



PRODUCTION AND COST BENEFIT ANALYSIS OF TIDBITS PRODUCED WITH FLOUR FROM CASSAVA AND BAMBARA NUT SEEDS

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Abstract: Producing snacks from blends of Bambara nut flour (BNF) and high-quality cassava flour (HQCF) has gained traction due to their nutritional value, affordability, and potential for local economic development. The functional benefits of such a snack stem from the nutritional standpoint of the gluten-free nature of the composite flour, richness in dietary fibre, and essential amino acids, suitability for malnutrition intervention and school feeding programs with the view to achieving SDG-3. Cost-benefit analysis of a newly developed food product is essential in determining the commercial viability of venturing into full-scale production. This study evaluated the production and cost benefit analysis of tidbits produced with blends of flour from Bambara nut and cassava. HQCF and BNF were prepared from cassava (IITA-TMS-IBA070593) and Bambara nut seeds (SAMNUT 21). The HQCF and BNF were blended in the ratio 60:40, with which the tidbits were produced. The results established that the composite flour made up of three kilograms (3 kg) of HQCF and two kilograms (2 kg) of BNF produced 5.35 kg of tidbits, yielding 53 units of 100 g each of packaged tidbit snacks. The calculated benefit-cost ratio (BCR) of 1.15 signifies a profitable operation, as values exceeding 1 indicate that benefits exceed costs, positioning the enterprise as a potentially profitable investment. Specifically, for every ₦1.00 spent on cassava tidbits processing, there was a return of ₦1.15, reinforcing the financial viability of the venture. Interestingly, for every ₦1.00 earned as revenue, 13.3% was retained as net profit, underscoring the profitability of the enterprise.

Keywords: conversion ratio, investment return, percent profit, total revenue, extrusion, tidbit

1. Introduction

Producing snacks from blends of Bambara nut flour and high-quality cassava flour (HQCF) has gained traction due to their nutritional value, affordability, and potential for local economic development. The functional benefits of such a snack stem from the nutritional standpoint of the gluten-free nature of the composite flour, richness in dietary fibre, and essential

amino acids, suitability for malnutrition intervention and school feeding programs with the view to achieving SDG-3. Originally domesticated in South America, cassava (*Manihot esculenta*) is a carbohydrate-rich tuber crop that is presently grown extensively in many tropical and subtropical parts of the world, particularly throughout Africa, Asia, and regions of Latin America. It's a vital food

security crop and industrial raw material due to its resilience, versatility, and carbohydrate-rich roots. Cassava thrives in poor soils and drought-prone areas, making it ideal for smallholder farmers. It is grown from stem cuttings rather than seeds. Typically, it is harvested 9–12 months after planting, depending on the variety. Food uses of cassava include Garri, fufu, tapioca, and cassava flour. Industrial uses of cassava include Ethanol, starch, animal feed, and biofuel. In terms of nutrition, cassava is high in carbohydrates, gluten-free, and contains vitamin C and iron. The global production figure as of 2022 was approximately 330 million metric tons [1, 2]. The top cassava producers as of 2022 are Nigeria, with production statistics of 60.8 million tons, the Democratic Republic of Congo, 48.8 million tons, Thailand, 34.1 million tons, Ghana, 25.6 million tons, and Cambodia, 17.7 million tons. Africa's Share was over 63% of global production, with Nigeria alone contributing 20%. The yield trend stipulates that Nigeria leads in volume, while a country like Cambodia has higher yields per hectare up to 27.4 t/ha [2]. Cassava is cultivated in 24 out of Nigeria's 36 states, with production concentrated in the southern and middle belt regions. Cassava is a versatile crop, being a significant source of carbohydrates, consumed as Garri, fufu, and tapioca. Cassava production in Nigeria has shown significant growth over the years, solidifying the country's position as the world's largest cassava producer. In 2024, cassava production in Nigeria was projected to reach 66.6 million metric tons (MT), representing a 6% increase from 2023 [3]. The highest cassava-producing regions in 2024 included Emuoha (Rivers), Akamkpa (Cross River), and Ohaji/Egbema (Imo), with production levels exceeding 600,000 MT each [3]. Nigeria's cassava output in 2022 was approximately 60.8 million metric tons, maintaining its global leadership in cassava production [3].

Cassava remains a vital crop for food security and economic growth in Nigeria, thanks to its adaptability and wide-ranging applications, which contribute to its importance [4].

Vigna subterranea, commonly known as Bambara nut, is an indigenous African legume predominantly associated with the West African region. It is highly valued for its resilience in arid conditions and poor soils, making it an important food source in regions with challenging climates. The nut is rich in nutrients, including carbohydrates, proteins, and essential amino acids, which contribute to its role in combating malnutrition. Additionally, its ability to fix nitrogen in the soil enhances soil fertility, supporting sustainable agriculture [5, 6].

Previous research highlights its versatility in culinary applications, such as being boiled, roasted, or processed into flour for various dishes. Studies also emphasize its potential in addressing food security and its cultural significance among African communities. Bambara nuts (*Vigna subterranea*) offer numerous health benefits. They are rich in essential nutrients, including proteins, carbohydrates, dietary fibre, and minerals like iron, calcium, and potassium. These nutrients contribute to improved digestion, enhanced energy levels, and overall health maintenance [7]. In addition, the seeds are rich in bioactive compounds, including flavonoids, tannins, and phytates, which possess strong antioxidative activities. These compounds play important roles in minimizing oxidative damage within the body and may contribute to lowering the incidence of long-term health conditions such as diabetes, heart-related disorders, and some forms of cancer. Additionally, Bambara nuts have antimicrobial properties that can inhibit microbial growth, further supporting health and food preservation. Their nutritional profile makes them a valuable food source for addressing malnutrition and promoting sustainable diets, especially in

regions with limited access to diverse food options [8]. Bambara nut production is primarily concentrated in Sub-Saharan Africa, with Nigeria being one of the leading producers. Global production of Bambara nuts is 308.26 million kilograms, with a 20.33% increase compared to the previous year. In Nigeria, the crop is grown throughout the country, excluding riverine and swampy areas, and is considered one of the centres of its origin. Nigeria is a major producer, with Burkina Faso leading in global production [9]. Nutritionally, high-quality cassava flour is gluten-free and rich in carbohydrates, while Bambara nut flour adds protein, fibre, and essential minerals (iron, calcium, potassium).

