

## Cost-Benefit Analysis of Kodo Millet Flour and Whey Protein Concentrate Based Low Fat Fiber Enriched Chicken Nuggets

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### Abstract

*The standardization of formulation and economic analysis of the development of Kodo Millet flour and whey protein concentrate based low fat fiber enriched chicken nuggets was worked out to propose a profitable processing model for chicken nuggets to tap the potential of increasing demand for functional animal based foods and local and national markets. The net initial investment for starting a business of chicken nuggets of 50 kg capacity per day was worked out to be about Rs 10 lakh. Daily net returns were recorded at Rs 2,997.19 for the treatment product and Rs 2,021.59 for the control. The benefit-cost ratio was 1.14 for treatment and 1.10 for control. The break-even output was 11.81 kg for treatment and 12.18 kg for control, well below actual production, offering safety margins of 74.88 per cent and 73.09 per cent, respectively. The payback period was 1.11 years for treatment and 1.65 years for control, with returns on investment of 90 per cent and 61 per cent, respectively. This venture can generate consistent income and jobs, especially for small-scale farmers, and supports agricultural diversification in Punjab, addressing economic challenges in the sector.*

**Key words:** Break even point, Fixed cost, Net returns, Payback period, Value addition, Variable cost.

**JEL Classification:** Q12, Q13, D61, L66

### Introduction

India's agricultural economy heavily relies on livestock production, which boosts the Gross Domestic Product (GDP) of the nation. After milk production, meat and egg production is the second most important component of livestock sector which provide regular source of income and employment to rural masses. Within the meat sector, poultry/ chicken meat is most important sector in India. Poultry farming comprises of layer farming for egg production and broiler farming exclusively for meat production. Poultry meat, rich in vitamins and proteins, is widely accepted meat in India being cheaper than goat and sheep meat.

Being good source of supplementary income and livelihood, livestock sector contributes 30.19 per cent and 38.44 per cent of the GDP in India (GOI, 2024) and Punjab (GOP, 2023), respectively. After the United States, India is the world's seventh-largest producer of chicken meat. Due to growing consumer demand for poultry products, the sector has seen exponential growth. A significant portion of the Indian population prefers poultry meat, especially chicken, as a source of protein due to its affordability and adaptability to different culinary cultures. India is a lucrative

market for poultry because of its widespread consumption of poultry meat, which is well-known for its nutritional value and affordability. In Punjab, a state in India known for its rural ability, domesticated animals make a significant contribution to the agricultural economy. Poultry farming, specifically broiler farming for meat production, has emerged as a productive endeavour inside the livestock farming.

Poultry meat contributes 10.91 per cent and 5.85 per cent to total value of output from livestock in India and Punjab, respectively (GOI, 2023). India contributes for around 3.05 per cent of world meat output. (FAOSTAT, 2023). Meat output in India in 2014-15 was 6.69 million tonnes, with further growth to 10.25 million tonnes in 2023-24 (GOI, 2024). Punjab produced 2.57 per cent of the meat in India (GOI, 2024). Availability of poultry meat is 3.63 kg/capita/annum in India and 4.16 kg/capita/annum in Punjab (GOI, 2024 and GOP, 2023) against the per capita requirement of 10.08 kg of meat as per recommendations of Indian Council of Medical Research (ICMR). The poultry enterprise has enough potential for creating additional incomes and employment.

The broiler farming provides financial and nutritional security and regular income to the households. There were about 2981 broiler farms in Punjab producing 114.51 million

broilers annually during 2021-22. Two types of production systems exist in broiler farming: contract and independent (non-contract) broiler farming. Independent (non-contract) broiler farmers run their business with their own resources and can earn good profit or incur loss depending upon market prices of the output, cost of various inputs used at the farm along with productivity levels, whereas under contract farming, companies provide fixed remuneration to the farmers on per kg live weight basis and bear all the market risk themselves. The independent boiler farmers can be benefitted a lot if they go for value addition of broiler meat into various types of value added chicken meat products.

