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Cost economics of pet food incorporated with rabbit offal's

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Abstract

The present study was undertaken to develop and evaluate the economic feasibility of pet food biscuits incorporated with rabbit offals. Rabbit liver, kidney, heart, and intestine were collected, processed into meals, and incorporated into standardized pet food formulations. Three formulations were evaluated: control (C), liver, kidney and heart meal incorporated treatment (T₁), and intestine meal incorporated treatment (T₂). The production economics, including raw material cost, overhead expenditure, production cost, selling price, profit, break-even point, and cost-benefit ratio, were estimated for each formulation. The total production cost per 100 kg was Rs. 10,921.16, Rs. 39,641.16, and Rs. 25,641.16 for C, T₁, and T₂, respectively. The corresponding cost of production per kg was Rs. 127.49, Rs. 454.44, and Rs. 297.29, respectively. Considering a 35% profit margin, the estimated selling prices were Rs. 172.11/kg for C, Rs. 613.49/kg for T₁, and Rs. 401.34/kg for T₂. The reported net profit per day after loan repayment was Rs. 4,364, Rs. 15,764, and Rs. 10,264 for C, T₁, and T₂, respectively. The break-even point was estimated at Rs. 6,49,875.43 for C, Rs. 6,71,203.92 for T₁, and Rs. 6,57,692.00 for T₂. Among the formulations, T₁ generated the highest reported daily net profit, followed by T₂ and the control. The findings indicate that incorporation of rabbit offals, particularly liver, kidney, and heart, offers potential for value addition and development of economically viable pet food products while promoting the efficient utilization of slaughterhouse by-products.

Keywords: Break-even point, cost-benefit ratio, economic feasibility, pet food, pet biscuits, production cost, rabbit offal

Introduction

Rabbits are considered promising food-producing animals because of their rapid growth rate, short reproductive cycle, high prolificacy, efficient feed utilization, and relatively low space requirements. These characteristics make rabbit production suitable for both small-scale and commercial farming systems. Rabbits can also be efficiently reared and transported for meat production. However, rabbit meat consumption remains comparatively low, with global per capita consumption reported to be only 0.242 kg in 2012 (Dalle Zotte, 2014) [5]. Limited consumer awareness regarding its nutritional benefits is considered one of the important factors contributing to its low consumption (Mancini *et al.*, 2020) [9].

Rabbit production was introduced in India through the Central Sheep and Wool Research Institute (CSWRI), Avikanagar, Rajasthan, and subsequently expanded through its North Temperate Regional Station at Garsa, Himachal Pradesh. Several breeds have been used for rabbit production in India, including Soviet Chinchilla, New Zealand White, Black Brown, Grey Giant, White Giant, Flemish Giant, and Silver Fox. A female rabbit has considerable reproductive potential and can produce a substantial quantity of meat through its progeny within a year. Rabbit meat is recognized for its desirable nutritional and dietary characteristics. It is a good source of high-quality protein and generally contains relatively low levels of intramuscular fat and cholesterol, along with a favourable polyunsaturated fatty acid profile (Wang *et al.*, 2020) [12]. These characteristics make rabbit meat an attractive option for health-conscious consumers.

Rabbit meat is generally more expensive than poultry meat (Kallas & Gil, 2012) [7], and its characteristic flavour may not be acceptable to all consumers (Hoffman *et al.*, 2004) [6]. These factors, together with limited consumer awareness and inadequate market development, have contributed to low consumption in several regions (Cullere & Dalle Zotte,

2018) [4]. Development of value-added products such as frozen, smoked, roasted, canned, cured, dried, pickled, and sausage-type products may improve consumer acceptance and increase the utilization of rabbit meat (Alekseeva *et al.*, 2018) [1]. Processing may also help to modify or mask the characteristic flavour of rabbit meat, thereby improving its acceptability (Hoffman *et al.*, 2004) [6]. Several studies have investigated the influence of genetic, age, environmental, nutritional, management, and pre- and post-slaughter factors on carcass characteristics, nutritional composition, and meat quality of rabbits (Apata *et al.*, 2012; Cullere *et al.*, 2018) [2, 3, 4].