The technical and economic feasibility of tidbits (snacks) production as a business venture needs to be assessed. Therefore, this study was conducted to assess the production and cost-benefit analysis of tidbits produced with blends of flour from cassava and Bambara nut seeds.

2. Materials and Methods

2.1. Materials

The material used for this study was cassava IITA-TMS-IBA070593 (Sunshine). The cassava roots were obtained from the International Institute of Tropical Agriculture (IITA). Bambara nut seeds (SAMNUT 21) were procured from Mokwa, Niger State.

2.2. Preparation of high-quality cassava flour (HQCF)

The high-quality cassava flour (HQCF) used for the study was produced from IITA-TMS-IBA070593 (Sunshine) varieties as described by Alimi et al. [10]. The flow chart for the production of HQCF is presented in Fig. 1.

2.2.1. Production of Bambara nut flour

Bambara groundnut (*Vigna subterranea*, SAMNUT 21 cultivar) seeds were sourced from Mokwa, Niger State. They underwent preliminary post-harvest handling involving manual selection to exclude

defective kernels, characterized by mechanical damage, pest infestation, and extraneous particulate matter, ensuring only physiologically sound seeds were retained for further processing. The seeds were subjected to hydration treatment (soaking) in potable water for 24 hours to initiate enzymatic activity and facilitate physicochemical softening. At intervals of six hours, the soaking water was carefully drained and replaced to facilitate easier removal of the seed coats, limit the loss of soluble nutrients, and encourage the migration of antinutritional compounds, including tannins and phytates, from the seeds into the surrounding liquid medium. Following hydration, seeds were transferred into controlled sprouting conditions for 72 hours, aimed at stimulating germination-mediated biochemical modifications. This phase was optimized to affect a reduction in carbohydrate and lipid fractions [11] while promoting enhanced protein synthesis, amino acid reconstitution, and enzymatic activation [12, 5].

Post-germination, the malted legumes were adequately drained to remove residual moisture, evenly distributed on perforated drying trays, and dehydrated in an NSPRI parabolic solar dryer (PSSD) at 60 °C for 24 hours until the target equilibrium moisture content $\leq 12\%$ was achieved to ensure microbial shelf stability and milling efficiency.

The dried malted seeds were then tempered to ambient temperature, size-reduced using a high-speed mill to produce a fine powder, screened through a 250 μm sieve to ensure uniform particle size distribution, and finally packaged in food-grade high-density polyethylene (HDPE) pouches to preserve functional and nutritional integrity before compositional and technological analysis (Fig. 2).

2.2.2. Flour blending

A composite flour consisting of high-quality cassava flour and Bambara nut flour was prepared by combining the two

ingredients in proportions of 60% and 40%, respectively. This formulated blend served

as the primary raw material for producing the tidbits.

Table 1.

Recipe for the production of tidbits	
Item(s)	Quantity
HQCF	3 kg
BNF	2 kg
Cray fish	4 g
Onion and pepper mix	136 g
Salt	4 g
Bouillon cubes	4 g
Water	200 g

Alimi et al. [5]