Through processing, value can be added to the produce and increase the monetary returns. The processing function has two fold benefit viz. Enhancing the shelf life of the raw produce and at the same time increasing the profit margins for the farmers/ entrepreneurs. In Addition, it also provides ample opportunities for self employment and creating employment for others as well. It also absorbs the surplus family labour. All this creates an excellent opportunity for Indian meat processing industry to produce processed meat products that would not only harness the livestock wealth of the country but also boost exports, earn valuable foreign exchange and increase the contribution of livestock sector in GDP.

Chicken meat is widely consumed across the globe due to the absence of any religious taboos and a healthier meat that is available at a cheaper price. Chicken nuggets are a popular food item widely consumed both in fast food chains and household meals. Traditionally, nuggets are prepared by using ground chicken meat that is shaped and breaded, followed by cooking by frying, baking or steaming. In general, these nuggets have high-fat content and additives and are deficient in dietary fibres and essential nutrients. Thus, researchers and food technologists have been exploring healthier formulations for the development of meat nuggets by incorporating plant-based ingredients aimed at enhancing the nutritional value of chicken nuggets without compromising their sensory qualities.

Consumer preferences are steadily shifting toward healthier and more sustainable food choices, such as low-fat and high-fibre food products. An increasing number of individuals are looking for foods that satisfy taste preferences and deliver added health benefits. This change in consumer behaviour further increases the demand for functional food products that positively affect health and cater to basic nutritional value, owing to the presence of biologically active compounds. Functional ingredients like whole grains, seeds, millet, and legumes have gained significant interest in food science due to their associated health-promoting properties. These components are rich sources of dietary fibre, essential vitamins and minerals, antioxidants, and various bioactive compounds that contribute to improved health outcomes

Therefore, with the aim to harness the opportunity in

global and domestic functional food market, formulation for preparation of low fat chicken nuggets incorporated with Kodo Millet flour and whey protein concentrate was standardised and its cost and returns were worked out so as to establish its economic viability.

### **Data Sources and Methodology**

The place of the study was the Department of Livestock Products Technology (LPT) in College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), (Ludhiana), Punjab, India. The developed product was sold to the local population of the city.

Ludhiana is an industrial city in Punjab with wide variations in household incomes. Food habits in Punjab favour non-vegetarians across a wide section of society, with Ludhiana not an exception. Ludhiana, being an industrial city, comprises a population of working people with fairly good incomes. Busy working hours and tiring work schedules leave the majority of people with processed food as a favoured choice. This provides a potential market for processed meat foods throughout the year.

Live broiler chicken was obtained from the Poultry Farm at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab. The birds were humanely slaughtered in the Experimental slaughterhouse of the Department of Livestock Products Technology, GADVASU, Ludhiana. External fat, fascia and other connective tissues were manually removed by hot deboning the carcass. The deboned meat was collected and chilled overnight at refrigeration temperature (4°C), then packed in low-density polyethylene (LDPE) bags of 200 gauge and stored at -18 °C for use within three months. Kodo millet flour and whey protein concentrate were sourced from local market. Ingredients such as spices (for the formulation of spice mixture) and condiments (onion, ginger, garlic; 3:1:1) used in the study were purchased from local markets.

The spices were thoroughly cleaned and dried in an industrial dryer at 60±2°C for 24 hours before being separately ground into a fine powder using a domestic grinder. The spice mix was created by combining various spices according to the formulation developed in the laboratory, then stored in a moisture-free polyethylene terephthalate (PET) jar for future use. The condiment mix was achieved by combining onion, ginger, and garlic paste in a 3:1:1 ratio. Table salt from Tata Chemicals Ltd. in Mumbai and refined soybean oil from Fortune, Adani Wilmar Ltd, were sourced from the local market.

