ESTIMATION OF PRODUCTION COST FOR HARD-VARIANT OF CHHANA-MURKI (INDIAN COTTAGE CHEESE BASED DESSERT)

 SHALINI ARORA¹*, ASHOK A. PATEL², HARSH GURDITTA², UPASANA YADAV³ and SUMIT MAHAJAN¹
 ¹Department of Dairy Technology, College of Dairy Science and Technology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125004, India
 ²Dairy Technology Division, ICAR- National Dairy Research Institute, Karnal-132001, India
 ³Department of Food and Nutrition, Institute of Home Economics, University of Delhi, Delhi-110016

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ABSTRACT

The study has been aimed to estimate the production cost for hard-variant of *chhana-murki*. The product is a bite size cube and it is a concentrated source of fat and protein. The cost of production of hard-variant of *chhana-murki* was worked out keeping several assumption in to consideration and the major being 300 days of plant run and 500 kg *chhana-murki* production capacity of the plant per day. Various heads were taken into account for estimating the expenditure for production of *chhana-murki* in a running plant namely, cost of raw material, capital requirement, land and building, plant and machinery, manpower, administration, utilities, manufacturing, packaging, cost of by product, marketing, logistics etc. Finally, the cost of production for *chhana-murki* was estimated at Rs. 253.23/kg.

Keywords: Chhana-murki, Cost of production, Paneer, Traditional Indian Dairy Products

The traditional Indian dairy products (TIDPs) represent strong ancient traditions and rich cultural heritage. The popular milk products include *chhana* and *chhana*-based sweets, *khoa* and *khoa*-based sweets, *paneer* and *paneer*-based products and regional *chhana* products. The conversion of milk into TIDPs results in 200% value addition while the western dairy products accounts for about 50% in terms of added value.

Chhana-murki (CM) is a traditional dairy product popular in the northern and eastern region of India. Two varieties of CM are available in the market and the product is prepared from *chhana* as well as *paneer*. The product prepared from *chhana* is soft and syrupy and that obtained from *paneer* is somewhat dry or hard with close-knit texture. Both the varieties are manufactured and marketed by local halwais, with little or no innovation which further limits its up-gradation. Further, the products obtained using traditional practices are not of uniform composition and quality.

Therefore, there is an immense potential of organized manufacturing, mechanized processing, packaging system and marketing of indigenous milk products. The organized production of TIDPs produces product of uniform quality and extended shelf life thereby contribute towards innovation and profit by expanding the product portfolio. After optimization at laboratory scale, the estimation of production costs for process up gradation /mechanized production of *chhana-murki* (hard-variety), at plant scale become essential. Therefore, the analysis of the cost of production of hard variant of CM is vital to study the commercial viability of such product.

MATERIALS AND METHODS

Raw materials

Freshly pooled buffalo milk (7-8% Fat content and 8.5-9% SNF) obtained from institute's cattle yard was received from Experimental Dairy, National Dairy Research Institute (NDRI), Karnal (Haryana), India, in clean, sanitized and dry aluminium can. The milk was standardized as per experimental requirement. Commercially available cane sugar procured from the experimental dairy store of the institute was used for osmotic dehydration and as ingredient. Commercial grade citric acid, monohydrate (SQ grade, Qualigens Fine chemicals, Mumbai, India) was used for adjusting pH for coagulation of milk. The rose flavour was procured from local suppliers of International Flavors & fragnances (IFF) at Karnal, Haryana, India.

