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Original Research Article

Techno-economic evaluation of probioticated *Kunu-zaki* drinks produced from millet and cocoa powder

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Abstract
This work aimed at evaluating the techno-economic analysis of the production of probioticated *Kunu-zaki* drinks using millet and cocoa powder. The production process was based on the assumption of a uniform cash flow over a period of 10 years. The equipment for the production process was identified based on the process flow chart. The *Kunu-zaki* production process was based on a constant mass flow of 7500 packets/hr while the sensitivity of the plant was examined by varying the plant operation days. The techno-economic analysis of the plant revealed that the capital cost and annual operation cost were ₦6.26 $\times 10^8$ and ₦2.67$\times 10^9$, respectively. The annual revenue after tax was ₦6.56 $\times 10^8$ while the return of investment, single payback period, discounted payback period, gross margin and internal rate of return were 64.1%, 1.56 years, 2.06 years, 23.11 and 82.38%, respectively. The sensitivity analysis of the plant revealed the feasibility of the plant at 330 and 300 operation days.

Keywords: *Probioticated Kunu-zaki, Techno-economic analysis, Internal rate of return, Food Security, non-alcoholic beverage*

1.0 Introduction

Milk and its fermented products, such as yoghurt, have been the probiotic carriers of choice for various reasons, including milk's recognition as a healthy product. However, more recent research efforts into the probiotic potentials of cereal-based beverages are yielding remarkable results. There is a wide variety of traditional non-dairy fermented beverages produced around the world, and many of them are non-alcoholic beverages manufactured with cereals as the principal raw material (Prado et al. 2008; Saleena et al., 2023).

According to Lamsal and Faubion (2009), cereal-based foods offer opportunities to include probiotics, prebiotics, and fibre in the human diet. Cereals contain water-soluble fibre (such as β-glucan and arabinoxylan), oligosaccharides (such as galacto- and fructo-oligosaccharides) and

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resistant starch have been suggested to fulfil the prebiotic concept.

Increasingly, whole grain matrix is becoming one of the favoured choices as a probiotics delivery vehicle. This is mainly because the formulation of probiotics with whole grain products offers consumers both probiotics and the aforementioned whole grain benefits, e.g., non-digestible carbohydrates, soluble fibre, phytochemicals, and other bioactive components (Lamsal and Faubion, 2009). This not only enhances the dietary value of the product but also appeals to an emerging consumer lifestyle.

Kunu-zaki is one of the most highly consumed cereal-based, non-alcoholic, non-carbonated beverages in Nigeria (Ayo et al., 2004). It is a fermented non-alcoholic cereal beverage whose popularity is due to its characteristic sweet-sour taste typical of lactic acid bacteria fermented foods of African origin (Efiuvwevwere and Akoma, 1995). Cereals used for *Kunu-zaki* include sorghum (Sorghum bicolour), millet (Pennisetum typhoideum), maize (Zea mays), rice (Oryza sativa), acha (Digitalis exilis) or wheat (Triticuma estivum) and other cereals which could be used in non-composite proportions. The traditional processing of *Kunu-zaki* involves the steeping of millet or sorghum grains, wet-milling with spices (ginger and pepper), wet-sieving and partial gelatinization of the slurry, followed by the addition of sugar and bottling. A brief fermentation usually occurs during *Kunu-zaki* processing. Due to the increasing consumption of *Kunu-zaki* drinks in Nigeria, there is a need to assess the feasibility of its production on a commercial basis. Therefore, the main objective of this study was to conduct engineering economic studies on the potential production of probioticated *Kunu-zaki* drinks of Cocoa blend packaged in a tetra pack.

2.0 Materials and Methods

2.1 Plant material

The probioticated *Kunu-zaki* production plant was assumed to be built in Oyo State (Nigeria) with the government of Oyo state incurring the land cost. The design of the plant was such that a total capacity of 13.94 tons per day of millet grain was converted into probioticated *Kunu-zaki* drink, hence in a year (330 days), a total of 4600.2 tons per year of millet grain would be utilized. This plant capacity was chosen based on the availability of millet grain which was the major raw material in Nigeria (National Bureau of Statistics, 2022). The probioticated *Kunu-zaki* beverage production plant lifetime was set to be 10 years.