The frozen, de-boned meat was thawed in the refrigerator for 12 to 14 hours before being cut into small pieces of approximately of 1 inch<sup>3</sup>. It was then minced once through a 6 mm plate and again through a 4 mm plate using a meat mincer (Mado Eskimo Mew-714, Mado, Germany). An emulsion was prepared using a bowl chopper (Model: TC11,

Scharfen, Germany), and the formulation was used to replace lean meat as per Table 2. Cooking yield increased with the incorporation of KMF and WPC, so in the treatment, the cooking yield was around 94 per cent whereas in the control, it was 90.50 per cent. Hence, the final output quantity varied for treatment and control and it was 47.02 Kg for treatment and 45.25 Kg for control.

#### Assumptions in computation of production cost:

The current study is based upon the following certain assumptions:

- The entrepreneur has his own poultry farm from which poultry birds are processed on regular basis.
- The developed chicken nuggets could be sold locally without any need for market intermediaries/ channels/ cold chain facilities.
- No problem for demand of the developed product due to rising income levels, urbanization and increasing health awareness among the consumers.
- Three laborers were employed @ Rs. 350 per day and no management cost was taken into account.
- The use or income from by-products was not considered.
- Material which was used in preliminary trials for the purpose of standardization of formulation was not considered.
- Marketing cost has been considered as 10 per cent of the variable cost.
- Price of the control product was taken at Rs. 500/- per Kg considering the price of raw chicken meat prevalent in the unorganised market in India, and price of developed chicken nuggets in the study was taken @ Rs. 530/- per Kg due to its higher quality and health benefits.
- Building rent was taken as Rs. 30,000 per month per hall for a floor space of 15' feet X 15' in suburbs.
- Prevalent market rates were considered for costing the raw material and packaging material.
- Actual life of the equipments and machinery was taken into consideration and its junk value was taken as 5 per cent of the initial value.
- Rate of interest on capital invested was considered to be 10 per cent.

#### Formulas used:-

##### Cooking yield

$$\text{Cooking yield \%} = \frac{\text{Initial pre-cooked weight}}{\text{Final cooked weight}} \times 100$$

##### Depreciation

Depreciation was calculated using Straight line method.

$$\text{Annual Depreciation} = \frac{\text{Initial cost-junk value}}{\text{Number of useful years}}$$

##### Break even output

Contribution per unit = Total returns per unit - Total variable cost per unit

$$\text{Break-even output (units)} = \frac{\text{Total Fixed costs per day}}{\text{Contribution per unit}}$$

Margin of safety = Total output - Break even output

$$\% \text{ Margin of Safety} = \frac{\text{Margin of safety}}{\text{Total output}} \times 100$$

##### Benefit- cost ratio

$$\text{Benefit-Cost ratio} = \frac{\text{Gross returns}}{\text{Total cost}}$$

##### Returns

$$\text{Net Returns} = \frac{\text{Gross returns}}{\text{Total cost}}$$

##### Value addition

Per cent value addition = Net returns per day/ Value of raw chicken \* 100

##### Payback period

Payback period (Years) = Initial capital investment/ Net returns per year

##### Returns on Investment

Returns on Investment (ROI) per cent = Net returns per year/ Initial capital investment \* 100

