoleptic studies inferred that 10% of untreated, 15% of heat-treated and 10% of germinated BGFs were optimum acceptable levels for fortification. Use of 35% sugar, 22.5% fat and 0.5% sodium stearoyal-2 lactylate improved significantly the biscuit baking quality. In general, biscuits made from composite flour containing 15% heat treated BGF, and optimized biscuit formulation were better than those made from 10% of untreated or germinated BGFs" [61]. [69] evaluated "the wheat flour and soy-fortified biscuits prepared with standardized levels of ingredients and emulsifiers (SSL and/or GMS) for chemical composition, *in vitro* digestibility and PER. Addition of 20% defatted soy flour in the recipe increased the protein, ash, crude fibre, calcium, phosphorus, iron, sugar (reducing and non-reducing) and available calcium, phosphorus, iron, sugar (reducing and non-reducing) and available lysine contents of biscuits. No trypsin inhibitor activity was found in soy biscuits but had marginally higher non-enzymatic browning than the control samples. The *in vitro* digestibility values of control and soy biscuits were found to be 68.46% and 83.82% respectively. The PER of soy biscuits (1.41) had improved to a greater extent, which could be attributed to the higher levels of protein and available lysine content in defatted soy flour".

Adebayo [70] evaluated "replacement of wheat flour up to 40% level with defatted soy flour in the standard sweet biscuits recipe, which increased the protein content from 6.02 to 14.8%, bending hardness from 3.60 to 9.80 N and cutting hardness from 6.02 to 23.04 N of the biscuits. Sensory evaluation showed that all of the biscuits from various blends were acceptable with no significant difference among them".

According to research [72] on biscuits made with finger millet flour, a moisture content of 5% equating to 32% Rh was crucial for the product's storage stability.

When packaged in double packs made of polypropylene/pearlized BOPP and metalized polyester/poly laminate, the biscuits had a shelf life of 75 and 50 days at 90% Rh, 38°C, respectively, and over 120 days at 60% Rh, 27°C in both types of packs. Their shelf life and sorption properties were comparable to those of regular glucose biscuits.

[73]evaluated "the nutritional quality of biscuits enriched with spray dried egg powder, before and after storage for 6 months under ambient temperature (20-30 ^{o}C). The food intake, weight gain of rats and PER of the biscuits enriched with spray dried egg powder were evaluated by rat feeding trails and compared with those from popular brand biscuits. Protein enrichment resulted in a 3-fold increase in the PER value compared to control. Egg although being an excellent source of protein, the PER value was not found to be at par with casein because of the fortification being done at low levels, to maintain acceptable sensory attributes".

8. POSSIBLE CHALLENGES OF THE USE OF COMPOSITE FLOUR AND BLENDS OF WHEAT LESS FLOURS

The execution of the cassava-wheat composite biscuit policy may face several difficulties.

The policy itself is one of them. Since 1979, there have been at least five changes to Nigeria's wheat policies. During this time, the policy has changed under many governments. As a result, participants feel dubious about the stability of the current policy. The milling of cassava is very different from the milling of wheat. The mills will need to undergo significant change in order to implement the legislation, which might be expensive. Additionally, millers and bakers will need to be trained, which the government has already begun to do [74].
In order to fully fulfill the Nigerian cassava biscuit policy, 1200 metric tonnes of HQCF will be needed annually.

The 5-10% cassava inclusion program had previously been unsuccessfully implemented in the nation.Therefore, it is improbable that such a nation will try to implement 40%.

According to studies, without the use of improvers, biscuits of satisfactory quality can be manufactured at a 10% inclusion level. However, at 40%, improvers will be necessary.

These improvers must be imported at significant expense because they are not made in Nigeria [75]. Cassava was specifically mentioned in the Nigerian biscuit policy as a means of making composite bread.

However, as a result of the agricultural transformation agenda (ATA) of the current and previous governments, cassava has been used primarily for food (85-90% of total production), feed composition (primarily for fish and poultry), and for manufacturing purposes such as those in the textile, paper, beverage, and glue/gum industries.

The Nigerian biofuel policy, which chose cassava for the generation of fuel ethanol for use in transportation [53] and cooking, was also adopted by the same government.

With so many different applications for cassava, it is unlikely that the millers could produce flour of the necessary quality.Smallholders in Nigeria supply the majority of the country's HQCF [77]The 200,000-300,000 tonnes of HQCF required for 10% cassava flour inclusion in composite flour could not be supplied by these smallholders [78]. Therefore, 40% will be more difficult.

Yam, maize, sweet potatoes, and cowpea, other local alternative crops, are also in short supply [76]. Additionally, wheat traders and other individuals with unfavorable opinions of composite flour control the majority of the mills in Nigeria [16].Weak HQCF supply networks, strong customer desire for 100% wheat bread, and millers' resistance to using composite flour are only a few of the significant issues that [71] listed as being threats to the cassava biscuit policy.

