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Economic evaluation of functional chicken meat nuggets formulated with little millet flour

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ABSTRACT

The need for healthier meat products that are ready to eat or cook has grown as a result of rapid urbanization and lifestyle changes. Although processed meat products provide meat eaters with delicious and convenient options, their high price makes it challenging for the typical consumer to include them into their diet. Thus, the current study's goal is to produce inexpensive and healthier meat products using functional ingredients and compare the manufacturing costs of these products to those of the control product. Nuggets of chicken meat were made using a regulated recipe and extended with a precisely measured amount of little millet flour (LMF). LMF levels were optimized by various trials based on sensory qualities, and those with sensory attributes closer to the control were chosen.To identify the most cost-effective preparation, the price of chicken nuggets after lean meat was substituted with a chosen amount of LMF was examined. The results showed that LMF- incorporated chicken nuggets were less expensive than control items. Thus, it was concluded that the most cost-effective formulation among the levels of incorporation was one that added 6% of LMF at the expense of lean meat.

Key words: Chicken nuggets, cost, economics, functional ingredients, little millet flour

INTRODUCTION

The rise in the cost of various commodities makes it extremely difficult to make animal protein available to all societal segments at a reasonable price. Increasing affluence, urbanization, and the younger generation's increasing understanding of nutrition are the main causes of the rising demand for meat and meat products among consumers. Animal proteins in the form of meat must be incorporated into a daily diet in order to meet the ICMR recommendation for protein consumption of 1 g kg^{-1} body weight/day with Net Protein Utilization (NPU) of 65. Today's rapidly expanding poultry business in India may provide a low-cost supply of proteins with excellent biological value. With 5.18 million tons of poultry meat produced annually, India ranks fourth in the world (BAHS, 2025). Poultry meat has become a mass-consumer commodity worldwide because of its affordable price, high nutritional value, accessibility to all, and lack of associated religious taboos (Sammani et al., 2025; Tramboo and Khan, 2024; Anantaraman, 2022). Chicken meat is chosen over other meats because it has more protein, less overall fat and 50% saturated fat (Mishra et al., 2014) and is therefore chosen over other meats. Meat is regarded as a complete protein since it has all of the required amino acids as well as fatty acids, minerals and vitamins (Rahman et al., 2023). However, meat is devoid of

dietary fibers and also deficient in calcium. Dietary fiber are mostly found in plant materials. Dietary fiber in the diet helps in preventing the occurrence of many lifestyle diseases such as type II diabetes, cardiovascular diseases, obesity, certain cancers and bowel disorders (Kumar et al., 2015). There is growing interest in using extenders, binders and fillers in place of some or all of the meat systems in order to reduce product costs, improve functional qualities and enhance or preserve the expected nutritional and sensory aspects of finished goods for consumers. When added as extenders to meat products, cereals, millets and non-meat proteins enhance yield, texture, functionality and palatability while lowering production costs. This locally accessible cereal flour is far less expensive than other widely used binders/extenders, such as refined wheat flour and maize flour. As a result, it might be utilized to create new, less expensive and functional meat products. The use of LMF as an extender/binder as well as a functional ingredient in emulsion based meat products has not been explored to its maximum. Therefore, in the present study, the production cost of chicken nuggets formulated with optimum level of LMF was determined and compared with control, to conclude and suggest the level of incorporation of LMF for the economic production of functional chicken nuggets.

MATERIALS AND METHODS

Dressed broiler chickens were procured from the local market of Bhubaneswar and manually deboned in the Livestock Products Technology (LPT) Department at OUAT, Bhubaneswar, C.V.Sc. & A.H. Fascia, connective tissue and any separable fat were removed from the lean meat. The meat was then packaged in low density polyethylene (150 gauge) bags and frozen at -18 to -20°C until needed. Food-grade chemicals were obtained from Qualigens, Merck, BDH, and Analar. The refined wheat flour (maida) and LMF were obtained from the local market of Bhubaneswar. To prepare nuggets, condiment and garlic were peeled, cut into small pieces and homogenized in a mixer to obtain a fine paste. Spices were prepared in the laboratory as per a pre-standardized formulation.

Preparation of chicken nuggets

The incorporation level of LMF was optimized by substituting lean meat in the control formulation at three graded concentrations. Evaluation of physicochemical properties and sensory attributes indicated that a 6% inclusion level of LMF was the most suitable. Using this optimized level, functional and extended chicken nuggets were developed by replacing lean meat in the pre-standardized formulation and processing protocol with LMF.

Formulation

The base formulation used for preparing chicken nuggets was standardized as shown in Table 1, and the product developed using this formulation served as the control for comparison with the extended variants. Lean chicken meat was trimmed, cut into small pieces, and minced twice through an 8-mm plate using a meat mincer (Santos, France). The minced meat was then combined with sodium tripolyphosphate (STPP), salt, refined wheat flour, condiments, spice mix, whole egg liquid, and the optimized level of LMF. All these constituents were mixed for about 1 min to obtain a uniform batter or mix. The mix was then placed inside a rectangular mould and kept for steam cooking under pressure for 15 min. After thorough cooking, the product was cooled to ambient temperature, cut into pieces measuring approximately 10 × 15 × 5 mm, and packaged aerobically in LDPE pouches. The packaged nuggets were stored under refrigerated conditions (4 ± 1 °C). A panel of seven trained assessors evaluated the sensory attributes of the functional chicken nuggets at the optimized LMF level using an 8-point descriptive scale (Naveena et al., 2006), where a score of 8 indicated an extremely desirable attribute and a score of 1 indicated an extremely undesirable attribute. The most economically feasible extended nugget formulation was determined by calculating the production cost of the functional and extended chicken nuggets based on the cost of the ingredients and processing procedures involved.