## Results and Discussion

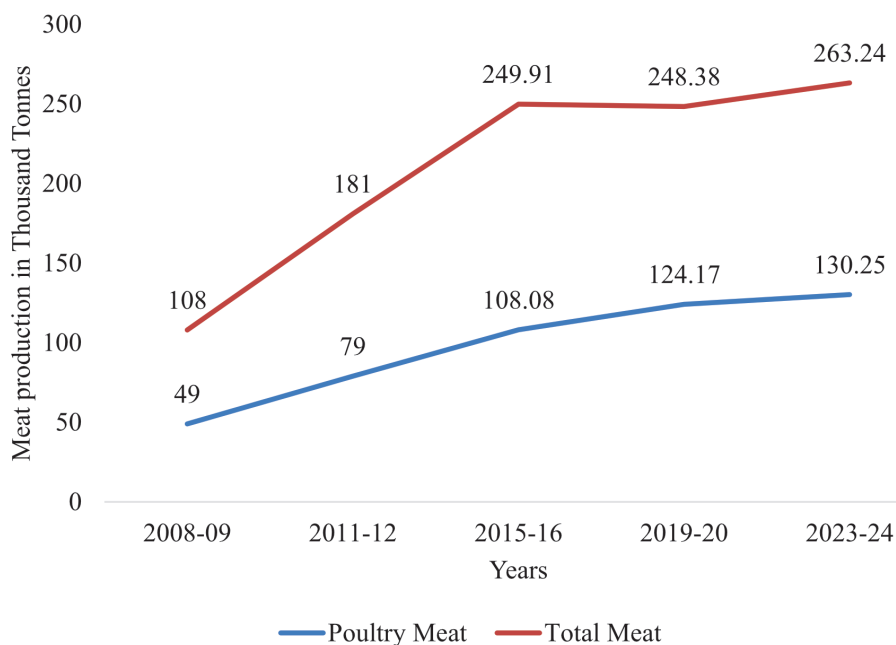
### Meat production in Punjab and India

Species wise meat production in Punjab and India has been presented in Table 1. A perusal of the table revealed that total meat production in Punjab was 263.25 thousand tonnes during 2023-24 which was 2.57 per cent of total meat production of India (10252.7 thousand tonnes). In a species-wise analysis, it has been observed that the contribution of poultry meat was highest both in Punjab (49.48%) and India (48.96%). This proportion signifies the importance of poultry meat in Punjab as well as India. Figure 1 shows the trends in poultry meat and total meat production in Punjab from 2008-29 to 2023-24. Total meat production has increased from 108 thousand tonnes during 2008-09 to 263.24 thousand tonnes during 2023-24 at an annual growth rate of 9.58 per cent. Further, poultry meat increased from 49 thousand tonnes to 130.25 thousand tonnes during the above time period at an annual growth rate of 11.05 per cent. The farmers are getting regular income and employment from poultry farming. To further enhance the income and profit levels of the farmers, there is urgent need of value addition of raw chicken meat into value added meat products which have higher shelf life also compared to raw meat.

**Table 1: Species wise meat production in Punjab and India during 2023-24**

Species	(000 tonnes)			
	Punjab	%	India	%
Cattle	0	0.00	266.4	2.60
Buffalo	117.06	44.47	1854.64	18.09
Sheep	5.22	1.98	1141.45	11.13
Goat	9.82	3.73	1588.94	15.50
Pig	0.9	0.34	381.81	3.72
Poultry	130.25	49.48	5019.41	48.96
<b>Total</b>	<b>263.25</b>	<b>100.00</b>	<b>10252.7</b>	<b>100.00</b>

Source: Basic Animal Husbandry Statistics (BAHS) 2024, GOI

**Figure 1: Poultry Meat and Total Meat trends in Punjab**

#### **Formulation for preparation of low- fat chicken nuggets incorporated with Kodo Millet flour and WPC**

Three different levels of Kodo millet flour viz. 10 per cent, 15 per cent and 20 per cent were tried for incorporation in chicken nuggets. On the basis of physicochemical, proximate, colour, texture and sensory attributes, 15 per cent KMF was selected. Similarly, three different levels of WPC viz. 2 per cent, 3 per cent and 4 per cent were tried in 15 per cent KMF incorporated chicken nuggets and out of these, 3 per cent level of incorporation of WPC was selected. The treatment involved adding 15 per cent Kodo Millet Flour (KMF) and 3 per cent Whey Protein Concentrate (WPC), which were then compared to a control that did not include KMF and WPC. Minced meat was chopped for one minute after being mixed with salt, nitrite and Sodium Tetra Pyrophosphate (STPP). The mixture was combined with ice flakes and chopped for

an additional minute (Table 2). Throughout the process, the temperature was kept below 10°C by using ice flakes. Finally, the emulsion was placed in stainless steel molds and cooked in an autoclave at 121°C for 15 minutes under 15 psi. The cooked nuggets were allowed to cool to room temperature before samples were collected for various analyses.