Preparation of hard-variant of chhana-murki

Freshly pooled buffalo Milk (7-8% Fat and 8.5-9% SNF)

Standardization (5.5 % Fat and 8.5% SNF)

$$\downarrow$$

Heating (up to 90° C)
 \downarrow
Cooling to coagulation temperature (81° C)
 \downarrow
Addition of acidulant solution (Citric acid @ 1% w/v)
 \downarrow

Draining of whey

^{*}Corresponding author: shaliniarora.luvas@gmail.com

$$\downarrow$$
Hooping
$$\downarrow$$
Pressing (0.047kg/cm²) for 15 min
$$\downarrow$$
Cutting into blocks
$$\downarrow$$
Dicing of paneer into one cm cubes
$$\downarrow$$
Cooking of paneer cubes in boiling syrup (5-10 min each)
$$\downarrow$$
Sieving of panner cubes and condensing of syrup (10 min)
$$\downarrow$$
Heating discontinued
Paneer cubes again added in condensed syrup
$$\downarrow$$
Stirring and slow shaking till dryness (for 10-15 min or till coating of sugar)
$$\downarrow$$
Hard-variant of chhana-murki
$$\downarrow$$
Allowing to cool
$$\downarrow$$
Packaging and Storage

Techno-economic feasibility

The cost of production of hard variant of *chhana-murki* was estimated after standardizing the ingredients and the process protocol for the product manufactured. For this purpose, the cost analysis data available with the operational aspect of the Experimental Dairy Plant, NDRI, Karnal was utilized as the basis. The cost of manufacture of *chhana-murki* was estimated as per the guidelines given by Singh and Kalra (1979), Prajapati (1988), Marouli and Maroulis (2005) and Chauhan *et al.* (2007) with some

modifications. In order to arrive at a reasonably realistic cost, estimate of processing and that of the end product, certain assumptions were made.

Basic Assumptions for Cost Estimation

Plant capacity: *Chhana-murki* would be a part of composite milk plant handling 50,000 L of milk per day for producing market milk, dahi, paneer and ghee (from surplus fat). 1923 L of milk would be utilized for making 385 kg of paneer (corresponding to 20% yield) and 284.51 kg of sugar would be used for manufacturing 500 kg *chhana-murki* on a daily basis. This would yield 150 tonnes of product per annum (300 working days).

Manufacturing schedule: It was assumed that the plant would be operating in 2 shifts of 8 hours each. Half of the second shift would be used for cleaning and maintenance of the plant. The plant would be operated for 300 days a year. The demand was expected to match with the production and the product dispatch would be made on every alternate day.

Milk procurement: Milk will be procured through a contractor, and will be delivered at the factory site in chilled condition.

Product mix: Buffalo milk testing 6.0% fat and 9.0% SNF would be received and standardized to 5.5% fat and 8.5% SNF. Paneer would be the main product and ghee would constitute a minor product (by-product). The mass balance showing respective quantities of the main product and the minor product is given in Table 1.

Cost of raw materials and products: All the ingredients/ raw materials other than milk required for the *chhanamurki* would be purchased from the open market. Further, while calculating the values for direct and indirect costs, the most recent cost data available with the Dairy Plant of the Institute for the year were considered.

RESULTS AND DISCUSSION

Capital Requirement: A comprehensive list of the major processing equipment used for processing 1923 L of milk per day (for CM), corresponding to 150 tonnes of the finished product per annum is given in Table 2. The total

	Material balance for producing 500 kg CM per day					
S.No.	Input	Output				
	Particulars	Quantity (kg)	Particulars	Quantity (kg)		
1	Buffalo milk (having 6.0% fat and 9.0% SNF)	1923	Paneer*	385		
2	Surplus fat	11.5	Ghee	10.9		
3	Paneer	384.5	Chhana-murki	500.00		

Table 1

* Paneer prepared from buffalo milk standardized to 5.5% fat and 8.5% SNF.