2.2 Economic analysis

An economic evaluation of the production process system was based on the established processing conditions for probioticated *Kunu-zaki* production by Adebayo-Tayo e*t al*. (2016) and presented in Figure 1. The production process for the *Kunu-zaki* was based on a constant mass flow rate from an aseptic brick carton filling machine with a line production speed of 7500 packets per hour having a net volume of 1 litre per pack. The cost was based on this level for an industrial plant working one 8-hour shift for 330 days per annum (Ilori et al., 2015). The cost of purchasing new equipment (Table 1) was based on recent data from a variety of equipment manufacturers and suppliers and also based on information obtained from the internet on the price of equipment.

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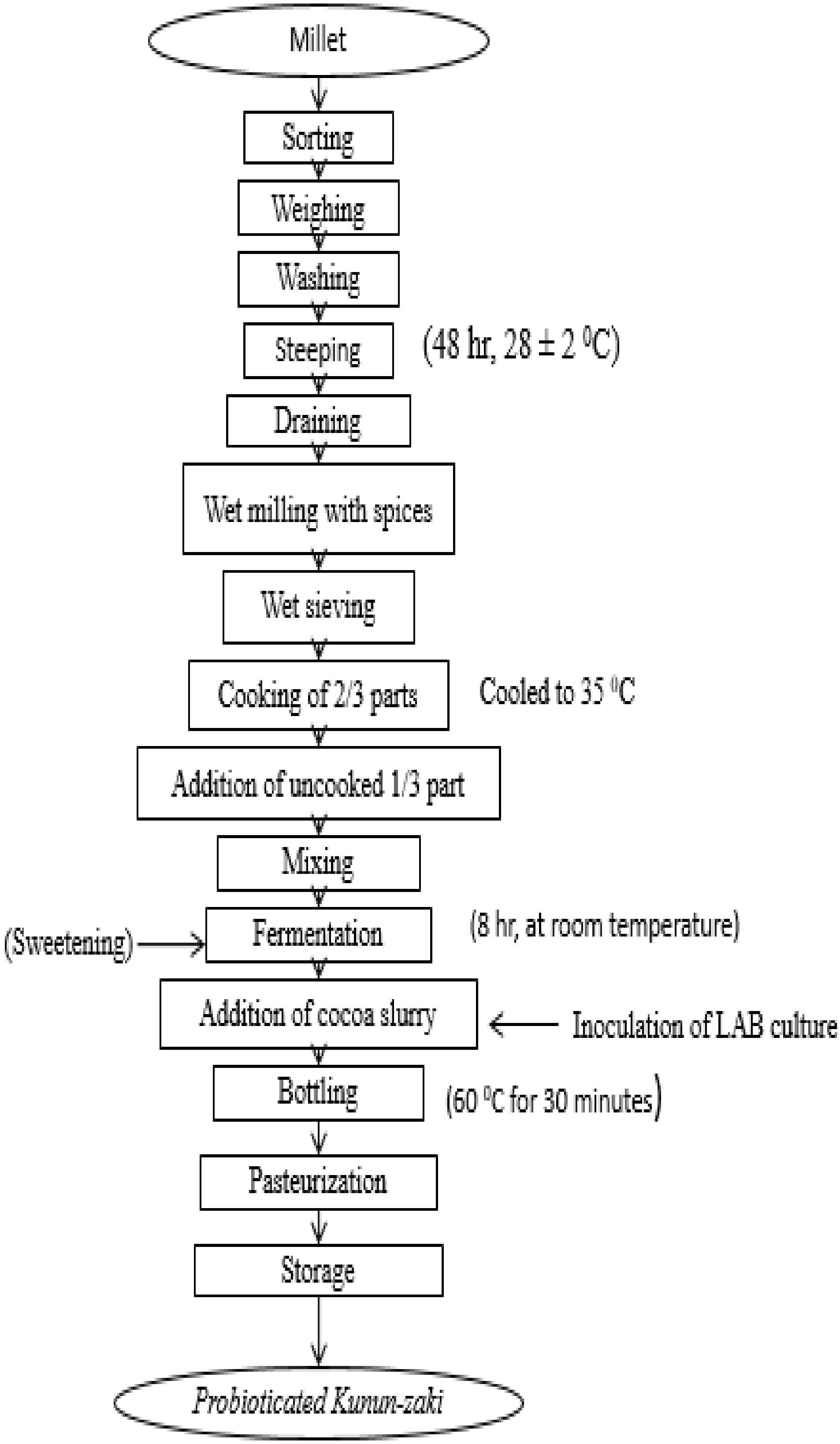

Figure 1. Flow chart for the production of probioticated *Kunu-zaki* drinks adapted from Adebayo-Tayo *et al*., (2016).