The protocol for developing chicken meat nuggets was standardized after numerous trials with varying ingredient levels in the formulation mix, adhering to the principles of meat processing technology. The finalized formulation mix was approved for nugget production following the standardization of cooking time and temperature settings.

#### **Cost returns structure**

Evaluating the commercial feasibility of the newly developed chicken nuggets through a cost-benefit analysis

**Table 2: Formulation and cost of 250 g product**

Items	Treatment				Control			
	Quantity	per cent (%)	Unit Cost (per Kg)	Total Cost (Rs)	Quantity	per cent (%)	Unit Cost (per Kg)	Total Cost (Rs)
Chicken Meat (g)	133.75	53.5	350	46.8125	178.75	71.5	350	62.5625
Kodo Millet Flour (g)	37.5	15	140	5.25	0	0	140	0
Water (g)	20	8	0	0	20	8	0	0
Oil (g)	17.5	7	150	2.625	17.5	7	150	2.625
Condiments (g)	7.5	3	400	3	7.5	3	400	3
Salt (g)	3.75	1.5	40	0.15	3.75	1.5	40	0.15
Spices (g)	7.5	3	650	4.875	7.5	3	650	4.875
Refined Wheat Flour (g)	7.5	3	50	0.375	7.5	3	50	0.375
Egg (g)	7.5	3	168	1.26	7.5	3	168	1.26
Sodium Nitrite (g)	0.15		550	0.0825	0.15		550	0.0825
Whey Protein Conc. (g)	7.5	3	2200	16.5	0	0	2200	0
Electricity				2.09				2.09
LDPE Packaging Film Roll	0.25		1.30	0.3	0.25		1.30	0.3
Nylon Barrier pouches	0.25		2.50	0.6	0.25		2.50	0.6
Labour Cost (3 labours for 50 kg product daily)	0.015		350	5.25	0.015		350	5.25
Miscellaneous expenses*				4				4

Note: \*Misc. expenses include tissue paper, aluminium foil, detergent soap, gloves, face masks, sanitizer, water and sewer charges etc

is essential. This assessment explores whether the product can be introduced on a small scale and expanded over time, serving as a lucrative alternative to the conventional wheat-paddy cropping system. The findings are intended to guide farmers and entrepreneurs looking to venture into chicken processing (Brar *et al.*, 2021). Detailed estimates of capital investment, production costs, and profitability are provided, with a breakdown of fixed, variable, and total costs per unit outlined in the sections below.

#### Investment Pattern

The capital investment was determined by accounting for the permanent equipment needed to establish a processing facility for producing low-fat, fiber-enriched chicken nuggets incorporating kodo millet and whey protein concentrate. The Table 3 lists the required equipment, their quantities, costs, and annual depreciation. The total initial investment for a 50 kg daily capacity was Rs 9,98,528. Key investments include

**Table 3: Fixed Capital Investment required for setting up business of chicken nugget manufacturing**

Particulars	Quantity	Rate (Rs)	Total Cost (Rs)	Expected Life (Yrs)	Annual Depreciation (Rs)
Meat Mincing Machine	1	283000	283000	20	13443
Deep Freezer	1	89250	89250	15	5653
Bowl Chopper	1	330000	330000	20	15675
Refrigerator	1	65920	65920	15	4175
Autoclave	1	204358	204358	15	12943
Aluminium mould, stainless stell table, knives, utensils etc			20000	5	3800
Sealing Machine	1	6000	6000	5	1140
Total Investment			998528		56828



**Table 4: Components of Fixed cost for production of chicken nuggets**

Particulars	Amount (Rs)
Initial Capital Investment	998528
Depreciation on machinery	56827
Interest on capital investment	99853
Rent of building	360000
Total fixed cost per annum	516680
Total fixed cost per day	1416

