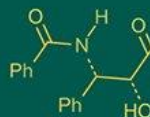


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Economic evaluation of functional shelf-stable chicken meat protein bars under pilot-scale processing

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Abstract

The present study evaluated the economic feasibility of producing functional shelf-stable chicken meat protein bars under pilot-scale processing conditions. Production cost was estimated by considering the expenses associated with raw materials, processing equipment, utilities, packaging, labour and other operational costs using prevailing market prices. The economic analysis revealed that raw materials constituted the major share of the total production cost. The total production cost for 100 protein bars was estimated at ₹ 6,558.11, and the developed product was priced at an estimated retail value of ₹72 per 50 g bar. The findings indicate that the developed chicken meat protein bar is economically feasible for pilot-scale production and possesses promising commercial potential. Further reduction in production cost may be achieved through bulk procurement of raw materials, process optimization and large-scale manufacturing.

Keywords: Chicken meat protein bar; cost economics; commercial feasibility; pilot-scale processing; shelf-stable meat products

1. Introduction

The global demand for convenient, nutrient-dense, ready-to-eat foods has increased substantially owing to changing lifestyles, urbanization and growing health consciousness among consumers. Among these products, protein bars have gained considerable popularity because they provide concentrated amounts of high-quality protein in a convenient form suitable for sports nutrition, meal replacement, weight management and healthy snacking. The global protein bar market is projected to expand steadily due to increasing consumer awareness regarding the role of dietary protein in muscle development, weight control and overall health (Market Research Future, 2023) [8]. Protein bars generally contain 20-50% protein and are designed to deliver balanced nutrition with improved portability and extended shelf life, making them attractive functional foods for a wide range of consumers (Kelly, 2019; Solowiej *et al.*, 2020) [6, 9]. Chicken meat is recognized as an excellent source of high biological value protein containing all essential amino acids in balanced proportions, along with important micronutrients such as iron, zinc, phosphorus and B-complex vitamins. In comparison with many plant proteins, chicken meat proteins possess superior digestibility and bioavailability, making them an ideal ingredient for the development of functional protein-rich foods (Bohrer, 2017; Godfray *et al.*, 2018) [1, 3]. Furthermore, chicken meat proteins exhibit desirable functional properties including water-holding capacity, emulsification and gel formation, which facilitate the manufacture of value-added processed meat products (Kumar *et al.*, 2023) [7]. Despite the nutritional advantages of meat proteins, the majority of commercial protein bars are formulated using dairy or plant proteins, whereas scientific literature on meat-based protein bars remains scarce.

The incorporation of functional ingredients such as dietary fibre, natural antioxidants, seeds and plant bioactives improves nutritional quality while enhancing oxidative stability, shelf life and consumer acceptability (Jimenez-Colmenero *et al.*, 2001; Ursachi *et al.*, 2020) [5, 10]. Consequently, the development of shelf-stable meat-based protein bars represents an innovative strategy to combine the nutritional advantages of meat proteins with the health-promoting properties of functional ingredients.

Besides nutritional quality and sensory acceptability, the commercial success of any novel food product largely depends on its economic feasibility.

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Cost of production is one of the most important parameters determining whether a product can be manufactured and marketed profitably on a commercial scale. Economic evaluation involves systematic estimation of expenditure associated with raw materials, processing equipment, utilities, packaging materials, labour, maintenance and other operational expenses. Such analysis assists manufacturers in establishing competitive pricing strategies, estimating profit margins and evaluating the commercial viability of newly developed products. According to the Institute of Cost and Works Accountants (ICWA), cost represents the monetary value of resources consumed in the production of goods or services and forms the basis for assessing production efficiency and profitability.