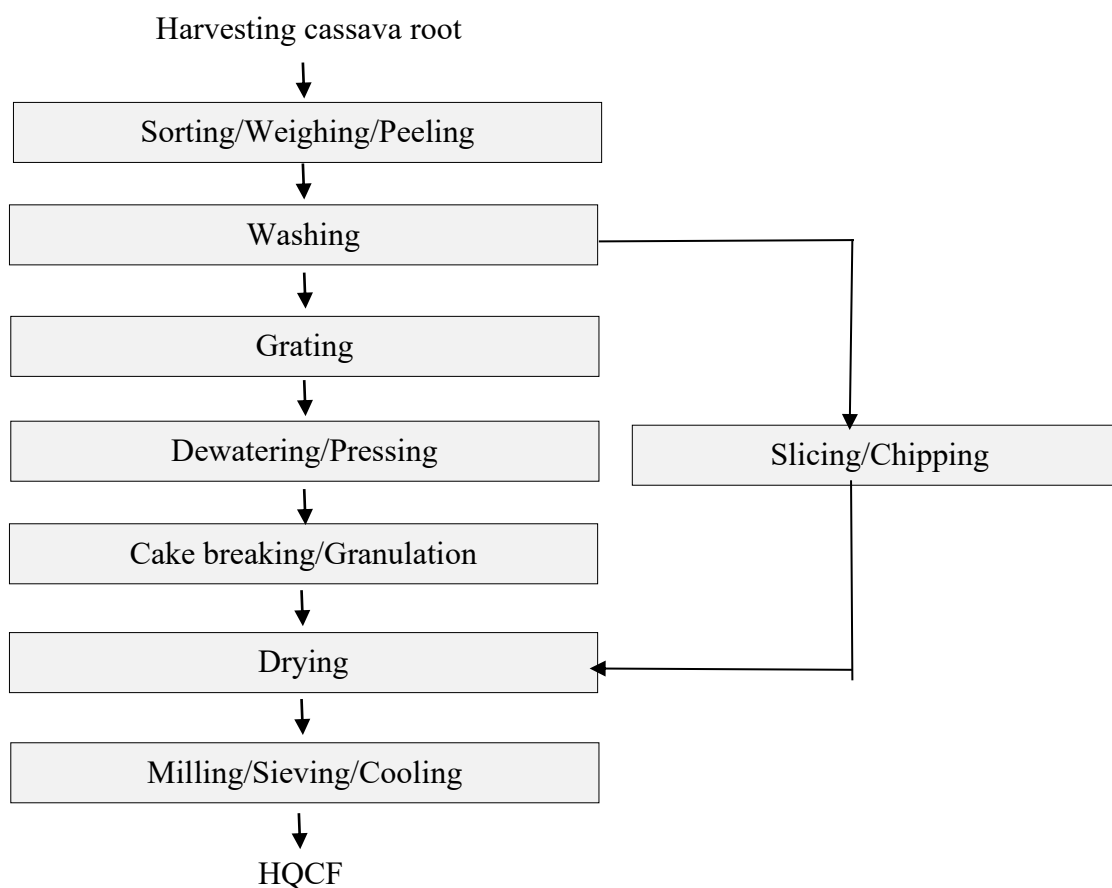


Fig. 1. Flow chart for the production of high-quality cassava flour
 Alimi et al. [5]

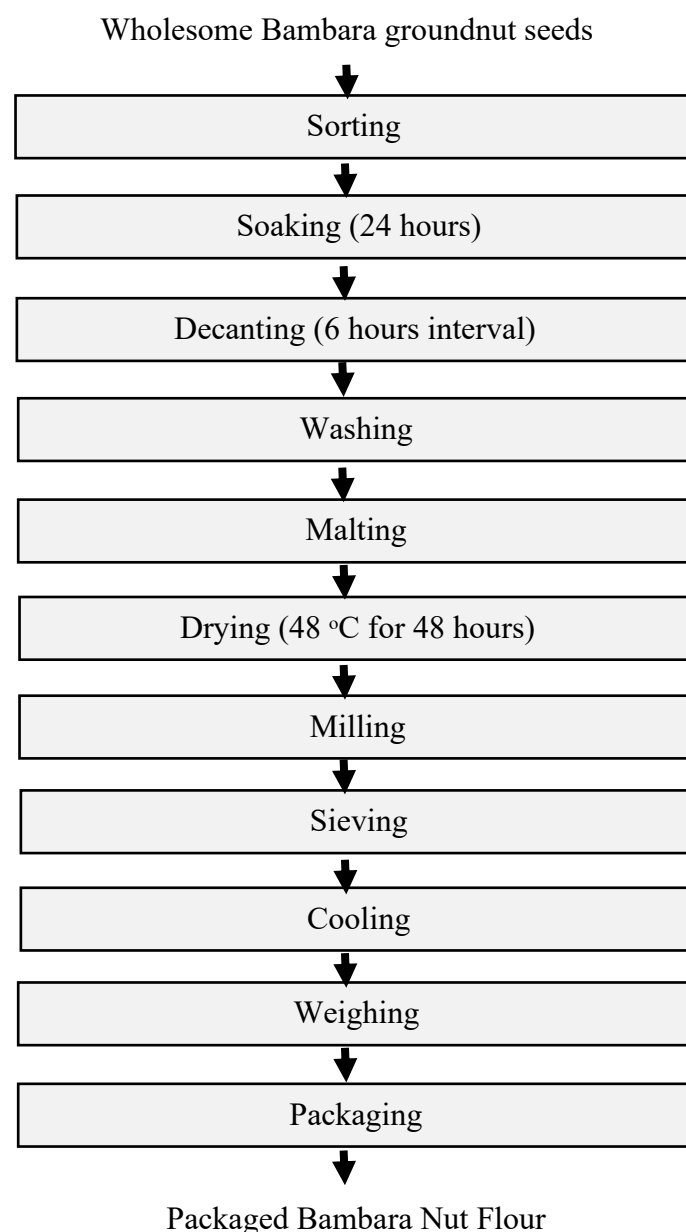


Fig. 2. Flowchart for the production of Bambara nut flour
Alimi et al. [5]

2.2.3. Production of tidbits

A composite flour formulation comprising 3 kg of high-quality cassava flour (HQCF) and 2 kg of Bambara groundnut (*Vigna subterranea*) flour was weighed and subjected to dry blending using a mechanical mixer to achieve uniform particle distribution. The dry phase was followed by the sequential incorporation of liquid constituents, including 250 mL of

potable water and other standardized wet ingredients. These were integrated through high-shear mixing until a homogeneous batter matrix was formed, ensuring consistent hydration and ingredient dispersion. The resultant paste was manually extruded into preheated groundnut oil, which had been fortified with freshly sliced *Allium cepa* (onion) to enhance organoleptic properties,

particularly flavour development via volatile sulphur compound release. The snack matrix was deep-fried in refined vegetable oil using a thermostatically controlled electric fryer (Model: Moulimex) at 190 ± 2 °C for 12 minutes, until reaching a Maillard-induced golden-brown colouration and achieving desirable textural attributes - crispy exterior and tender crumb

(Fig. 3 and 4). The thermal processing ensured adequate moisture reduction, enhanced shelf stability, and supported flavour compound development via lipid interaction and amino-carbonyl reactions. The fried tidbits were allowed to cool and then packed into high density polyethylene for airtightness to prevent moisture absorption.