Statistical analysis

The research was carried out in six separate trials (n = 6). SPSS software version 22.0 (Chicago, IL, USA) was used to compile and statistically evaluate the data obtained from all replicates. Using the methods outlined by Snedecor and Cochran (1967), analysis of variance (ANOVA) and Duncan's multiple range test were used to identify significant differences between treatments at a significance level of $p < 0.05$. The control and treatment groups were also compared for each parameter at each sample interval using an independent t-test.

RESULTS AND DISCUSSION

The comparative cost of producing 10 kg of control nuggets and 10 kg of extended or functional chicken nuggets is summarized in Table 2. The calculation includes expenses for all essential raw materials such as deboned chicken meat, refined wheat flour, salt, spice mix, condiments, STPP, refined oil, ice flakes, whole egg liquid, and LMF. The retail prices of these ingredients generally remain stable in local markets; however, bulk procurement from wholesalers or distributors can further reduce the overall production cost.

The total formulation cost for producing 10 kg of the control product was Rs.1988, whereas the cost for the LMF-incorporated formulation was Rs.1868. Thus, both the functional and extended nugget formulations were more economical than the control. The reduced cost for the LMF-based product is largely attributable to the lower price of LMF compared to deboned chicken meat, even when used at the optimized inclusion level.

The overhead expenses associated with producing 10 kg of product are shown in Table 3. These include labour charges (skilled and unskilled), electricity, building rent, packaging materials, water supply, equipment maintenance, loan instalments, LPG usage, and depreciation of equipment at 10% per annum. Overhead cost remained the same for both control and LMF-treated nuggets, amounting to Rs.1740.50 for each 10 kg batch.

Table 1. Basic formulation for preparation of chicken meat nuggets

Items	Quantity (g/100 g of mix)
Chicken meat	70
Refined oil	8
Whole egg liquid	2.75
Refined wheat flour	2.5
Ice flakes	10
Salt	1.5
Condiments	3
Spice mix	2
STPP	0.3
Sodium nitrite (on weight basis)	150 ppm

Table 2. Comparative cost for formulation of 10 Kg control and functional chicken meat nuggets

Ingredients	Rate	Control nugget		6% LMF Treated nugget	
	Rs./ kg	Qty	Rs.	Qty.	Rs.
Chicken (deboned)	240	7	1680	6.4	1536
Refined oil	120	0.8	96	0.8	96
Refined wheat flour	20	0.25	5	0.25	5
Salt	20	0.15	3	0.15	3
Condiments	60	0.3	18	0.3	18
Spices mix	300	0.2	60	0.2	60
Whole egg liquid	120	0.275	120	0.275	120
STPP	200	0.03	6	0.03	6
LMF	40			0.6	24
Total			1988		1868

Table 3. Overhead production cost of 10 kg chicken meat nuggets

Labour charges	Skilled staff = 500 /day Unskilled staff = 450 /day Total= 950/day
Electric charges	30.95 KWh × Rs.6/ KWh = Rs.185.7/ day
Equipment depreciation*	@ 10% per annum i.e. = Rs.26,060 /annum i.e. = Rs.86.86/day (300 working days per annum)
Cost of packaging material	Rs.200/day
Water charges	Rs.20/day
Maintenance cost	Rs.70/day
Rent of building	~ Rs.100/day
Cost of LPG	Rs.50/day
Insurance	Rs.8.33/day
Installment of loan	Rs.69.61/ day
Total overhead cost	Rs.1740.50/ day

Table 4. Total expenditure(Cost/day in Rs.)

Cost analysis	Control	LMF 6%
Raw material cost	1988.00	1868.00
Cost of machineries (Depreciation cost)	86.86	86.86
Cost of electricity	185.70	185.70
Packaging cost	200.00	200.00
Labour cost	950.00	950.00
Rent	100.00	100.00
Maintenance cost	70.00	70.00
Instalment of loan	69.61	69.61
Cost of water	20.00	20.00
Cost of LPG	50.00	50.00
Insurance	8.33	8.33
Total processing expenditure	3728.50	3608.50
Marketing costs (21%)	782.98	757.78
Total	4511.48	4366.28
Gross profit (12%)	541.37	523.95
Cost of 10 kg product	5052.85	4890.23
Cost of 1 kg of product	505.28	489.02
Cost of 100 g packet	50.52	48.90

The total cost of producing 10 kg of chicken nuggets was calculated to be Rs.5052.85 for the control formulation and Rs.4890.23 for the LMF-incorporated product. Accordingly, the cost per kilogram of nuggets amounted to approximately Rs.505.28 for the control and Rs.489.02 for the treatment group. Since both products received comparable sensory ratings, the formulation with the lower production cost was considered more economical. The findings demonstrate that incorporating LMF at the optimized level of 6% reduced the cost of chicken nuggets by Rs.16.26 per kilogram compared with the control formulation (Table 4).

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