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Table 1: Estimate of major equipment and cost of probioticated *Kunu-zaki* in (1 litre) packet

Cost estimates, labour and utilities requirement						
Operation	**Equipment**	**Capacity**	**Number required**	**Cost (₦)**	**Labour Required**	**Electricity (KW/H)**
Weighing	Weighing Scale	8t/h	2	335500	1	2
Sorting	Sorting/sieving machine	11t/h	1	457500	1	7
Steeping	Steeping tank	500L	2	854000	1	
Washing	Washing machine	1t/h	2	1189500	1	3
Wet milling	Milling machine	1t/h	3	2836500	2	16.5
Wet sieving	Sieving/filtering Machine		2	1952000	1	3.5
Cooking	Stem Cooking jacket	20000l/h	3	2562000	2	1.5
Mixing	Mixer	5000L/h	2	3660000	1	15
Pasteurization	Pasteurizer		1	2592500	1	8
Packaging	Aseptic brick carton filling machine	7500 packs/h	1	61000000	1	40
Coding	Coding Machine		1	137250	1	1.2
Cartooning	Packaging table (5 x 8)		1	900000	3	
Boiler	Boiler		1	10705500		
Generator	Generator		1	9638000	1	
	CIP		1	1616500	1	4.3
	Well + Pump		1	1860500		
Total				101702250	18	100

An exchange rate of ₦1700 to US$ in November 2024 was assumed current prices of equipment.

Moreover, the chemical engineering plant cost index (CEPCI) was used to update the equipment cost to 2023 prices using the equation below.

$$\textit{Cost of Equipment in year A} = \textit{Cost of Equipment in year B} \times \frac{\textit{Cost index in year A}}{\textit{Cost index in year B}} \quad (1)$$

It was estimated that an average of 1000 litres of diesel at ₦1140/L would be used per month.

2.3 Total capital cost

Total capital cost (TCC) for the probioticated *Kunu-zaki* production plant was divided into two categories: fixed capital investment (FCI) and working capital cost (WCC). FCI consist of the equipment purchase cost and additional direct/indirect costs for building the plant. (Tang et al. 2016). Table 1 shows the price of equipment used in the *Kunu-zaki* production process as obtained from the equipment manufacturer and cost escalation from the previously known price of similar equipment. These prices are valid for November 2024 at the exchange rate of ₦ 1700 to US$1. In addition to the purchase of bare equipment, additional direct/indirect costs (such as installation, piping and construction) were also considered. Therefore, the TCC could be calculated according to Eq. (2).

$$\boldsymbol{TCC = FCI + WCC} \qquad (2)$$

The Lang method was used to estimate the fixed capital investment (FCI) from the process equipment cost C_{eq}, using the empirical equation (Coulson and Richardson, 2005; Peters et al., 2003; Zacharias and George, 2008):

$$\mathbf{FCI} = f_L C_{eq} \qquad (3)$$

Where f_L is the Lang factor and C_{eq} is the purchased equipment cost. A lang factor of 4.85 for slurry food was used. The working capital cost was estimated as a fraction of the fixed capital investment according to Zacharias and George (2008) using Eq. (4).

$$\mathbf{WCC} = f_{WF}\mathbf{FCI} \qquad (4)$$

Where f_{WF} is the working capital factor which is 0.25 for food processing plant

The establishment of the food processing plant was supported by the Ondo state government so land cost will not be taken into consideration.

2.4 Annual production cost

To estimate the annual production cost (APC), raw materials (RMC), utilities (UC), operating labour (OLC), maintenance and repair (MRC), laboratory cost (LC) and other necessary costs (OC) were considered and were calculated using the method described by Zacharias and George (2008) and represented by Eq. (5).

$$\boldsymbol{APC = RMC + UC + OLC + MRC + LC + OC} \qquad (5)$$

The essential materials required for the manufacture of the product are millet, cocoa powder, cloves, black and red pepper, and sugar lactic bacteria acid starter culture. The quantities required were multiplied by the operating hours per annum to get the annual requirements. Prices of the raw materials (obtained from the local market) fluctuate with the availability of the product. An average price is arrived at having taken into consideration the price difference at times of scarcity. Cost estimates of ₦60/unit were obtained for the packets (6×20cm) and ₦30/unit for the distribution carton (40×30×12cm). The outer carton would contain 12 units of the 1-litre pack.