2. Materials and Methods

The cost economics of the developed functional shelf-stable chicken meat protein bar was evaluated under pilot-scale processing conditions after standardization of the product formulation and processing protocol. The production cost was estimated using the prevailing local market prices of raw materials, packaging materials, processing equipment, utilities and labour during the study period. Initially, the raw material cost for the preparation of coarse chicken meat powder was calculated based on the quantities of deboned chicken meat, condiments, spices, oil and other ingredients required to produce chicken meat powder from chicken meat marinade. Subsequently, the ingredient cost for the preparation of 100 chicken meat protein bars was estimated considering the optimized formulation comprising chicken meat powder, roasted peanut powder, sesame seeds, oat flakes, pumpkin seeds, skim milk powder, potato starch, sunflower oil, sugar syrup, xanthan gum, herbs, spices and other minor ingredients. The total production cost included variable costs such as raw materials, packaging, electricity, water, LPG and labour, together with fixed costs including depreciation of processing equipment, building rent and maintenance expenses. The depreciation cost of processing equipment was calculated at the rate of 10% per annum using the straight-line method. Electricity consumption was estimated from the power ratings of individual processing equipment and their duration of operation, while labour charges were calculated according to prevailing wages for one skilled and one unskilled worker required per production batch. Packaging cost was estimated based on the quantity of aluminium laminate pouches required for the finished product. Total expenditure was obtained by summing all fixed and variable costs, and a gross profit margin of 10% was considered for estimating the expected retail price of the developed protein bar on a per kilogram as well as per 50 g bar basis.

3. Results and Discussion

Institute of cost and work accounts (ICWA) India defined cost as measurement in monetary terms of the amount of resources used for the purpose of production of goods or rendering services. In manufacturing of goods and services, cost refers to sum total of the value of resources used like raw material and labour and expenses incurred in producing or manufacturing of given quantity.

3.1 Percentage Yield of Bar

Yield of the CMPB was calculated on present basis based on weight of raw samples as follows:

$$\text{Bar yield (\%)} = \frac{\text{Weight of CMPB produced (g)}}{\text{Weight of raw chicken used (g)}} \times 100$$

100 gm of Chicken meat gave 30 gm of chicken powder on dry basis and 5 gm powder was wasted during sieving process to even the particle size (3-5.5mm).

In 1 bar-25 gm of coarse chicken powder was used with equal amount of other ingredients to form 50 gm CMPB.

So, from 100 gm Chicken meat 1 CMPB was made.

Bar yield (%) = 50%

3.2 Raw material cost

Raw material cost is one of the principal components of product cost. The cost of raw materials for CMPB preparation is given below.

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Ingredients	Qty. required in kgs	Price in Rs/kg	Cost in Rs.
Deboned Chicken meat	10.00	410	4100.00
Onion	1.343	27	36.26
Garlic	0.331	100	33.00
Pumpkin seeds	0.100	500	50.00
Oat flakes	0.200	78	15.60
Sugar syrup	0.150	130	19.50
Refined oil	0.670	92	61.64
Peanuts (Roasted)	0.575	85	48.87
Xanthin gum	0.050	355	17.75
Potato starch	0.125	276	34.50
Black pepper	0.047	750	35.25
Mixed herbs	0.050	500	25.00
Spice mix	0.106	493	52.25
Water	1.575	20	31.50
Skim milk powder	0.125	350	43.75
Salt	0.151	23	3.47
Red chilli powder	0.077	140	10.78
Citric acid	0.035	1188	41.58
Sesame seeds	0.250	170	42.50
Golden berry powder	0.100	250	25.00
Total			4728.20

Cost of raw materials for 100 CMPB's (50 gm each) was estimated as Rs. 4728.20/-with 50% CMPB yield and 50% moisture wastage while making chicken coarse powder.

