



## Process Protocol and Cost of Production of Functional Fiber-Enriched Pork Loaves

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### ABSTRACT

The objectives of the present study was to standardize the protocol for production of functional pork loaves and to assess the economics of production of the developed product. Four treatments were prepared with incorporation of inulin powder (IP) as fibre source viz. Control (0% IP; C), 1% (T<sub>1</sub>), 2% (T<sub>2</sub>) and 3% (T<sub>3</sub>) by replacing the amount of lean meat in the product formulation. Different batches were steam cooked at 110 °C for 40 minutes, cooled, sliced and evaluated for different quality parameters. The cooking yield and emulsion stability improved with the increase in level of incorporation of inulin. The cost of production also increased with increase in inulin level in product and calculated as highest in T<sub>3</sub>. The net profit for the control and 1% IP enriched pork loaves was highest whereas lowest for 3% IP pork loaves. The break-even point was estimated on the basis of value ₹ marketed product and calculated as ₹ 1195188.00 for control whereas ₹ 1331576.00 for T<sub>3</sub> and cost-benefit ratio 35% for control and T<sub>1</sub>. Net Income (₹/month) after repayment of loan was highest for control and T<sub>1</sub> as ₹ 77533.00 and lowest for T<sub>3</sub> 70033.00. The estimated details of economics of the developed product concluded that there is marginal increase about 1% in the price of functional pork loaves and this venture can a successful enterprise.

**Keywords:** Pork, loaves, inulin, cost of production, break-even point, cost-benefit ratio

India is bestowed with vast livestock population which plays an important role in the economics of the country. Pig population records around 966.17 million in world and 10.29 million in India (FAO 2012). Pig farming is growing rapidly in India due to a high fecundity, prolificacy, short gestation period, fast growth rate, high feed conversion ratio and higher dressing percentage compared to all other livestock (Khandagale *et al.*, 2013). In India the total meat production estimated to be 6.30 million tonnes, out of which pork share 0.33 million tonnes, accounts for 5.24 % of the total meat production. Meat is considered as nutritious food due to its high biological value proteins, essential fatty acids, vitamin-B complex and mineral content (Mehta *et al.*, 2011; Singh *et al.*, 2014; Verma *et al.*, 2015;) however, it is deficient in the dietary fiber. Nowadays the demand for healthier meat products like fiber-enriched, low-fat, reduced cholesterol, low-salt,

omega-3 enriched fatty acid and with health enhancing bioactive compounds is rapidly increasing worldwide.

The incorporation of fiber in meat products is known to reduce the risk of diseases like colon cancer, diabetes, obesity, cardiovascular diseases, maintain low levels of serum triglycerides, cholesterol and enhance the absorption and bioavailability of minerals (Lopez *et al.*, 1998). Inulin is not absorbed by the gastro-intestinal tract, but it is fermented by the colonic microorganism so it acts as prebiotics. In addition, it improves the cooking yield of meat products it has inherent properties to retain the water and fat during the cooking. In turn reduces the cost of production.

According to the Euro Monitor International, a research company, the amount of money on average an Indian spends on meals outside the home has doubled (Verma *et*

*al.*, 2014). It might be due to the busy lifestyle, increased in purchasing power and change in the food habit. However, apart from nutritional the nutritional benefits, the marketability of the food products are also directed by the economics of the product.

Therefore, the present study was focussed on the development of the protocol for the processing of fibre enriched functional pork loaves along with economics of preparation of low cost value added pork loaves.