Fig. 3. Pictorial view of tidbits after frying before packaging



Fig.4. Pictorial view of tidbits after packaging

2.2.4. Determination of profitability

To assess the annual economic viability of tidbits production utilizing high-quality cassava flour (HQCF) and Bambara nut flour (BNF), a budgetary analysis was conducted using the cost-return framework. This approach quantifies financial performance by computing net income, which represents the margin between total production costs and total revenue

generated. The overall profitability of the process is evaluated through key financial indicators, including the benefit-cost ratio, percentage net profit, operating efficiency ratio, and return on investment. The mathematical formulation of net income is presented in Equation 1 below.

$$NI = TR - TC \quad (1)$$

$$TC = TVC + TFC \quad (2)$$

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Where:

NI = Net Income (₦)

TR = Total Revenue (₦)

TC = Total Cost (₦)

TVC = Total Variable Cost (₦)

TFC = Total Fixed Cost (₦) (Total amount of depreciated equipment)

2.2.5. Conversion ratio and yield of tidbits produced with flour from cassava and Bambara nut

The composite flour, made up of three kilograms (3 kg) of high-quality cassava flour and two kilograms (2 kg) of Bambara nut flour (BNF), produced 5.35 kg of tidbits, yielding 53 units of 100 g each of packaged tidbit snacks.

3. Results and Discussion

The information on total revenue generated, total variable cost components, total fixed cost (TFC), depreciation of tidbit's production equipment, profitability indicators, and cost and returns analysis associated with tidbits' production are presented in Tables 2-7.

3.1. Total revenue generated on tidbit production

The result presented in Table 2 shows the total revenue generated from the production and sale of tidbits formulated from cassava and Bambara nut flour. The study revealed that a total of 144 production batches were carried out annually, based on a production frequency of twelve batches per month. At this production level, a total quantity of 770.4 units of tidbits was produced, generating an annual revenue of ₦9,158,400. The result indicates that the production of tidbits from cassava and Bambara nut flour possesses considerable economic potential and could serve as a viable agro-processing enterprise. The production frequency recorded in this study suggests that the processing operation was stable and sustainable throughout the year. Continuous production at twelve batches per month indicates consistent availability

of raw materials and the possibility of maintaining a regular market supply. This finding supports the growing interest in the utilization of composite flour from indigenous crops for commercial snack production. Studies have shown that cassava and Bambara nut flour blends can be effectively incorporated into snack and bakery products with acceptable functional and sensory qualities [13, 14]. The annual revenue generated from the enterprise demonstrates that value-added processing of cassava and Bambara nut can improve the economic value of these crops. Cassava is widely cultivated in Nigeria and is often consumed in traditional forms with relatively low financial returns. However, converting cassava flour into processed snack products increases its market value and creates additional income opportunities for processors and entrepreneurs.

Bambara nut, on the other hand, contributes nutritional quality, particularly protein enrichment, thereby enhancing product acceptability and consumer appeal. Similar observations were reported by researchers who noted that composite flour snacks enriched with Bambara nut possess improved nutritional and sensory characteristics that can support market competitiveness [15, 16]. The substantial revenue obtained in the present study further suggests that tidbit production could contribute to employment generation and rural economic development. Activities such as flour processing, frying, packaging, transportation, and marketing require labour input, thereby creating opportunities for income generation along the value chain. In addition, the commercialization of locally sourced snack products may reduce dependence on imported wheat-based snacks and encourage the utilization of indigenous raw materials. This aligns with findings from previous studies, which emphasized the economic and food security benefits associated with cassava-based food

processing and composite flour technology [17].

Furthermore, the revenue performance observed in this study indicates favourable consumer acceptance of the product. Consumer demand for convenient, ready-to-eat snacks continues to increase, particularly when products are affordable, nutritious, and properly packaged. The ability of the enterprise to generate over nine million naira annually implies that the tidbits were commercially attractive and marketable.

This reinforces the importance of product diversification and value addition in improving the profitability of underutilized

crops such as Bambara nut, which is now referred to as an opportunity crop.

The result demonstrates that the production of tidbits from cassava and Bambara nut flour is economically promising. The high annual revenue generated suggests that the enterprise can remain profitable when efficient production practices, quality control measures, and effective marketing strategies are maintained.

The findings, therefore, highlight the potential of composite flour technology in promoting food innovation, entrepreneurship development, and sustainable utilization of local agricultural resources.

Table 2.

Total revenue generated from tidbits' production			
Production and Revenue			
Parameter	Batches	Quantity	Price
Annual batch of production (i.e., 12 batches per month)	144	770.4	11,887.850
Total Revenue (₦)	9,158,400	(Price × quantity sold)	

3.2. Total variable cost on tidbit production

The result presented in Table 3 shows the total variable cost incurred during the production of tidbits formulated from cassava flour and Bambara nut flour. The total variable cost (TVC) was estimated at **₦7,934,400**, indicating the amount expended on operational inputs that vary

directly with the level of production. The cost components considered in the study included raw materials, labour, energy, packaging materials, and transportation/logistics. The distribution of these expenses provides important insight into the major factors influencing the profitability and sustainability of the enterprise.

Table 3.

Total variable cost components (TVC) of tidbit's production		
Cost Component	Amount (₦)	Description
Raw materials (HQCF & BNF, ingredients)	5,200,000	Cassava flour, Bambara nut flour, spices, oil
Labour (processing, packaging)	1,200,000	Labour valued
Energy (fuel/electricity)	650,000	Processing, frying, drying
Packaging materials	550,000	Nylon, labelling, sealing
Transportation & logistics	334,400	Distribution and input sourcing
Total Variable Cost (TVC)	7,934,400	Sum of all variable costs