3.3 Cost of machinery and accessories

The essential equipment's and accessories required for processing of CMPB are air fryer, deep freezer, hot air oven, mixer grinder, sealers, mortar and pestle, mould and 2 sieves of different pore size. The approximate cost of processing machinery is given below:

The approximate cost of processing machinery is given below:

Items	No. required	Cost in Rs.
Industrial Air fryer	1	200000
Deep freezer	2	84000
Food dryer	1	120000
Mixer grinder	1	7000
Mould (50)	2	600
Seives (Large)	2	1000
vacuum packaging machine	1	150000
Utensils, knives etc	-	5000
Total		567,600

Depreciation rate @ 10% per annum = Rs. 56,760 and Rs. 157.66/day

3.4 Cost of electricity

Electricity is required for operating different machinery and lighting. The quantity of electricity consumed, and its cost is given below:-

The quantity of electricity consumed, and its cost is given below

Instruments	Watts X h of operation	KWh
Industrial Air fryer	1500 x 0.20	0.30
Deep freezers 2 no.	2000 x 24	48
Food dryer	1000 x 18	18
vacuum packaging machine	1500 x 1	1.5
Others	1000 x 2	2
Total electricity consumption	-	69.80
Cost of electricity	98.30 x Rs. 6.25/KWh	Rs. 436.25/day

3.5 Packaging cost

Finished CMPB after cooling and with appropriate moisture content should be properly packaged in moisture proof aluminium laminates packaging material. 100 packets of bar containing one CMPB in each packet are to be packed. 1kg aluminium laminates will be required. Therefore, the cost @ Rs. 230 per kg is Rs. 230/100 packets of 50 gm each and Rs. 2.30/packet.

3.6 Labour cost

Presently, in India, the labour cost of skilled person is around Rs. 500/day and for unskilled person is around Rs. 250/day. For making 100 CMPB packets, one skilled person and one unskilled person is required per day. Total labour cost = Rs. 750/day

3.7 Cost of water

Water is the most essential non-food ingredient in food processing plant. The cost of water can be reduced by obtaining Municipal water supply and an amount of Rs. 40/day will be sufficient as the cost of water.

3.8 Cost of LPG (Liquefied Petroleum Gas)

For industrial use, cost of an LPG cylinder is around Rs. 1676/cylinder and an amount of Rs. 50/day is needed as the cost of LPG when one cylinder is used just for heating the coating material of CMPB.

3.9 Rent

Property and constructed building are the basic infrastructure required for processing plant. A building in a peri urban area/locality which has sufficient space to hold the entire processing unit for setting up a small-scale product processing unit with all facilities will cost around Rs. 5000 per month. Therefore, rent per day-Rs. 166/day.

3.11 Maintenance cost

The day-to-day materials in use are detergent, soap, sanitizers etc. These are required to maintain the equipments, building and premises hygienically and would cost approximately Rs. 100/day.

3.12 Marketing cost

Nil (own marketing). Since the through put is small and product is shelf stable and new, own marketing is preferred to understand market expectations and further development.

3.13 Total expenditure

Sum of all costs incurred in 3.20 to 3.11 accounts for total cost of production. Therefore, the total expenditure for production of 100 CMPB (50 gm each) from 10 kg chicken is Rs. 6558.11/-

3.14 Gross Profit

A gross profit of 10-12% is common in premium commodities.

At a gross profit margin of 10% from 200 CMPB's will be Rs. 655.81/-

4.6.13 Retail cost of Chicken meat protein bar.

$$\text{Cost of 1 CMPB} = \frac{\text{Total expenditure (6558.11) + Gross profit (655.81)}}{\text{Product yield (100 bars)}}$$

$$= \text{Rs. 72}$$

Therefore, estimated retail price for one chicken-based protein bar of 50 gm is Rs. 72/-The margin of profit can be substantially increased, or cost of the product can be reduced by efficient sourcing of chicken meat and spices and by effectively utilizing the fine powder formed during preparing coarse chicken meat powder.

4. Conclusion

The economic evaluation demonstrated that the developed functional shelf-stable chicken meat protein bar can be produced economically under pilot-scale processing conditions. Raw materials constituted the major component of the production cost, while the estimated retail price indicated good commercial viability. The developed product has promising potential for commercialization as a convenient, protein-rich functional meat product, and its profitability may be further improved through process optimization, bulk procurement of raw materials and large-scale production.

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