### MATERIALS AND METHODS

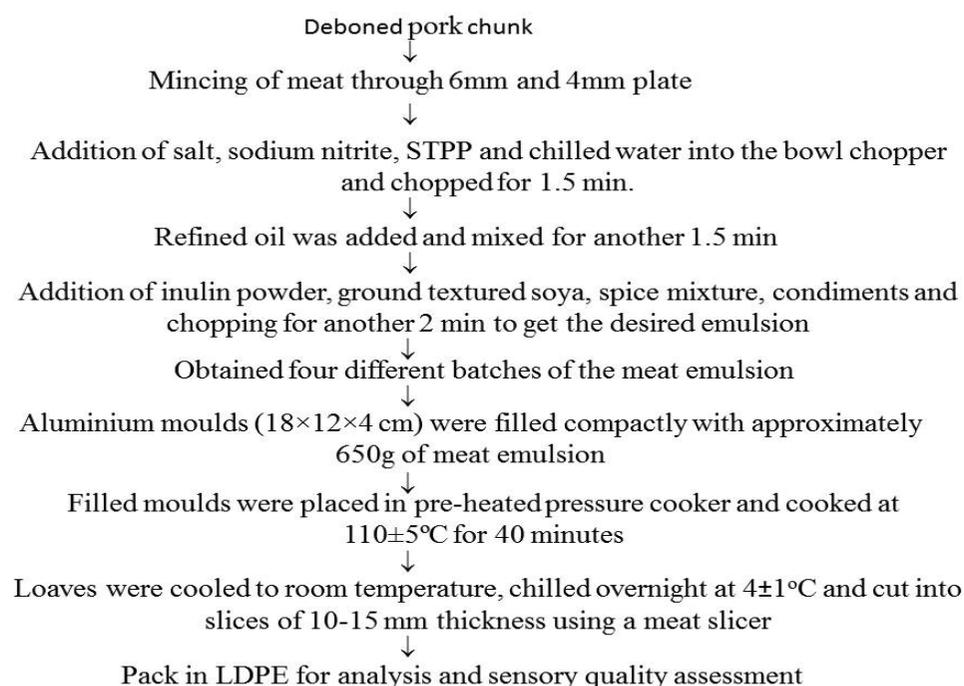
Three castrated Large White York shire pigs of 9-12 months of age, weighing 80-90 kg were purchased from the Livestock Farm, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The animals were slaughtered in experimental slaughter house following the standard procedure while keeping animal welfare aspects in consideration. The carcasses were hot deboned manually and the fascia, external fat and other connective tissue were removed. The recovered deboned meat was chilled overnight in refrigerator, packed in low-density polyethylene (LDPE) bags and stored under frozen condition (-18°C) till further use. All other ingredients including spice and

condiments (onion, garlic, ginger; 3:1:1) mixture used in the study were procured from the local market.

The ingredients for spice mix were procured from local market, cleaned, dried and grinded to fine powder. The spice mix was prepared by mixing different spice ingredients as per the formulation developed in laboratory (Table 1). The condiment mix was prepared by mixing onion, ginger and garlic paste, respectively in 3:1:1 ratio (Table 2). Table salt (Tata Chemicals Ltd., Mumbai), and refined soybean oil (Fortune, Adani Wilmar Ltd) were procured from the local market. All the ingredients were cleaned and dried in industrial drier at 60±2°C for 24 hours and then pulverized in domestic grinder and stored in a moisture free PET (polyethylene terephthalat) jar separately till further use.

### Methodology for Preparation of pork loaves

The deboned frozen pork was cut into small chunks and minced twice in a meat mincer (Mado Eskimo Mew-714, Mado, Germany) through 6mm and 4mm plates. Then emulsion was prepared in a bowl chopper (Model: TC11, Scharfen, Germany) as per the detailed formulation given in Table 1. Four treatments were prepared with



**Figure 1.** Flow diagram for preparation of pork loaves

the incorporation of inulin powder (IP) viz. Control (0% IP; C), 1% (T<sub>1</sub>), 2% (T<sub>2</sub>) and 3% (T<sub>3</sub>). Meat emulsion (approximate 650 g) was manually placed into aluminium moulds (dimension~18×12×4 cm), packed compactly and the lids of the moulds were tightly closed. The emulsion filled moulds from all the treatments were steam cooked in a pre-heated (110±05°C) autoclave without pressure for 40 min. The meat loaves were cooled to room temperature, chilled overnight at 4±1°C and cut into slices of 10-15 mm thickness using a meat slicer (Affettatrici, Sriman, AGATA 300, Padova, Italy) for analysis and sensory quality assessment.