The term utilities include power, steam, cooling, processing water and diesel. Energy consumption (kWh per 8-h shift) for the processing is described in Table 1. Electrical energy used by the various equipment was calculated from the electrical ratings specified by the manufacturers. The national rates for industrial users supplied by the public corporations were used (power at ₦256/KWh). The labour costs were evaluated based on labour requirements, qualifications, experience with similar processes and current wage levels. The numbers of operating labour were estimated as 1.5 times the calculated number from Table 1 to take of emergencies and operating supervision was 20% of the operating labour (Olawoye et al., 2017). The average wage rates including allowances in the

Nigerian food industries (as of 2024) were ₦70,000/month for casual workers, ₦80,000/month for factory workers, ₦90,000/month for supervisors and ₦100,000 for engineers. The numbers of factory operators required per unit of equipment are shown in Table 1.

Maintenance per annum was evaluated at 10% of the fixed capital cost, while straight-line depreciation was used to calculate plant depreciation expense throughout the plant life (Akanbi and Taiwo, 1999). Zero salvage value was assumed for the equipment at the end of its life. In addition to the above operating costs, other general expenses including taxes, insurance, charge capital, royalties, sales expenses, general overheads etc. were taken into consideration. Estimation of these costs is described by Zacharias and George (2008). The bank interest rates for lending and saving were 20% and 25%. The selling price of the processed product was estimated at cost price plus 30% profit. The production cost for a 1-litre tetra pack was calculated using Eq. (6)

$$\textbf{Production cost} = \frac{\textbf{Annual Production Cost}}{\textbf{Annual Production Rate}} \qquad (6)$$

2.5 Annual profitability

The economic feasibility of the production of probioticated *Kunu-zaki* beverage was evaluated using the net present value (NPV), which gives the profit of the plant for a certain period by considering the time of value of money. Other criteria such as internal rate of return (IRR), simple payback period (SPBP), discounted payback period (DPBP) and rate of investment (ROI) were calculated using the procedure described by Coulson and Richardson (2005) and Zacharias and George, (2008). These methods were chosen because they directly account for the time value of money and are considered superior. In this analysis, cash flows were assumed to be uniform throughout the plant life. The minimum attractive rate of return (M.A.R.R) was taken as the minimum bank interest rate of 26 %. The bank rates varied between 20-25 % depending on the bank policy. A tax of 30 % is deducted annually and there is a capital asset allowance of 40 % on new equipment purchases in the year. In this analysis, capital asset allowance was not deducted in the first year and it was assumed that no additional equipment would be purchased in the life of the project. This was done to allow a general assessment of what would have been greatly affected by the deductions. No tax holiday was allowed for the evaluation to obtain a true picture when accounting for all possible expenditures.

Table 2 shows how the cash flow was obtained. NPV was estimated using Eq.7 for uniform series payments.

$$NPV = -Inv + A[USPV_{i,N}] + \frac{VN}{(1+i)N} \qquad (7)$$

Where Inv is the initial investment, A is the annual cash flow, i is the interest rate or discount rate, USPV is the uniform series of payment value, N is the plant life and VN is the salvage value of the equipment. Since the salvage value for the equipment is zero, the Eq. (7) becomes

$$NPV = -Inv + A[USPV_{i,N}] \qquad (8)$$

2.6 Sensitivity analysis

The *Kunu-zaki* production was sensitive to some variables such as operating days and plant capacity utilization. Therefore, there is a need to consider sensitivity analysis for the *Kunu-zaki* production. The variables which are operating days (330, 300, and 250) and plant utilization capacity (100, 85, and 70 %). The effect of the fluctuation of the variables on the plant profitability was evaluated.

3. Result and Discussion

3.1 Analysis of total capital cost

As shown in Table 1, the total equipment cost was ₦1.02 × 10^8. From the equipment cost (Table 1), the FCI of ₦5.01 × 10^8 was calculated using the Lang method (Coulson and Richardson, 2005; Peters, West and Timmerhaus, 2003). WCC of 25 % of the FCI for the food processing plant was assumed and this amounted to ₦1.25 × 10^8. Therefore, the total capital cost for the establishment of the cookies production plant was ₦6.26 ×10^8. The fixed capital investment accounted for 80 % of the total capital cost while the working capital accounted for 20 %.