**Table 5: Variable and total cost of production for 50 kg lot**

Items	Treatment			Control		
	Quantity	Unit Cost (per Kg)	Total Cost (Rs)	Quantity	Unit Cost (per Kg)	Total Cost (Rs)
Chicken Meat (Kg)	26.75	350	9362.50	35.75	350	12512.50
Kodo millet flour (Kg)	7.5	140	1050.00	0	140	0.00
Water (Kg)	4	0	0.00	4	0	0.00
Oil (Kg)	3.5	150	525.00	3.5	150	525.00
Condiments (Kg)	1.5	400	600.00	1.5	400	600.00
Salt (Kg)	0.75	40	30.00	0.75	40	30.00
Spices (Kg)	1.5	650	975.00	1.5	650	975.00
Refined Wheat Flour (Kg)	1.5	50	75.00	1.5	50	75.00
Egg (Kg)	1.5	168	252.00	1.5	168	252.00
Potassium Nitrite (Kg)	0.03	550	16.50	0.03	550	16.50
Whey Protein Conc. (Kg)	1.5	2200	3300.00	0	2200	0.00
Electricity			417.50			417.50
LDPE Packaging Film Roll	50	1.3	65.00	50	1.3	65.00
Nylon Barrier pouches	50	2.5	125.00	50	2.5	125.00
Labour Cost (3 laboures for 50 kg product daily)	3	350	1050.00	3	350	1050.00
Miscellaneous expenses*			800.00			800.00
Marketing cost			1864.35			1744.35
<b>Total Variable cost per day</b>			<b>20507.85</b>			<b>19187.85</b>
<b>Total variable cost per Kg of Product</b>			<b>410.16</b>			<b>383.76</b>
Total Cost per day (Fixed+variable cost)			21923.41			20603.41
Total Cost per Kg of product			466.26			455.32

Note: \*Tissue paper, aluminium foil, detergent soap, gloves, face masks, sanitizer, water and sewer charges etc

the bowl chopper (Rs 3,30,000), meat mincing machine (Rs 2,83,000) and autoclave (Rs 2,04,358) with a combined annual depreciation of Rs 56,828.

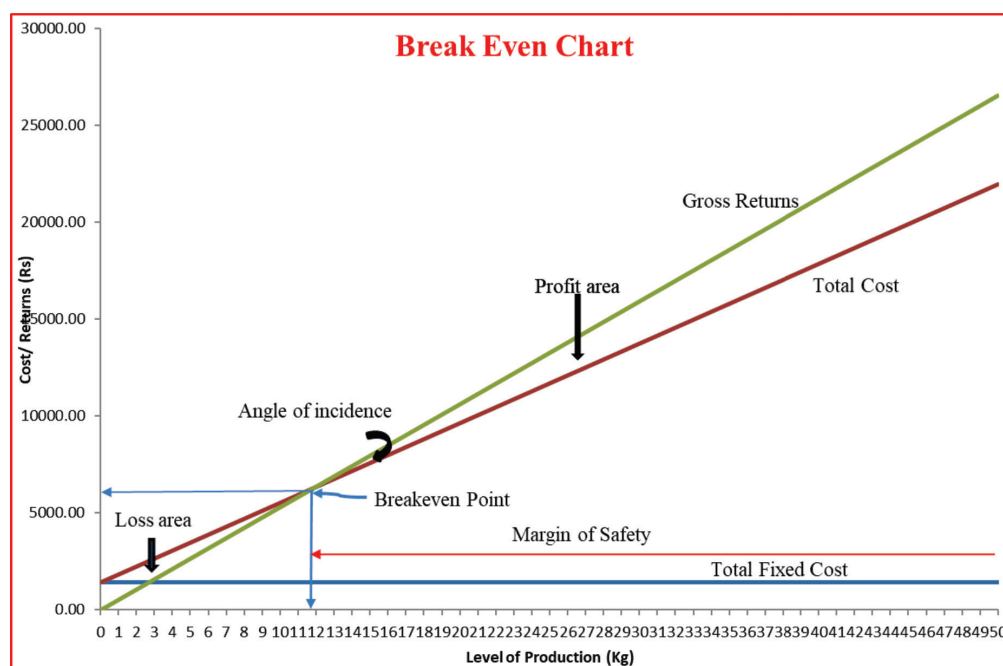
#### Fixed cost

Fixed costs were computed by combining the rent for the processing halls, equipment depreciation, and interest