**Table 1:** Cost of formulation of spice mix used in functional pork loaves 397.40 (₹/kg)

Name of ingredients	Quantity (g)	Rate (per Kg)	Approx. Cost
Aniseed (Soanf)	100	120.00	12.00
Black pepper (Kalimirch)	100	725.00	72.50
Caraway seeds (Ajwain)	100	190.00	19.00
Cardamom dry (BadiElaichi)	50	1300.00	65.00
Cardamom dry (ChhotiElaichi)	20	850.00	17.00
Cinnamon (Dalchini)	50	170.00	8.50
Cloves (Laung)	50	1000.00	50.00
Coriander (Dhania)	150	140.00	21.00
Cumin seeds (Zeera)	150	200.00	30.00
Capsicum powder (mirch powder)	80	150.00	12.00
Dry ginger powder (Soanth)	80	280.00	22.40
Mace (Javitri)	50	1000.00	50.00
Nutmeg (Jaifal)	20	900.00	18.00
Total	1000.00	-	397.40

#### Calculation of economics of production:

The economics was worked out with the following technical assumptions:

Per day production of pork loaves is 100 kg.

The unit remains in production for 25 day in a month therefore monthly production target of pork loaves is 100 × 25 = 2500 kg/ month.

Cost of ingredients is calculated on the basis of prevalent market rate in the local market.

To estimate accurate cost of production of pork loaves under commercial conditions, the expenditure incurred in terms of recurring items including labour charges, water and electricity charges, depreciation on machineries, rent, capital investment and its interest, non-recurring charges including cost of machine, equipments and utensils has been taken into consideration.

Income is considered from the sale of pork loaves and not from by-product of pig.

Sale price of pork loaves: ₹ 240/kg.

Price of the live weight of the pig is ₹ 60/kg.

Labour cost for per labourer is ₹ 220/day.

Cost of electricity is ₹ 6.0/unit.

All cost of formulation has been calculated in Rupees.

Formulas used in the calculation of the economics of pork loaves as follow-

Overhead cost (B) = Labour charges (I) + Electricity charges (II) + Depreciation cost per day (III) + Water charges (IV) + Cost of packaging material (V) + Room rent (VI) + Miscellaneous (VII)

**Cost of production for 100 Kg** = Formulation cost (A) + overhead production cost (B)

**Cost for 1 kg pork loaves** = (production of 100 Kg formulation/cooking yield)

**Income** = total sale price - total cost of production

Break-Even point =  $\frac{\text{Fixed cost} \times \text{Total sales}}{\text{Total sales} - \text{Variable cost}}$

Cost-benefit ratio =  $\frac{\text{Total profit}}{\text{Total cost of production}}$

**Net profit/month** = Total Profit- Amount of loan payment/ month

**Table 2:** Cost of formulation of condiment mixture used in functional pork loaves = 53.00/ Kg

Name of the ingredient	Quantity (g)	Rate (per Kg)	Approx Cost
Garlic (1)	200.00	100.00	20.00
Ginger (1)	200.00	90.00	18.00
Onion (3)	600.00	25.00	15.00
Total	1000.00	-	₹= 53.00/-

**Table 3:** Cost of production of deboned pork = 163.28/ Kg

Heads	Cost
Price of live pig	= 60.00/Kg
Dressing percentage (%)	= 72.45
Cost of 1 Kg dressed carcass	$\frac{60.00 \times 100}{72.45} = ₹82.82/\text{Kg}$
Average recovery of deboned meat (%)	= 50.72
Cost of 1 Kg deboned meat	$\frac{82.82 \times 100}{50.72}$
	= 163.28/Kg ( $\approx$ 117/Kg)