Due to the use of partially fermented cassava flour, some bakeries that have used composite flour in the past have reported some quality issues, including high sand content, foul odor, shorter product shelf life, gradual discoloration, unreliable supply, brittleness, and poor final product quality [71].

These are potential difficulties that can materialize in Nigeria if the use of composite and wheatless flours is mandated for the production of leavened and unleavened baked goods.

1. The non-wheat crops (such cassava) may not be sufficient or readily available for the creation of composite flours.
2. Multinational corporations operating in Nigeria are unwilling to use non-wheat flours to produce composite flour since doing so would cut down on the amount of wheat they import and the revenue their parent businesses receive from the selling of wheat.
3. It will be challenging for Nigerians to accept baked goods made using composite flours and wheatless flour

blends.The majority of Nigerians have a preference for imported goods or those created abroad.Without proper and rigorous sensitization, they would find it challenging to accept composite flour and mixes of wheatless flours for baked goods.

4. Infrastructure issues, especially for small and medium-sized would be operators that would like to start a business in the production of non-wheat flour, such as a lack of dependable power supply from the Power Holding Company of Nigeria (PHCN) and public water supply.
5. If cassava flour is going to be a part of the composite flour, the cyanide concentration needs to be detoxified to low and safe levels.
6. If the non-wheat crop is used as a staple food, competition between consumers and processors. Without a doubt, this would raise the price of the basic meals.
7. Potential sabotage by global flour milling corporations through the importation of subpar wheat for their mills, as the quantity and quality of gluten protein determine how much nonwheat flour is combined with wheat flour to create composite flour suited for biscuit production.

9. CONCLUSION

Nigeria issued a regulation requiring the flour mills to partially substitute wheat flour with 40% cassava flour for bread making in order to lessen the impact on the economy. The policy's possible advantages include a reduction in the severity of celiac disease, the use of locally accessible foodstuffs, the development of wealth and jobs, and a saving of Nigeria's annual foreign exchange revenues of N 254 billion.

According to studies, wheat can be largely replaced by cassava, other root crops/tubers (yam, coco-yam, sweat potato), grains (maize, rice, sorghum, and millet), legumes (soy, chick-pea, and cowpea), and certain underutilized crops (bread fruit, bread nut, and tigernut).

The majority of research found that substituting 5-10% wheat can be done without significantly affecting bread quality or yield. Although wheat can be substituted up to a level of 20%, bread quality may need to be maintained with the addition of emulsifiers, enzymes, hydrocolloids, and other improvers after that point. The installation of new machinery and the training of bakers and millers would be necessary to employ these additives, which could raise the cost of making bread. Poor bread quality, weak cassava flour supply chains, consumers' strong preference for 100% wheat bread, and millers' resistance to using composite flour are some further potential legislative obstacles. The 40% wheat flour substitute could fail like past attempts unless the aforementioned issues are adequately resolved.Additionally, composite flour with equal amounts of wheat flour and local food flour can be used to make high-quality biscuits and cakes with wheat content as low as 6–7%. They could be produced using protein. When premium wheat flour with a protein concentration of 13% or higher is combined with local food flours like cassava or cocoyam flour, the resulting composite flour has at least 6% wheat protein. Therefore, it is possible to save more than 20% and 50% of the foreign currency used to buy wheat for the production of flour for biscuits and cakes, respectively, if high quality wheat is imported and the flour is blended with local food flours to create composite flours.

This will both give our teeming youths jobs in the agricultural and food processing industries while also saving some foreign currency that might be put toward expanding other parts of the economy.

10. RECOMMENDATIONS

Since composite flour shows good potential for use as functional ingredients in bakery products, therefore the evaluation of the functionality of composite flour in test baking should be performed to ensure an increase in the use of composite flour made from many different raw materials in future.

At the same time, development and consumption of such functional foods not only improves the nutritional status of the general population but also helps those suffering from degenerative diseases associated with today's changing lifestyles and environment.

At the end of this research, the composite flour used in the production of this wheat free biscuit is highly recommended for children because of its high protein content, it is also recommended for patients living with Coeliac disease as cassava is used to replace wheat flour. Moreso for people having digestion problem because of the tigernut flour incorporated, the fibrous nature of tigernut will help improve digestion by increasing the frequency of stools and relieving constipation.

Much effort is needed to find the optimization of composite flour used for any bakery products by mixing different types of crop flours to maximize the composite bakery quality using the mixture response surface methodology.

In addition, the effects of the method of processing, such as toasting, boiling and fermentation of flour, could be used to improve rheology properties of composite bakery products. New discoveries can be made in the future, based on the data obtained, and more food products can be developed for domestic markets

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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