In addition to edible meat, slaughtering generates considerable quantities of animal by-products or offal. Proper utilization of these materials is important from both nutritional and environmental perspectives. Offal may contain approximately 15-20% protein and provides valuable amino acids, minerals, vitamins, and fatty acids (Liu, 2002) [8]. Rabbit liver is a nutrient-dense organ and is a good source of protein, vitamin A, riboflavin, iron, and selenium. Rabbit heart and kidney also provide valuable proteins and micronutrients. Intestinal tissues may contain protein and beneficial microbial populations and have been considered as potential ingredients in animal diets. Therefore, the utilization of rabbit offals in pet food may provide an opportunity to convert potentially underutilized slaughter by-products into nutritionally valuable products while reducing disposal-related environmental problems. The increasing humanization of pets has also encouraged owners to seek nutritionally balanced, safe, palatable, and convenient pet foods. The shift from household scraps and homemade diets towards commercially manufactured pet foods has been associated with greater awareness of animal nutrition. Homemade diets may sometimes be nutritionally unbalanced and deficient in protein, energy, calcium, phosphorus, vitamins, and trace minerals, potentially affecting the health and performance of companion animals (Pattanaik, 2011) [11]. Consequently, incorporation of nutrient-rich animal by-products into appropriately formulated pet foods may offer a practical approach to improving nutritional value while promoting sustainable utilization of slaughterhouse resources.

Therefore, the present study was undertaken to develop and standardize pet biscuits incorporating rabbit offals, namely liver, kidney, and heart, along with intestine, and to evaluate their physicochemical and microbiological characteristics and shelf-life stability during storage. The study aims to explore the potential of rabbit slaughter by-products as functional and economical ingredients for the development of value-added pet food products.

Materials and Methods

The present investigation was undertaken to standardize the procedure for the development of pet food incorporating rabbit offals (intestine, heart, liver, and kidney) and to evaluate the shelf life of the developed product. The study was conducted in three phases. In the first phase, rabbit intestine and visceral offals were collected during slaughter at the Livestock Products Technology Section, ICAR-CSWRI, Avikanagar. The small intestine was thoroughly washed with potable water to remove ingesta, followed by removal of the mucosal lining. The intestine was then cut

into pieces of approximately 1.5-2.5 cm in length, packed in low-density polyethylene (LDPE) bags, and stored under frozen conditions at $-18 \pm 1^\circ\text{C}$ until further use. Similarly, liver, kidney, and heart were trimmed to remove adhering connective tissue and separable fat, cut into small pieces, packed in LDPE bags, and stored at $-18 \pm 1^\circ\text{C}$ until further processing. Before processing, the frozen offals were thawed overnight at $4 \pm 1^\circ\text{C}$ in a refrigerator. In the second phase, pet food formulations were standardized according to the nutrient requirements specified by the National Research Council (NRC), and the most suitable formulation was selected based on the incorporation of an optimum level of rabbit offal meat. In the third phase, the standardized pet food was appropriately packaged and stored under ambient conditions ($32 \pm 1^\circ\text{C}$) for evaluation of its shelf life based on physicochemical and microbiological characteristics. Freshly rendered sheep fat was procured from the local market at Avikanagar on the day of use. Other ingredients, including soybean meal, refined wheat flour, and dicalcium phosphate, were procured from the local market at Avikanagar. Analytical-grade chemicals, reagents, and microbiological media required for various analyses were procured from standard commercial suppliers, including Ranbaxy, Polypharm, Qualigens, CDH, and HiMedia.

Formulas used for estimation of economics of the products

Cost of production for 100 Kg pet food = Cost of formulation + cost of overhead production

Cost of overhead production = Daily depreciation cost + Rent of building + Labour cost + Cost of electricity + Maintenance cost + Water charge + Cost of packaging

Cost for 1 kg pet food = (Production cost of 100 Kg formulation/% cooking yield)

Income = total sale price-total cost of production

Break-Even point = Fixed cost $\times$ Total sales/Total sales-Variable cost

Cost-benefit ratio = Total profit/Total cost of production

Net profit/day = Total profit-amount of loan payment/day

Results and Discussion

The fixed expenditure required for establishment of the pet food processing unit is presented in Table 1. The major equipment included a meat mincer, steam cooker, freezer, weighing balance, furniture, grinder, oven, packaging machine, and other miscellaneous items. The total fixed expenditure was estimated at Rs. 2,37,500. Considering an annual depreciation rate of 10%, the annual depreciation was calculated as Rs. 23,750. Based on 300 working days per year, the depreciation cost was estimated at Rs. 79.17 per working day. In addition to depreciation, the daily production expenses included building rent, labour, electricity, maintenance, water, and packaging costs. The estimated labour cost was Rs. 1,350 per day, comprising Rs. 600 for trained labour and Rs. 750 for untrained labour. Electricity expenditure was estimated at Rs. 360 per day, while rent, maintenance, and water charges were Rs. 140, Rs. 100, and Rs. 30 per day, respectively. The packaging expenditure was estimated at Rs. 500 per day. These costs represent the major fixed and operational components influencing the overall economics of pet food production.