3.2 Annual production cost

The quantity of raw materials required for the production of cookies as well as their quotations were summarized in Table 2. The annual raw materials cost was ₦1.26 × 10^{10}/year with the cost of food materials (millet, sugar, cloves, black and red pepper, etc.) constituting the largest part (₦1.14× 10^{10}/year) while the cost of packaging material amounted to ₦1.24 ×10^9/year. Table 3 shows the annual production cost of the probioticated kunun production plant for different numbers of operation days per year. Considering the plant operating for 330 days, the annual operating cost, which includes the cost of labour, maintenance, raw materials, utilities, laboratory and equipment running cost, was estimated at ₦1.63 × 10^{10}/year.

Table 2: Annual cost of raw materials for the probioticated *Kunu-zaki* production plant

Raw Materials	Daily Quantity (Kg)	Annual quantity (ton)	unit cost per kg (₦)	Annualcost (₦)
Cloves	14.4	4.752	3334	1.58 × 10^7
Ginger	187.2	61.776	2500	1.54 × 10^8
Black Pepper	14.4	4.752	3333	1.59 × 10^7
Red Pepper	72	23.76	2500	4.16 × 10^9
Sugar	3600	1188	3000	3.42 × 10^8
Cocoa Powder	345.6	114.048	1400	1.43 × 10^8
Ammonium Bicarbonate	3	0.99	9000	8.91 × 10^6
Millet	13940	4600.2	1400	6.4 × 10^9
Acid regulator	60	19.8	3000	5.94 × 10^7
LAB culture	12.6	4.158	30000	1.25 × 10^8
Tetra Pack*	60000	19800000	60/packet	1.19 × 10^9
Cartoon*	5000	1650000	30/cartoon	4.95 × 10^7
Total Raw Materials Cost				1.26 × 10^{10}

An exchange rate of ₦1700 to US$ in November 2024 was assumed.

Table 3: Annual production cost of the *Kunu-zaki* production plant

	Estimate costs (₦)		
Parameter	**330**	**300**	**250**
Raw materials	1.26×10^{10}	1.15×10^{10}	9.54×10^{9}
(food materials)	1.14×10^{10}	1.04×10^{10}	8.63×10^{9}
Packets	1.19×10^{9}	1.08×10^{9}	9.01×10^{8}
Carton	4.95×10^{7}	4.5×10^{7}	3.75×10^{7}
Utilities	2.80×10^{8}	2.54×10^{8}	2.13×10^{8}
Electrical	2.03×10^{8}	1.84×10^{8}	1.54×10^{7}
Diesel	7.72×10^{7}	7.02×10^{7}	5.85×10^{7}
Maintenance	5.01×10^{7}	5.01×10^{7}	5.01×10^{7}
Labour	2.61×10^{7}	2.61×10^{7}	2.61×10^{7}
Laboratory cost	1.32×10^{6}	1.32×10^{7}	1.32×10^{7}
General Expenses	1.74×10^{8}	1.55×10^{7}	1.34×10^{7}
Annual operating cost	1.63×10^{10}	1.49×10^{10}	1.25×10^{10}
Unit production cost	823.61	829.58	832.16

An exchange rate of ₦1700 to US$ in November 2024 was assumed.

The raw materials cost was observed to constitute 74.51% of the operation cost. The food materials (millet, cloves, sugar, black and red pepper etc.) amount to 94.52% while the packaging material constitutes 5.48% of the raw materials cost. It was observed that the annual utility cost (CU) for the plant operation was ₦2.80×10^{8}/year. At a production rate of 125 tetra packs per minute, and 1 litre of product/packet, a total of 60000 units (125 packets x 60 min x 8h) of product would be produced a day (15840 gallons of product). The major component, millet, would be required to the tune of 4600.2 tonnes/year for a 330-day production cycle. The probioticated kunu-zaki drinks production project will require 18 numbers of staff; this includes 8 casual workers, 5 factory workers, 3 supervisors and 2 engineers. The annual operating labour cost would amount to ₦2.61×10^{7}. Furthermore, the annual plant maintenance cost was assumed to be 10% of the FCI which amounted to ₦5.01×10^{7}. The unit production cost of probioticated *Kunu-zaki* obtained from this study was ₦ 823.61 per 1-litre packet which was much lower when compared to the commercial price of similar products i.e. yoghurt (2000/1 litre packets) found in the Nigeria market. The lower unit production cost could be attributed to the lower cost price of major raw materials (millet, cloves, black and red pepper) used for the *Kunu-zaki* production.