Raw materials accounted for the highest proportion of the total variable cost, with an estimated value of **₦5,200,000**. This category covered the procurement of high-quality cassava flour (HQCF), Bambara nut flour, spices, vegetable oil, and other ingredients required for tidbit production. The high expenditure on raw materials suggests that ingredient sourcing remains the major determinant of production cost in snack manufacturing enterprises. This finding is expected because cassava flour and Bambara nut flour constitute the principal raw materials used in the formulation of the product. In addition, the increasing market prices of edible oil and food ingredients may have contributed significantly to the high cost recorded. Similar observations were reported in studies on composite flour snacks, where raw materials represented the largest share of production expenses due to the quantity of ingredients required for continuous processing [18, 14]. The labour cost of **₦1,200,000** represents the second-largest variable cost component in the production process. This cost covered processing activities such as mixing, frying, drying, packaging, and handling of finished products. The result indicates that tidbit production is relatively labour-intensive, particularly under semi-mechanized processing conditions. Labour remains essential in maintaining product quality, hygiene, and production efficiency. The substantial labour input observed in this study further suggests that the enterprise has the potential to create employment opportunities within the food processing value chain. Previous studies on snack processing from composite flours have similarly highlighted the importance of labour in ensuring efficient product handling and maintaining the sensory quality of processed snacks [15]. Energy cost amounted to **₦650,000**, covering fuel and electricity used during frying and drying, and other heat-related processing

operations such as sealing with impulse sealing machine during packaging. The relatively high energy expenditure may be associated with unstable electricity supply and dependence on alternative energy sources such as fuel-powered generators. Frying operations generally require considerable heat energy, thereby increasing operational expenses during large-scale production. This result agrees with reports that food processing enterprises in developing countries often experience elevated processing costs due to high energy demand and inconsistent power supply [18]. Packaging materials accounted for **₦550,000** of the total variable cost. This component included expenses related to nylon packs, sealing materials, and product labels. Packaging plays a critical role in maintaining product quality, extending shelf life, and improving consumer appeal. Proper packaging also enhances product safety and marketability, particularly for ready-to-eat snack products. The amount allocated to packaging in this study indicates the importance of presentation and branding in increasing the commercial value of the tidbits. Researchers have emphasized that appropriate packaging contributes significantly to consumer acceptance and competitiveness of locally processed snacks [17]. Transportation and logistics recorded the least cost component at **₦334,400**. This expense covered the movement of raw materials to the processing site as well as the distribution of finished products to markets and consumers. Although comparatively lower than other production costs, transportation remains an important operational factor capable of influencing profit margins, especially in periods of rising fuel prices and poor transportation infrastructure. Efficient sourcing and distribution systems are therefore necessary to minimize avoidable expenses and ensure timely product delivery. More importantly, the total variable cost obtained in this study

indicates that the production of tidbits from cassava and Bambara nut flour requires substantial operational investment, particularly in raw material procurement. Nevertheless, the observed cost structure suggests that the enterprise can remain economically viable when efficient resource management, improved processing methods, and proper market coordination are implemented. The findings further support the growing relevance of composite flour technology in promoting value addition, utilization of indigenous crops, and development of sustainable food processing enterprises.

3.3. Total Fixed Cost (TFC) of tidbits production

The result presented in Table 4 shows the total fixed cost (TFC) associated with the production of tidbits from cassava and Bambara nut flour. Fixed costs refer to expenses incurred on durable production assets that do not vary directly with the quantity of output within a specific production period. In this study, the total fixed cost was estimated at **₦10,335** per annum based on the depreciation values of the processing equipment and utensils used during production. The relatively low fixed cost recorded suggests that tidbit production can be established with modest capital investment, making it suitable for small- and medium-scale food enterprises.

The frying equipment had the highest purchase value of **₦25,000** with an annual depreciation cost of **₦5,000** using the straight-line depreciation method. Frying is one of the major processing operations involved in tidbit production; therefore, the importance of the equipment in ensuring product quality and processing efficiency cannot be overlooked. The higher depreciation value recorded for the frying equipment reflects its critical role in large-scale snack production. Adequate frying facilities contribute to uniform heat transfer, improved texture, and enhanced sensory characteristics of snack products [18]. The

result, therefore, indicates that investment in efficient frying equipment is essential for sustainable production and quality assurance.

The grinder recorded a purchase value of **₦20,000** with an annual depreciation cost of **₦4,000**. This equipment was necessary for size reduction, blending, and achieving uniformity in the composite flour mixture. Proper mixing of cassava flour and Bambara nut flour is important for obtaining a homogenous mixture of ingredients, desirable functional and nutritional properties in the final product. Studies on composite flour technology have emphasized the importance of adequate mixing equipment in improving flour homogeneity and product consistency [14]. The moderate depreciation cost observed in this study suggests that the grinder can provide long-term production value when properly maintained.

The sealing machine had a purchase value of **₦10,000** and an annual depreciation of **₦2,000**. Packaging and sealing are essential components of snack food processing because they help maintain product quality, prevent contamination, and improve shelf stability. Proper sealing also enhances the marketability of ready-to-eat products by improving appearance and consumer confidence. The inclusion of a sealing machine in the production process demonstrates attention to product preservation and commercialization. According to Ubbor *et al.* [15], packaging quality significantly influences consumer acceptance and storage stability of snack products developed from composite flours. Utensils and trays recorded the lowest purchase value of **₦6,675** with a depreciation value of **₦1,335** annually. Although these items are relatively inexpensive, they remain essential for handling, drying, cooling, and transferring products during processing. Their contribution to hygiene and operational convenience is important in maintaining

product safety and efficient workflow during production activities. The straight-line depreciation method adopted in the study assumes an equal reduction in asset value over the five-year useful life of the equipment. This method is commonly used in small-scale agro-processing enterprises because of its simplicity and ease of computation. The estimated annual depreciation values, therefore, represent the yearly fixed production cost attributable to equipment usage. Worth pointing out is the fact that the low total fixed cost obtained in this study indicates that tidbit production

from cassava and Bambara nut flour does not require highly sophisticated or excessively expensive equipment. This finding suggests that the enterprise is economically accessible to local processors, youth entrepreneurs, and small business operators interested in value-added food production. The affordability of the required processing assets may encourage wider adoption of composite flour technology, promote utilization of indigenous crops, and support income generation within the food processing sector.