**Table 4:** A. Cost production for 100 Kg functional pork loaves

Ingredients	Rate ₹/kg	C		T1		T2		T3	
		Qt. (Kg)	Cost	Qt (Kg)	Cost	Qt. (Kg)	Cost	Qt. (Kg)	Cost
Pork	163.28	69.388	11329.67	68.388	11166.39	67.388	11003.11	66.388	10839.83
Condiment mix (3:1:1)	53.00	3.00	159.00	3.00	159.00	3.00	159.00	3.00	159.00
Spice mix.	397.40	2.00	794.80	2.00	794.80	2.00	794.80	2.00	794.80
Sodium tetra pyro-phosphate	1960.00	0.30	588.00	0.30	588.00	0.30	588.00	0.30	588.00
Refined Oil	90.00	5.00	450.00	5.00	450.00	5.00	450.00	5.00	450.00
Ice Water	-	7.00	-	7.00	-	7.00	-	7.00	-
Egg liquid	100.00	5.00	500.00	5.00	500.00	5.00	500.00	5.00	500.00
Salt	14.00	1.50	21.00	1.50	21.00	1.50	21.00	1.50	21.00
Refined wheat flour	30.00	3.00	90.00	3.00	90.00	3.00	90.00	3.00	90.00
*Texturized soya protein (hydrated 1:3)	200.00	1.00	200.00	1.00	200.00	1.00	200.00	1.00	200.00
Inulin powder	425.00	0.00	00.00	1.00	425.00	2.00	850.00	3.00	1275.00
Sodium nitrite	428.00	0.012	5.14	0.012	5.14	0.012	5.14	0.012	5.14
Baking powder	300.00	0.50	150.00	0.50	150.00	0.50	150.00	0.50	150.00
Sugar	40.00	0.300	120.00	0.300	120.00	0.300	120.00	0.300	120.00
<b>Total (₹)</b>	-	-	14407.61		14669.33		14931.05		15192.77

\*Price of Texturized soya protein calculated on the basis of dry weight i.e. (1%) while in formulation it is take as (3%) on wet basis (Texturized soya protein 1:3 Water)

**B: Overhead production cost for 100 Kg pork loaves.**

**I. Labour charges**

Unskilled worker (5-daily paid labourers)  
 (220.00/day × 5) = 1100/-

**II. Electricity charges**

**Table 5.** Consumption of electricity by equipment

Equipment	Watt × hrs	KWH Unit
Refrigerator (2No.s)	2 × 200 × 24	9.60
Bowl chopper	1500 × 3.0	4.50
Meat mincer	1200 × 4.0	4.80
Pressure cooker	1500 × 6	9.00
Packaging machine	100 × 2	0.20
Light, fan etc.	400 × 8	3.20
Total		31.30

Electricity charge (6/Unit) (31.30 × 6.0) = 187.80/-

**Table 6.** Depreciation cost of equipments used for processing of pork loaves

Equipment	Cost
Refrigerator	35000.00
Pressure cooker	3000.00
Meat Mincer	180000.00
Bowl chopper	150000.00
Sealing machine	6000.00
Stainless steel tables, knives, aluminium mould etc.	10000.00
Total	384000.00/-

Depreciation @10% per annum = 38400.00/-

III. Depreciation cost per day = 105.21/-

IV. Water charges = 25.00/day (Approx.)

V. Cost of packaging material

**Table 7.** Cost of packaging material for control and treatment groups

Groups	Cooking yield	No. of package of products	Cost of packaging materials
Control	91.47 Kg	91470/250g=365.88	366X0.40=146.40
T1	93.21 Kg	93210/250g=372.84	373X0.40=149.20
T2	93.84 Kg	93840/250g=375.36	375X0.40=150.00
T3	94.53 Kg	94530/250g=378.12	378X0.40=151.20

VI. Room rent (5000/ month) = 166.67 per day

VII. Miscellaneous= 150.00 per day

**Table 8.** Total overhead cost for control and inulin enriched pork loaves

Group	Overhead cost
C	1100+187.80+105.21+25.00+146.40+166.67+150.00=1881.08
T1	1100+187.80+105.21+25.00+149.20+166.67+150.00=1883.88
T2	1100+187.80+105.21+25.00+150.00+166.67+150.00=1884.68
T3	1100+187.80+105.21+25.00+151.20+166.67+150.00=1885.88

**Table 9.** Calculation of per kg cost of pork loaves

Group	Cost of production for 100 Kg formulation	For 1 kg pork loaves
Control	14408.00+1825.28=16289.08/-	178.08(≈ 178/-)
T1	14669.00+1828.08=16552.88/-	177.59 (≈ 178/-)
T2	14931.00+1828.88=16815.68/-	179.20 (≈ 179/-)
T3	15193.00+1830.08=17078.88/-	180.67(≈ 181/-)