3.3 Profitability

The main revenue of the plant was from the sales of the probioticated *Kunu-zaki* produced from the production process. Considering the production plant operating for 330 days per year, the unit sales price of 1 litre *Kunu-zaki* drink was ₦1070.70 which was much lower when compared to the sales (₦2000/1 litre packets) of commercial cookies found in the local market of Nigeria. The sales price of the *Kunu-zaki* amounted to annual revenue of ₦2.12×10^{10} as shown in Table 4. By accounting for the production cost, the annual profit of the plant before tax was ₦4.89×10^{9}. According to Nigeria Tax Law, an income tax of 30% was deducted from the annual profit which resulted in an income tax of ₦1.42×10^{9}. The annual cash flow obtained after which the income tax had been deducted from the annual profit stood at ₦3.52×10^{9} when the production plant works at full capacity.

Table 4: Annual profitability of the *Kunu-zaki* production plant

	330	300	250
Unit Sales price	1070.70	1078.45	1081.80
Annual Production rate	1.98×10^7	1.80×10^7	1.50×10^7
Annual Production cost	1.63×10^{10}	1.49×10^{10}	1.25×10^{10}
Annual Revenue	2.12×10^{10}	1.94×10^{10}	1.62×10^{10}
Profit	4.89×10^9	4.48×10^9	3.79×10^9
Before Tax Earning	4.94×10^9	4.53×10^9	3.79×10^9
Tax (30% BTE)	1.42×10^9	1.3×10^9	1.08×10^9
Cash Flow	3.52×10^9	3.23×10^9	2.72×10^9

An exchange rate of ₦1700 to US$ in November 2024 was assumed.