Table 4.

Total Fixed Cost (TFC) of tidbit production				
Asset	Purchase Value (₦)	Useful Life (Years)	Depreciation Method	Annual Depreciation (₦)
Frying equipment	25,000	5	Straight-line	5,000
Mixer/grinder	20,000	5	Straight-line	4,000
Sealing machine	10,000	5	Straight-line	2,000
Utensils & trays	6,675	5	Straight-line	1,335
Total Fixed Cost (TFC)				10,335

$$\text{Depreciation Formula: Annual Depreciation} = \frac{\text{Cost of Asset}}{\text{Useful Life}}$$

3.4. Depreciation of tidbit production equipment

The results presented in Table 5 show the depreciation cost of equipment used in the production of tidbits from cassava and Bambara nut flour, as well as the level of production and market losses encountered during processing and distribution. These parameters are important in determining the economic efficiency and sustainability of

the enterprise because they directly influence production cost, product quality, and effective output available for sale.

The depreciation analysis revealed that the total annual depreciation cost of the production equipment was **₦10,335**. Depreciation represents the gradual reduction in the value of processing equipment over time due to continuous use and wear.

Table 5.

Depreciation of tidbit production equipment			
Asset	Cost (₦)	Useful Life (Years)	Annual Depreciation (₦)
Frying equipment	25,000	5	5,000
Mixer/grinder	20,000	5	4,000
Sealing machine	10,000	5	2,000
Utensils & trays	6,675	5	1,335
Total Depreciation (TFC)	–	–	10,335

Parameter	Value	Description
Production loss (%)	5%	Due to breakage, burning, and handling losses
Market loss (%)	2%	Unsold or damaged products
Effective output	93%	Adjusted saleable output

In this study, all assets were assigned a useful life of five years using the straight-line depreciation method. The frying equipment recorded the highest annual depreciation value of ₦5,000, followed by the grinder with ₦4,000, while the sealing machine and utensils had depreciation values of ₦2,000 and ₦1,335, respectively. The higher depreciation value associated with frying equipment indicates its central role in the production process and the intensity of its use during frying operations. Frying is a major processing stage in snack production because it contributes significantly to texture, flavour development, and overall product acceptability [18]. The grinder also contributed substantially to equipment depreciation because of its importance in achieving uniform blending and particle size reduction of cassava and Bambara nut flour. Proper mixing enhances flour homogeneity, which is necessary for producing tidbits with consistent quality and desirable sensory properties. Similar findings have been reported in studies on composite flour snacks where adequate processing equipment improved product quality and production efficiency [14]. The relatively lower depreciation values observed for the sealing machine and utensils suggest that these items experience less operational stress and may require less frequent replacement. The total depreciation cost obtained in this study indicates that the fixed asset requirement for tidbit production is relatively affordable and manageable for small-scale food processors. This finding suggests that the enterprise can be established with moderate capital investment, thereby encouraging entrepreneurship and local participation in value-added food processing. The use of simple and accessible equipment may further support the adoption of cassava and Bambara nut composite flour technology among rural and urban processors. The study further revealed a **5% production**

loss, which was attributed to breakage, burning, and handling losses during processing. Production losses are common in snack manufacturing, especially during frying, drying, packaging, and transportation operations. Breakage may occur during handling and packaging due to the fragile nature of fried snack products, while burning may result from excessive frying temperature or prolonged heat exposure. The level of production loss recorded in this study is relatively moderate and suggests that the processing operation was reasonably efficient. Nevertheless, minimizing such losses is important because they reduce the quantity of marketable products and may affect profitability. According to Ubbor et al. [15], improved processing control and proper handling techniques can significantly reduce physical losses in snack production systems. A further **2% market loss** was recorded due to unsold or damaged products. Market losses may arise from poor storage conditions, packaging defects, transportation damage, or reduced consumer demand over time. Although the percentage recorded was relatively low, it still represents a reduction in potential revenue. The result, therefore, highlights the importance of proper packaging, effective distribution systems, and market planning in ensuring product stability and consumer acceptance. Appropriate packaging materials and good storage practices are known to improve shelf life and reduce spoilage of snack products produced from composite flours [14]. The combined production and market losses resulted in an **effective output of 93%**, indicating that the majority of the produced tidbits were successfully retained for sale and consumption. This relatively high effective output demonstrates that the production process was economically efficient and capable of minimizing wastage to a reasonable level. The result also suggests that the product possessed

acceptable quality characteristics that supported marketability and consumer acceptance. The findings indicate that tidbit production from cassava and Bambara nut flour can be economically sustainable when appropriate equipment maintenance, careful processing operations, and efficient marketing strategies are implemented. The moderate depreciation cost and relatively low production losses observed in this study further confirm the potential of composite flour technology in supporting profitable small-scale snack production and promoting the utilization of locally available agricultural resources.

3.5. Profitability indicators for tidbits production from HQCF and BNF

The profitability analysis presented in Table 6 provides an economic evaluation of tidbits production from high-quality cassava flour (HQCF) and Bambara nut flour (BNF). The result shows the relationship between production costs, revenue generation, and overall financial performance of the enterprise. The profitability indicators obtained in this study demonstrate that the production of tidbits from cassava and Bambara nut flour is economically viable and capable of generating positive financial returns when properly managed. The total revenue (TR) realized from the enterprise was **₦9,158,400.00**, while the total variable cost (TVC) and total fixed cost (TFC) were estimated at **₦7,934,400.00** and **₦10,335.00**, respectively. The total cost (TC), obtained as the sum of variable and fixed costs, amounted to **₦7,944,735.00**. The result indicates that variable costs accounted for the major proportion of production expenses, while fixed costs contributed only a small fraction of the overall cost structure. This pattern is common in food processing enterprises where raw materials, labour, and energy expenses dominate operational expenditure [18]. The net income (NI) generated from the production enterprise was **₦1,213,665.00**, obtained after deducting