**Table 10.** Income and total profit from pork loaves

Group	Income/ Kg	Income/100 Kg	Total profit/month
Control	62.00	6200.00	154797.00
T1	62.00	6200.00	156033.00
T2	61.00	6100.00	152012.00
T3	59.00	5900.00	148321.00

**Table 11.** Calculation of variable cost and total project cost for control and treated groups

Group	Fixed cost	Variable cost	Total project cost
Control	384000.00	25x16289/-	407227.00
T1	384000.00	25x 16553/-	413822.00
T2	384000.00	=25x 16816/-	=420392.00
T3	384000.00	=25x 17079/-	=426972.00

Say total project cost = 820000.00

Loan about = 830000

Amount of interest @12%/annum = 99600.00

Amount of loan payment/month= 929600.00/12=77467.00 (12 month only)

**Table 12.** Net profit/ month after payment of loan

Group	Total sales/ month	Variable Cost	Total cost of production/ day	Net profit/ month (After payment of loan 77467/ Month)
Control	600000.00	407227.00	17800.00	77533.00
T1	600000.00	413822.00	17800.00	77533.00
T2	600000.00	420392.00	17900.00	50033.00
T3	600000.00	426972.00	18100.00	70033.00

## RESULTS AND DISCUSSION

Different quality parameters were evaluated to access the effect of incorporation of inulin powder in meat emulsion for low-fat pork loaves (pH, emulsion stability, moisture, fat), as well as in cooked pork loaves viz. physico-chemical properties, cooking determinants, instrumental texture and

colour profile, and sensory quality attributes. Reduction in cooking loss and enhanced water-holding capacity was observed upon addition of fiber in meat products. Results showed that inulin (2%) can be successfully utilized in the formulation of pork loaves without affecting the physico-chemical, textural and sensory attributes. Pork loaves with inulin had higher dietary fiber content and higher cooking yield, juiciness and lower calories.

**Table 13.** Calculation of Break Even Point and Cost benefit ratio control and inulin incorporated pork loaves.

Group	Break-Even Point	Cost-benefit ratio
Control	$384000 \times 600000$ $600000 - 407227$ $=1195188.00$	$6200/17800.00$ $=0.35$ or 35%
T1	$384000 \times 600000$ $600000 - 413822$ $=1237525.00$	$6200/17800.00$ $=0.35$ or 35%
T2	$384000 \times 600000$ $600000 - 420392$ $=1282794.00$	$6100/17900.00$ $=0.34$ or 34%
T3	$384000 \times 600000$ $600000 - 426927$ $=1331576.00$	$5900/18100.00$ $=0.33$ or 33%

The total cost of production of spice mix. for pork loaves was estimated on the basis of ingredients used and average cost of ingredients on existed market price. The amount and rate of ingredients used in formulation are mention in the Table 1. On that basis the total cost of formulation of spice mix. for one kg was ₹ 397.40. The cost of the condiments used in the preparation of the pork loaves was also calculated on the basis of the market price of onion, ginger and garlic listed in the Table 2. The costs of condiments depend on ratio of the onion, ginger and garlic used in condiments. On the basis of the above observations cost of condiment mixture was ₹ 53 per kg.

Cost of dressed meat was calculated on the basis of live weight price i.e. (₹ 60/kg, sale price of GADVASU) of pig weight and on basis of the dressing yield of carcass (72.45%) i.e. calculated in the Table 3 and rate of one kg meat with bone is around ₹ 82.82 /Kg and average recovery of deboned meat (50.72%) from the dressed pig carcass and therefore the price of the one kg deboned pig meat was calculated as ₹ 163.28 (Table 3).

The cost of formulations of control pork loaves and inulin incorporated pork loaves (T1, T2 and T3) were calculated

individually on the basis of ingredients used. The detailed information related to cost of formulation calculations for control and inulin incorporated samples are given in Table 4. The cost of formulation for 100.00 Kg control product is ₹ 14407.61, whereas for T1 ₹ 14669.33, ₹ 14931.05 for T2 and ₹ 15192.77 for T3. The variation in the cost of formulation of pork loaves might be due to the different levels of the meat and inulin powder in the control and treated samples. Similar results were reported by Verma *et al.* (2013) for chicken meat noodles using whole wheat and rice flour.