Table 1: Fixed expenditure for pet food

Equipments	Price (in rupee)
Meat mincer	60,000
Steam cooker	8,000
Freezer (2)	50,000
Balance	1500
Furniture	6000
Grinder	4000
Oven(2)	100000
Packaging machine	3000
Miscellaneous	5000
Total fixed expenditure	237500

1. Annual depreciation @ 10% = 23,750/Annum
2. $12 \times 25 = 300$, $23750/300 = 79.16$ i.e
Daily depreciation cost per day @ 25 working day = 79.16/day
3. Rent of building = 3500/month
Money paid for rent per day @ 25 working days/month = 140/day
4. Labour cost:-
Trained labour @ 300 (2) = 600/day
Untrained labour @ 250 (3) = 750/day
Total = 1350/day
5. Cost of electricity 45 unit @ 8.00/Unit = 360/day

6. Maintenance = 100/day
7. Water charge (approx) = 30/day
8. Cost of packaging @ 1.25/Package = 500/day

The formulation-wise production cost for 100 kg of pet food is presented in Table 2. The control formulation consisted mainly of refined wheat flour, fat, egg, soybean flour, dicalcium phosphate, baking soda, and salt. The total raw material cost of the control formulation was Rs. 8,362 per 100 kg. For T₁, 40 kg of rabbit liver, kidney, and heart meal was incorporated at a cost of Rs. 750/kg, resulting in an additional ingredient cost of Rs. 30,000. In T₂, 40 kg of rabbit intestine meal was incorporated at a cost of Rs. 400/kg, contributing Rs. 16,000 to the formulation cost. Thus, the raw material cost of T₂ was lower than that of T₁ but substantially higher than that of the control formulation. Considering a profit margin of 35%, the reported selling prices or maximum retail prices were Rs. 172.11/kg for the control, Rs. 613.49/kg for T₁, and Rs. 401.34/kg for T₂. The substantially higher selling price calculated for T₁ reflects its higher production cost. However, market acceptance of a higher-priced product would depend on the nutritional benefits, palatability, quality, consumer perception, and willingness of pet owners to pay for value-added rabbit offal-based pet food.

Table 2: Formulation cost for 100 kg pet food

Cost of production of control , offal and intestine treated pet food for one Kg							
	Particulars	Cost (Rs) of 100 Kg formulation of pet food					
		Control		T ₁		T ₂	
		Quantity (%)	Cost (Rs.)	Quantity (%)	Cost (Rs.)	Quantity (%)	Cost (Rs.)
	Raw material cost						
	Refined wheat flour @ Rs.32/Kg	65	2080	25	800	25	800
	Fat @ Rs.20	8	160	8	160	8	160
	Egg @ Rs.7.5/Egg	500	3750	500	3750	500	3750
	Soya Flour @ Rs.220/kg	10	2200	10	2200	10	2200
	Dicalcium phosphate @ Rs.29/Kg	1	29	1	29	1	29
	Baking soda @ Rs.320/Kg	400	128	400	128	400	128
	Salt @ Rs.25/Kg	600	15	600	15	600	15
	A Total		8362		7082		7082
	Test Ingredients						
	Liver, Kidney, Heart meal @ Rs750/Kg	-	-	40	30,000	-	-
	Intestine meal @ Rs.400/Kg	-	-	-	-	40	16000
	B Total				30,000		16000
C	Other cost						
1	Packaging		500		500		500
2	Labour charge		1350		1350		1350
3	Cost of water	-	30	-	30	-	30
4	Depreciation		79.16		79.16		79.16
5	Electricity 30 unit @ Rs.10	-	360	-	360	-	360
6	Rent	-	140	-	140	-	140
7	Maintenance	-	100	-	100	-	100
	C Total		2559.16		2559.16		2559.16
	Total cost of production for 100 kg formulation (A + B + C)		10921.16		39641.16		25641.16
D	Product yield		85.66		87.23		86.25
E	Cost per Kg		127.49		454.44		297.29
F	35% Profit, MRP of Product		172.11		613.49		401.34

The reported income and profit values are presented in Table 3. The reported income per kilogram was Rs. 45 for the control, Rs. 159 for T₁, and Rs. 104 for T₂. On the basis of the reported calculations, T₁ generated the highest gross income, followed by T₂ and the control. The higher income

associated with T₁ was primarily due to its higher selling price. However, the economic advantage should be interpreted in relation to both production cost and actual quantity of finished product obtained.