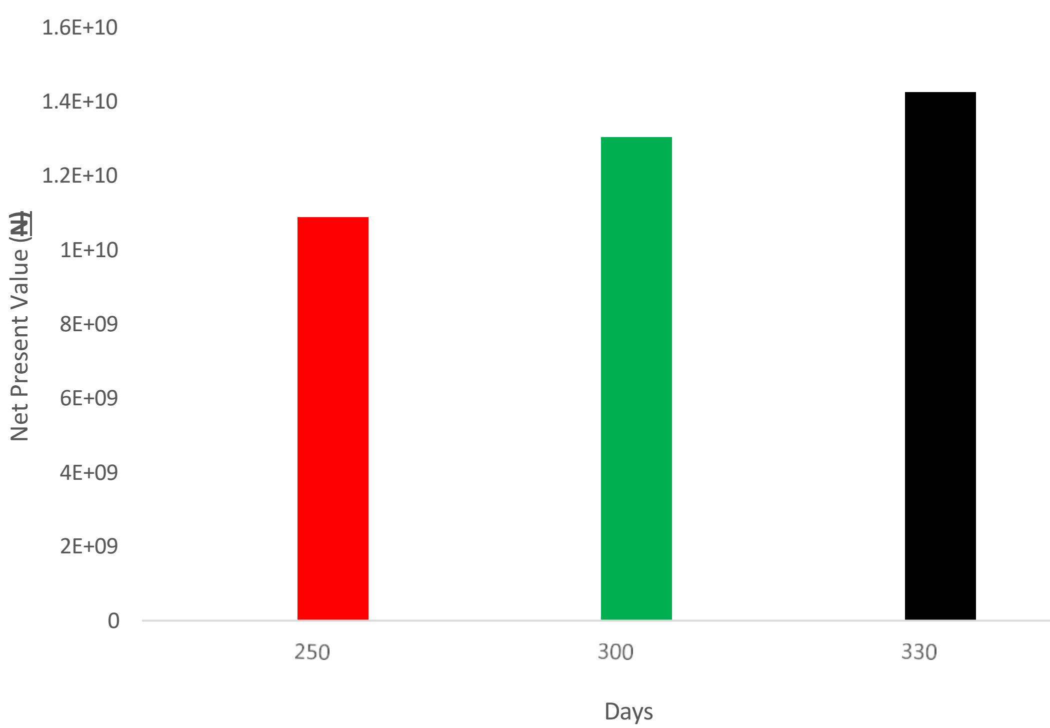

Figure 2 - The net present value at different days of operation

As shown in Figure 2, the net present value (NPV) of the whole project was equivalent to ₦1.43 $\times 10^{10}$ when the discount rate was 20%. The NPV for the project decreases as the discount rate increases. This result correlates with earlier reports by Kadiri et al. (2016) and Taiwo et al. (1997). Apart from the NPV, DPBP and the IRR were used to evaluate the profitability of the processing plant. The discounted payback period is the time (t) at which the NPV equals zero which is also the time to recover the FCI. As shown in Table 5, the DPBP value of the plant operating for 330 days was 2.06 years. The IRR is the interest (or discount rate) for which the NPV is equal to zero. At present in Nigeria, the minimum acceptable rate is 27%. When the NPV became zero, the discount rate was 82.38% which was also considered to be the internal rate of return (IRR). The IRR as an economic index of a project is acceptable when the IRR is equal to or greater than the minimum acceptable rate and rejected when the IRR is lower. The higher IRR showed the more attractiveness of the project. Moreover, several non-discounted (time value for money is not considered) profitability criteria were calculated for the cookies plant. This includes the SPBP, the ROI and the gross margin. The SPBP is the time in which the cumulative cash flow (CCF) equals zero and the ROI is the percentage of that money recovered annually from the plant's profit (ROI% = Profit/FCI). The gross margin is the ratio of the annual profits divided by the annual revenues. The values for these above profitability criteria with respect to plant operation days are presented in Table 5. The simple payback period was 1.56 years when the plant was operated for 330 days annually. The higher discount rate led to a lower NPV and a longer payback period. It meant that the project became less attractive when the discount rate increased as shown in Figure 3. The positive NPV was a key value to determine the feasibility of the project. Based on the above analysis, this project was economically feasible.

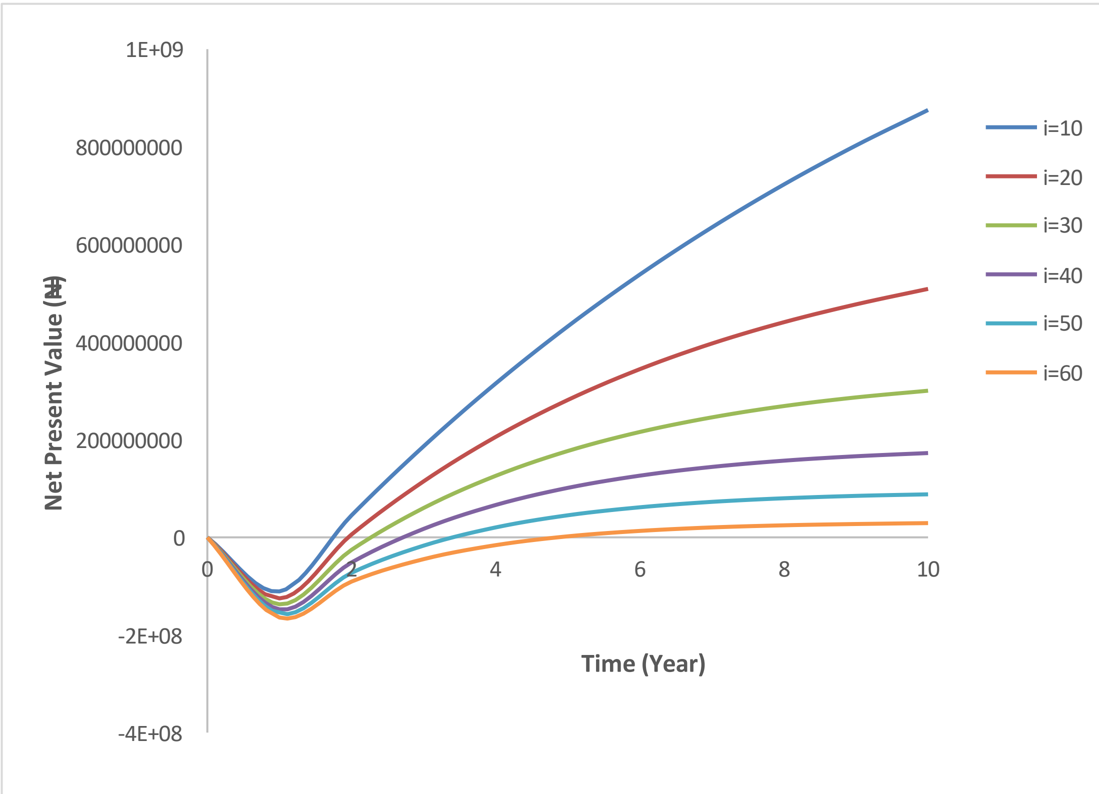

Figure 3 - Net present value at different discount rates

Table 5: Profitability indicators of the *Kunu-zaki* production plant

	330	**300**	**250**
NPV (₦)	1.43×10^{10}	1.30×10^{10}	1.09×10^{10}
IRR (%)	82.38	82.24	81.95
ROI (%)	64.10	57.14	44.05
Gross Margin (%)	23.11	23.19	22.84
SPBP (years)	1.56	1.75	2.27
DPBP (years)	2.06	2.37	3.32

An exchange rate of ₦1700 to US$ in November 2024 was assumed.