total production costs from total revenue. The positive net income recorded in this study indicates that the tidbit production enterprise was profitable within the production period considered. This suggests that the value-added processing of cassava and Bambara nut into snack products can provide sustainable income opportunities for processors and small-scale entrepreneurs. The profitability observed may be attributed to efficient utilization of local raw materials, favourable market demand for snack foods, and effective production management. Similar findings have been reported by Oluwamukomi et al. [14], who observed that composite flour-based snacks enriched with legumes possess commercial potential due to their nutritional quality and consumer acceptability. The gross margin (GM) of **₦1,224,000.00** further confirms the economic strength of the enterprise. Gross margin represents the difference between total revenue and total variable costs and reflects the enterprise's ability to cover fixed costs and generate profit. The positive gross margin obtained indicates that the enterprise generated sufficient income above direct operational expenses. This result implies that the production process was efficient enough to sustain ongoing production activities while still providing returns to the producer. According to Ubbor *et al.* [15], value-added snack production from composite flour blends can improve profitability through increased product diversification and enhanced consumer appeal. The benefit-cost ratio (BCR) of **1.15** indicates that for every ₦1.00 invested in the production enterprise, approximately ₦1.15 was realized as revenue. A BCR greater than one is generally considered an indication of economic viability and profitability. Therefore, the value obtained in this study suggests that tidbit production from HQCF and BNF is financially rewarding and worth investing in. The result supports the growing relevance of

cassava-based value addition and the utilization of underexploited legumes such as Bambara nut in food product development. The operating ratio (OR) recorded in the study was **86.7%**, indicating that approximately 86.7% of the total revenue generated was utilized in covering production costs. Although the ratio is relatively high, it still leaves a reasonable proportion of income as profit. Lower operating ratios are generally preferred because they indicate greater production efficiency; however, the value obtained in this study remains acceptable for a developing agro-processing enterprise where raw material and energy costs are substantial. The percentage net profit (PNP) of **13.3%** indicates that about 13.3% of the total revenue generated remained as net profit after all production expenses had been deducted. This result reflects the capacity of the enterprise to generate meaningful returns despite the operational costs involved. The profitability margin obtained suggests that the enterprise has the potential for long-term sustainability when efficient cost-control measures are implemented.

Similarly, the return on investment (ROI) of **15.3%** demonstrates that the enterprise generated a return of 15.3% on the total amount invested in production. A positive ROI indicates efficient utilization of

production resources and financial viability of the enterprise. The result, therefore, confirms that investment in tidbit production from cassava and Bambara nut flour can be economically beneficial, particularly for small- and medium-scale food processors seeking value-added opportunities in indigenous crops. Importantly, the profitability indicators obtained in this study reveal that the production of tidbits from HQCF and BNF is economically feasible and capable of generating appreciable financial returns. The positive values recorded for net income, gross margin, benefit-cost ratio, and return on investment demonstrate the commercial potential of the enterprise. The findings further emphasize the importance of composite flour technology in promoting food diversification, income generation, and sustainable utilization of locally available agricultural resources.

Profitability analysis was further validated through key financial indicators. The calculated benefit-cost ratio (BCR) of 1.15 signifies a profitable operation, as values exceeding 1 indicate that benefits were greater than the costs, positioning the enterprise as a potentially profitable investment [12, 19]. Specifically, for every ₦1.00 spent on tidbits processing, there was a return of ₦1.15, reinforcing the financial viability of the venture (Table 7).

Table 6.

Profitability Indicators for Tidbits Production from HQCF and BNF			
Indicator	Formula	Substitution	Result
Total Revenue (TR)			9,158,400.00
Total Variable Cost (TVC)			7,934,400.00
Total Fixed Cost (TFC)			10,335.00
Total Cost (TC)	$TC = TVC + TFC$	$7,934,400 + 10,335$	7,944,735.00
Net Income (NI)	$NI = TR - TC$	$9,158,400 - 7,944,735$	1,213,665.00
Gross Margin (GM)	$GM = TR - TVC$	$9,158,400 - 7,934,400$	1,224,000.00
Profitability Index			
Benefit Cost Ratio (BCR)	$BCR = TR / TC$	$9,158,400 / 7,944,735$	1.15
Operating Ratio (OR)	$OR = TC / TR \times 100$	$7,944,735 / 9,158,400 \times 100$	86.7%
Percentage Net Profit (PNP)	$(NI / TR) \times 100$	$(1,213,665 / 9,158,400) \times 100$	13.3%
Return on Investment (ROI, %)	$(NI / TC) \times 100$	$(1,213,665 / 7,944,735) \times 100$	15.3%

3.6. Cost and returns analysis for tidbits from HQCF and BNF

The results presented in Table 7 show the cost and returns analysis for tidbits produced from high-quality cassava flour (HQCF) and Bambara nut flour (BNF). The analysis provides important information on the economic performance, profitability, and financial sustainability of the production enterprise. The findings revealed that the production of tidbits from cassava and Bambara nut flour generated positive financial returns, indicating that the enterprise is economically feasible and commercially viable. The total revenue (TR) realized from the sale of the tidbits was **₦9,158,400.00**, while the total variable cost (TVC) incurred during production was **₦7,934,400.00**. The total fixed cost (TFC), represented by the depreciated value of processing equipment, was relatively low at **₦10,335.00**. Consequently, the total cost of processing (TC), obtained by summing the variable and fixed costs, amounted to **₦7,944,735.00**. The result indicates that variable costs constituted the major proportion of the production expenses, while fixed costs contributed minimally to the total production cost. This trend is commonly observed in agro-processing enterprises where raw materials, labour, and energy account for the largest share of operating expenses [18]. The net income (NI) obtained from the enterprise was **₦1,213,665.00**, indicating that the production venture generated substantial profit after accounting for all processing costs. The positive net income recorded demonstrates that the processing of cassava and Bambara nut flour into tidbits is financially rewarding and capable of generating income for processors and entrepreneurs. The profitability observed in this study may be associated with the utilization of locally available raw materials, efficient production processes, and consumer demand for affordable snack products. Similar studies have shown that

composite flour technology can enhance the commercial value of indigenous crops while promoting income generation and food diversification [14].