on the capital investment, as shown in the Table 4. For a 50 kg daily capacity, the annual fixed cost came out to be Rs 5,16,680. The primary contributor is the hall rent at Rs 3,60,000 (69.68%), followed by interest on capital at Rs 99,853 (19.32%), and depreciation at Rs 56,827 (11.00%). This translates to a daily fixed cost of Rs 1,416.

**Table 6: Returns from production for 50 Kg lot**

Items	Treatment (Output= 47.02 Kg) Sale price= Rs 530/Kg	Control (Output= 45.25 Kg) Sale price= Rs 500/Kg
Total Returns (Rs)	24920.60	22625.00
Net Returns per Kg of Product (Rs)	63.74	44.68
Net Returns per day (Rs)	2997.19	2021.59
Net Returns per month (Rs)	74929.68	50539.68
Net Returns per Year (Rs)	899156.17	606476.17
Per cent Value addition	32.01	16.16
Benefit Cost Ratio	1.14	1.10
Breakeven Point (Kg)	11.81	12.18
Payback period (Years)	1.11	1.65
ROI (Per cent)	90	61
Margin of Safety Kg	35.21	33.07
Margin of safety %	74.88	73.09



### Variable and total cost

Variable costs were calculated by summing expenses for raw materials, electricity, packaging, water, miscellaneous items, and marketing, as detailed in the table below for both the treatment (developed product) and control (standard chicken nuggets). Ingredients were procured locally at prevailing market rates. For a 50 kg daily capacity, the variable cost was Rs 20,507.85 per day for the treatment product and Rs 19,187.85 for the control, with raw chicken meat and whey protein concentrate (for treatment) being the

largest expenses (Table 5). The per kg variable cost was Rs 410.16 for treatment and Rs 383.76 for control. Including fixed costs, the total daily production cost was Rs 21,923.41 for treatment and Rs 20,603.41 for control, equating to Rs 466.26 and Rs 455.32 per kg, respectively.

### Returns

Gross returns were calculated by multiplying the production volume by the selling price, assumed at Rs 530 for the treatment product and Rs 500 for the control. Net returns were derived by deducting total production costs from

gross returns. For a 50 kg daily capacity, daily net returns were Rs 2,997.19 for the treatment product and Rs 2,021.59 for the control, with monthly returns of Rs 74,929.68 and Rs 50,539.68, respectively (Table 6 And Figure 2). Krofa *et al* (2018) also found that the net returns were higher for the treatment than the control. Value addition stood at 32.01 per cent for treatment and 16.16 per cent for control. The benefit-cost ratio was 1.14 for treatment and 1.10 for control, both exceeding 1, confirming profitability. The break-even output where revenue matches costs (Medinaa *et al*, 2015) was 11.81 kg for treatment and 12.18 kg for control, well below actual production, offering safety margins of 74.88 per cent and 73.09 per cent, respectively. Similar results were found by Kumar *et al* (2016) according to whom the break even output was 4.36 kg in the case of paneer nuggets product which was much lower than the actual level of production of 20 kg ensuring enough margin of safety i.e. 78.2 per cent. This reduces risk from market price fluctuations. The payback period was 1.11 years for treatment and 1.65 years for control, with returns on investment of 90 per cent and 61 per cent, respectively.

### Conclusions and Policy Implications

The developed nuggets yield an impressive annual net return of Rs 8.99 lakh with a 74.88 per cent safety margin, making it an appealing startup opportunity with an initial investment of around Rs 10 lakh. The rapid payback period of 1.11 years and 90 per cent return on investment highlight its potential. This venture can generate consistent income and jobs, especially for small-scale farmers, and supports agricultural diversification in Punjab, addressing economic challenges in the sector.

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