Table 6: Economic analysis for the production of *Kunu-zaki* for 330 days in the year at different plant capacities

	Estimated cost (₦) at different plant capacity		
	100%	**85%**	**70%**
Raw materials	1.26×10^{10}	1.07×10^{10}	8.82×10^{9}
(food materials)	1.14×10^{10}	9.69×10^{9}	7.98×10^{9}
Packets	1.19×10^{9}	1.01×10^{9}	8.33×10^{8}
Carton	4.95×10^{7}	4.21×10^{7}	3.47×10^{7}
Utilities	2.80×10^{8}	2.80×10^{8}	2.80×10^{8}
Electrical	2.03×10^{8}	2.03×10^{8}	2.03×10^{8}
Diesel	7.72×10^{7}	7.72×10^{7}	7.72×10^{7}
Maintenance	5.01×10^{7}	5.01×10^{7}	5.01×10^{7}
Labour	2.61×10^{7}	2.61×10^{7}	2.61×10^{7}
Laboratory cost	1.32×10^{6}	1.32×10^{6}	1.32×10^{6}
General Expenses	1.74×10^{8}	1.49×10^{8}	1.25×10^{8}
Annual operating cost	1.63×10^{10}	1.39×10^{10}	1.16×10^{10}
Unit production cost	823.61	828.57	835.67
Unit Sales price	1070.	1077.15	1086.37
Profit	4.89×10^{9}	4.18×10^{9}	3.48×10^{9}
Before Tax Earning	8.51×10^{8}	4.23×10^{9}	3.52×10^{9}
Tax (30% BTE)	1.95×10^{8}	1.21×10^{9}	9.97×10^{8}
Cash Flow	3.52×10^{9}	3.02×10^{9}	2.53×10^{9}
NPV	1.43×10^{10}	1.22×10^{10}	1.01×10^{10}
IRR (%)	82.37	82.14	81.80

An exchange rate of ₦1700 to US$ in November 2024 was assumed.

3.4 Sensitivity

A reasonable return on investment needs to be considered for investment in the *Kunu-zaki* production plant. Therefore, a sensitivity analysis was carried out to examine the effects of uncertainties in the forecasts on the viability of a project. The effect of varying production days and plant utilization capacity on the economic performance of the plant is represented in Tables 3, 4, 5, and 6. As expected, as the number of operating days and plant utilization capacity decreases, the cost of raw materials, general expenses and utility decreases proportionately. Only labour costs are unchanged. This was based on the assumption that the operators are regular salary earners. The product cost per unit increased as the number of production days and plant utilization capacity decreased. This may be attributed to certain general expenses that are incurred whether the plant is producing or not. Reducing the number of operating days from 330 to 300 days caused a 0.61 % increase in unit production cost while a further decrease to 250 days resulted in a 1.94% increase in the unit cost of production. Similarly, decreasing the plant utilization from 100% to 85 and 70% caused a 1.07 and 2.6% increase in the unit production price of the *Kunu-zaki* drink. The proportion of increase above also affects the selling price of the production in a similar trend. As shown in Tables 4, 5, 6 and Figure 2, both the annual profit and NPV decrease as the plant operation days and plant utilization capacity decrease. The positive NPV at different operation days and plant utilization capacity show the viability of the plant.

4.0 Conclusion

This study evaluates the economic production of cookies for different production schedules per annum, i.e. the number of days. The total capital investment of ₦6.26 $\times 10^8$ and the total production cost of ₦1.63 $\times 10^{10}$/year were calculated respectively when the plant was operating for 330 days. The total revenue after tax was ₦3.52 $\times 10^9$/year, which is majorly from the sales of probioticated *kunu-zaki* drinks produced from the operation. The return on investment was 64%, the single payback period and discounted payment period were 1.56 and 2.06 years respectively, while the internal rate of return was 82.38%. Sensitivity analysis revealed that a reduction in plant operating days, as well as plant utilization capacity, increased the unit production cost of the *Kunu-zaki* drink. The large NPV estimated for the probioticated *Kunu-zaki* drink production plant as well as the affordable selling price could serve as an incentive to entrepreneurs who wish to invest in probioticated *Kunu-zaki* production.

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Conflict of interest

There is no conflict of interest among the authors.

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