Table 3: Income and total profit from control, offal and intestine treated pet food

Groups	C (Rupees)	T ₁ (Rupees)	T ₂ (Rupees)
Income/Kg	45	159	104
Income/100 Kg	4500	15900	10400
Total profit/day	4500	15900	10400

The total project cost, including fixed expenditure and production cost, was estimated at Rs. 2,48,421.16 for the control, Rs. 2,77,141.16 for T₁, and Rs. 2,63,141.16 for T₂ (Table 4). The higher project cost for T₁ was again

attributable to the comparatively high cost of the offal ingredient. The total project cost was lowest for the control because no additional rabbit offal meal was incorporated, while T₂ occupied an intermediate position.

Table 4: Calculation of variable cost and total project cost for control, offal and intestine treated pet food

Groups	Fixed cost (Rupees)	Variable cost (Rupees)	Total project cost (Rupees)
C	237500	10,921.16	248421.16
T ₁	237500	39,641.16	277141.16
T ₂	237500	25,641.16	263141.16

Total project cost = ₹ 400000

Loan amount = ₹ 340000

Margin money = ₹ 60,000

Amount of interest @ 12%/annum = ₹ 40,800

Amount of loan payment/month = 3400 (for 12 months month only)

Amount of loan payment/day = ₹ 136

For project financing, the total project cost was considered to be approximately Rs. 4,00,000, with a proposed loan amount of Rs. 3,40,000 and margin money of Rs. 60,000. At

an interest rate of 12% per annum, the annual interest on the loan amount was estimated at Rs. 40,800. The reported monthly repayment was Rs. 3,400, equivalent to approximately Rs. 136 per working day when calculated over 25 working days per month. After consideration of the reported loan repayment, the estimated net profit per day was Rs. 4,364 for the control, Rs. 15,764 for T₁, and Rs. 10,264 for T₂ (Table 5). According to these reported figures, T₁ provided the highest daily net return, followed by T₂ and the control.

Table 5: Net profit/day after payment of loan control, offal and intestine treated pet food

Groups	Total sales/day	Variable Cost	Total cost of production/day	Net profit/day (After payment of loan 136/day)
C	17211	10,921.16	12711	4364
T ₁	61349	39,641.16	45449	15764
T ₂	40134	25,641.16	29734	10264

Break-even analysis is an important indicator of the financial feasibility of a production enterprise because it indicates the level of sales or investment at which total revenue equals total cost. As reported in Table 6, the break-even values were Rs. 6,49,875.43 for the control, Rs. 6,71,203.92 for T₁, and Rs. 6,57,692.00 for T₂. T₁ showed the highest break-even value, indicating that a comparatively greater level of sales would be required to recover the investment under the assumptions used. The

control showed the lowest break-even value, while T₂ occupied an intermediate position.

The reported cost-benefit ratios were 0.35 for the control, 0.34 for T₁, and 0.34 for T₂. Although these values were expressed as percentages in the original table, a cost-benefit ratio is conventionally expressed as a ratio rather than a percentage. Therefore, the calculation and presentation of this parameter should be standardized before inclusion in the final thesis.

Table 6: Calculation of break even point and cost benefit ratio for control, offal and intestine treated pet food

Group	Break Even Point	Cost benefit ratio
C	$237500 \times 17211 / 17211 - 10921.16 = 649875.43$	$4500 / 12711 = .35$ or 35%
T ₁	$237500 \times 61349 / 61349 - 39641.16 = 671203.92$	$15900 / 45449 = .34$ or 34%
T ₂	$237500 \times 40134 / 40134 - 25641.16 = 657692.00$	$10400 / 29734 = .34$ or 34%

The overall cost for the production of 1 kg of pet food incorporated with rabbit offals was 454.44 for T₁, 297.29 for T₂, 127.49 Rs for control.

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