The laborer charges for pork loaves preparation were intended on the basis of five daily paid laborers used for the preparation of products and other related works. So on the basis of the market laborers rates charges is assumed as ₹ 220 per day. Hence the laborer cost for five laborers was calculated as ₹ 1100.00 per day. Electric charges for pork loaves preparation was calculated on basis of utilization of electricity by various equipment (Table 5) which is estimated as 31.30 KWH per day. The total expenditure was calculated as ₹ 187.80/day considering the cost of one unit of electricity is ₹ 6.0.

The cost of the all the equipments required during this project are mentioned in the Table 6 and their annual depreciation was calculated as ₹ 105.21 per day on the basis of 10% annual rate of depreciation. The requirement of the equipments is same for all the variants of pork loaves.

The packaging material low-density polyethylene (LDPE) for each pack for dispensing of 250 g of the product is calculated as ₹ 0.40/pouch. Therefore, the cost of packaging of product prepared from 100 kg emulsion is estimated as ₹ 146.40, ₹ 149.20, ₹ 150.00 and ₹ 151.20 for control, T1, T2, T3 products, respectively (Table 7). The variation in the packaging cost is attributed to the cooking yield of different products. Water charges, room rent and miscellaneous charges for developed products were calculated as 25.00, 166.67, 150.00 ₹/day, respectively. These charges are comparable for control and treated pork loaves.

The total overhead cost were obtained after addition of laborer charge, electricity charges, depreciation charges, water charge, room rent, miscellaneous charges and cost of packaging material presented in Table 8. Thus the total overhead cost for control pork loaves were calculated ₹ 1881.08, for T1 ₹ 1883.88, T2 ₹ 1884.68 and T3 ₹ 1885.88,

respectively. T3 have higher overhead cost followed by T2, T1 and control it might be due to the difference in the cooking yield and subsequently required number of packaging pouches than control and other treated products.

The production cost of 100 kg pork loaves was calculated with the summation of formulation cost and overhead production cost of all the products groups presented in Table 9. It was found that cost of production of 100 kg pork loaves control group = ₹ 16289.08/- ( $\approx$  16289.00). Cost of production of inulin enriched pork loaves i.e. for T1, T2 and T3 were ₹ 16552.88/100kg ( $\approx$  16552.00), ₹ 16815.68/100kg ( $\approx$  16815.00) and ₹ 17078.88/100 kg ( $\approx$  17078.00), respectively. Profit from sale was around ₹ 62.00/kg, ₹ 62.00/kg, ₹ 61.00/kg and ₹ 59.00/kg from C, T1, T2, T3 groups, respectively (Table 10).

Total project cost was calculated by summation of the fixed cost and variable cost (Table 11) was calculated as ₹ 791227.00 for control, T1 ₹ 797822.00, T2 ₹ 804392.00 and ₹ T3 810972.00. The variation in total project cost among the groups might be due to the variation in the variable cost of different groups (Table 12) and it was highest for T3.

Break-even point and cost-benefits ratio was calculated (Table 12) as ₹ 1195188.00 for control, ₹ 1237525.00 for T1, ₹ 1282794.00 for T2 and ₹ 1331576.00 for T3. The cost benefits ratio decreased in inulin incorporated sample and lower in T2 and T3 than control and T1. It might be due to decrease in total profit value in inulin incorporated sample and increase in total cost of production.

## CONCLUSION

The overall cost for the production of 1 kg of pork loaves was ₹ 178.08 ( $\approx$  178/-) for control, ₹ 177.59 ( $\approx$  178/-) for T1, ₹ 179.20 ( $\approx$  179/-) for T2 and ₹ 180.67 ( $\approx$  181/-) for T3, respectively. Hence, the cost of production of developed fiber enriched loaves was higher by only 1.6 than control, which is very normal. It can be affirmatively concluded from the study that the adaptation of the technology by the entrepreneurs as a business proposal can be profitable venture and hence has a substantial opportunities for the employment generations.

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