The gross margin (GM) of **₦1,224,000.00** further confirms the profitability of the enterprise. Gross margin represents the difference between total revenue and total variable cost and reflects the ability of the enterprise to cover direct operational expenses while still generating surplus income. The positive gross margin obtained suggests that the enterprise generated sufficient returns above the variable production costs. This indicates that the production process was operationally efficient and economically sustainable within the study period. The benefit-cost ratio (BCR) was estimated at **1.15**, indicating that every **₦1.00** invested in the production enterprise yielded approximately **₦1.15** in revenue. Since the BCR value is greater than one, the enterprise is considered profitable according to standard economic evaluation criteria. The result, therefore, demonstrates that the production of tidbits from HQCF and BNF is economically worthwhile and capable of providing returns above the production costs incurred. Previous studies on value-added snack production from composite flours have similarly reported favourable benefit-cost ratios due to increasing demand for nutritious and locally processed snack products [15].

The percentage net profit (PNP) recorded in the study was **13.3%**, implying that 13.3% of the total revenue remained as profit after deducting all production expenses. This value indicates a moderate profit margin and suggests that the enterprise can provide sustainable financial returns when proper cost management practices are maintained. The positive profit margin also demonstrates the economic advantage of utilizing cassava and Bambara nut flour in snack production, particularly considering the relatively low fixed cost requirement.

The operating ratio (OR) was estimated at **86.7%**, meaning that approximately 86.7% of the revenue generated was utilized in covering production expenses. Although the ratio appears relatively high, it still indicates that the enterprise retained part of the income as profit. High operating ratios are often associated with increased costs of raw materials, labour, and energy, which are major cost drivers in food processing operations. Nevertheless, the value obtained in this study remains acceptable for a developing agro-processing enterprise operating under fluctuating production and market conditions. The return on investment (ROI) was calculated as **15.3%**, indicating that the enterprise generated a return of 15.3% on the total capital invested in production activities. A positive ROI reflects efficient utilization of production resources and demonstrates the financial attractiveness of the enterprise. The result suggests that investment in tidbit production from cassava and Bambara nut flour can provide appreciable economic returns to processors, particularly small- and medium-scale entrepreneurs engaged in value-added food processing. Without mincing words, the findings from the cost and returns analysis demonstrate that tidbit production from HQCF and BNF is

economically profitable and sustainable. The positive values obtained for net income, gross margin, benefit-cost ratio, and return on investment indicate that the enterprise has strong commercial potential. The study, therefore, highlights the importance of composite flour technology in promoting value addition, enhancing the utilization of indigenous crops, supporting rural entrepreneurship, and improving income generation within the food processing sector.

Additionally, the return on investment (ROI) was estimated at 15.3%, indicating that for each ₦1.00 invested in the production of tidbits, the business realized a 15.3% increase in value. Moreover, the percentage net profit stood at 13.3%, meaning that 13.3% of the total revenue generated translated into net earnings. Consequently, for every ₦100 sold, a percentage net profit 13.3% was retained as net profit, underscoring the profitability of the enterprise [14]. Lastly, the operating ratio (OR), which measures the proportion of variable costs incurred per unit of sales, was found to be 86.7%. This implies that 86.7% of the variable costs were absorbed in production, while the enterprise continues to operate at an optimal level of efficiency.

Table 7.

Cost and returns analysis for tidbits from HQCF and BNF	
Parameters	Value (₦)
<u>Cost and Return</u>	
Total Revenue (TR)	9,158,400.00
Total Variable Cost (TVC)	7,934,400.00
Total Fixed Cost (TFC) (Depreciated value)	10,335.00
Total cost of processing (TC) (TVC+TFC)	7,944,735.00
Net Income (NI) = TR – TC	1,213,665.00
Gross margin (GM) = (TR – TVC)	1,224,000.00
<u>Profitability Index</u>	
Benefit cost ratio BCR = TR / TC	1.15
Percentage Net Profit (PNP)=(NI/TR) x 100	13.3%
Operating ratio (OR = TC / TR) x 100	86.7%
Return on Investment (ROI) = (NI / TC) × 100	15.3%
Source: Alimi et al. [5]	
Note: If BCR>1 = Profitable, BCR = 1 = Neither profitable nor Loss, and BCR<1 = Not profitable	

4. Conclusion

Quality tidbits (snacks) were successfully produced with blends of flour from cassava and Bambara nut seeds. Composite flour made up of three kilograms (3 kg) of high-quality cassava flour and two kilograms (2 kg) of Bambara nut flour (BNF) produced 5.35 kg of tidbits, yielding 53 units of 100 g each of packaged tidbit snacks. The calculated benefit-cost ratio (BCR) of 1.15 signifies a profitable operation, as values exceeding 1 indicate that benefits exceed costs, positioning the enterprise as a potentially profitable investment. Specifically, for every ₦1.00 spent on cassava tidbits processing, there was a return of ₦1.15, reinforcing the financial viability of the venture. Interestingly, for every ₦1.00 earned as revenue, ₦0.13 was retained as net income, underscoring the profitability of the enterprise. The study, therefore, highlights the importance of composite flour technology in promoting value addition, enhancing the utilization of indigenous crops, supporting rural entrepreneurship, and improving income generation within the food processing sector.

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