Table 2

Items of major capital investment, their cost and annual depreciation for processing of 1,923 liters of milk per day for CM manufacture

Items	Particulars	Nos.	Rate (Rs)	Estimated cost (Rs)	Depreciation rate (%)	Annual depreciation (Rs)	Depreciation for CM (Rs)
Milk reception equipment (weighing balance, dump tank, milk pumps, can etc)	5000 L/h	01	100000.00	100000.00	5	5000.00	500.00
Plate Chiller (PHE)	3000 L/h	01	100000.00	100000.00	5	5000.00	500.00
Storage tank	6000 L	01	150000.00	150000.00	5	7500.00	750.00
Balance tank	250 L	02	10000.00	20000.00	5	1000.00	100.00
Feed pump	2 HP	01	25000.00	25000.00	10	2500.00	250.00
Cream pump		01	15000.00	15000.00	10	1500.00	150.00
Sanitary pump		02	15000.00	30000.00	10	3000.00	300.00
Pasteurizer	3000 L/h	01	100000.00	100000.00	5	5000.00	500.00
Cream separator	1000 L/h	01	150000.00	150000.00	15	22500.00	2250.00
Paneer vat with accessories	3000 L	01	200000.00	200000.00	5	10000.00	1000.00
Paneer dicing machine	250 kg/h	01	125000.00	125000.00	10	12500.00	1250.00
Cold store and Refrigeration unit	1 tonne	01	150000.00	150000.00	15	22500.00	2250.00
Ghee boiler/kettle	250 L	01	60000.00	60000.00	5	3000.00	300.00
Steam boiler	500 kg/h	01	500000.00	500000.00	15	75000.00	7500.00
Power generator	100 KVA	01	500000.00	500000.00	15	75000.00	7500.00
Water storage tank	50000 L	01	160000.00	160000.00	5	8000.00	800.00
Pipe and fittings accessories			200000.00	200000.00	5	10000.00	1000.00
Cream storage tank	1000 L	01	50000,00	50000.00	5	2500.00	250.00
Steam kettle for <i>chhana-murki</i> with agitator and scraper	200 L	02	50000.00	100000.00	5	5000.00	500.00
Packaging unit		01	300000.00	300000.00	5	15000.00	1500.00
ETP unit		01	400000.00	400000.00	5	20000.00	1000.00
Light commercial vehicle		01	250000.00	250000.00	10	25000.00	2500.00
Lab equipment			50000.00	50000.00	10	5000.00	500.00
Total				37,35,000.0	0	3,41,500.00	34,150.00

¹The plant is having a processing capacity of 20000 LPD out of which 1923 kg milk is being used for manufacturing CM which is approximately 10% and that is why depreciation attributed to CM making has been approximated as 10% of total depreciation.

depreciation cost for these items were calculated as Rs. 34,150 (only for CM production) the details of which are given in Table 2. The costs shown are location specific for the estimation. The same format, however, could be adapted for costing of CM prepared under any given situation.

Direct Cost

Cost of raw materials: For calculating the cost of various ingredients used in the manufacture of paneer, the current (2017-18) market rates have been considered (Table 3). The various raw materials required for manufacturing 150 tonnes of CM per annum have been worked out. It may be observed from the table that the total cost of raw materials was estimated to be Rs. 3,28,48,152.00.

Labour and supervision: In accordance with the manufacturing operations to be performed in all operating shifts, the requirements of the personnel needed for the manufacture of 150 tonnes CM per annum were computed. The persons directly involved in the production are included plant operators and manufacturing labour. The total direct cost for labour and supervision was estimated at Rs. 6,54,000.00 per annum (Table 4). Labour and supervision charges are specific for the situation considered and are proportional to the volume of production. Since these charges are likely to depend on the complexity of plant, extent of automation and manufacturing practices, these need to be calculated for the specific situations.

	Table 3			
Raw materials cost for the pr	roduction of	f 150 tonnes	CM per	annum

S.No.	Items	Requirer	Requirement (kg)		Annual cost (Rs)
		Daily	Annual		
1.	Milk	1922.5	576750	50	2,88,37,500.00
2.	Citric acid anhydrous	3.36	1008	504.00	5,08,032.00
3.	Sugar	284.51	85353	40.00	34,14,120.00
4.	Rose flavor	0.5	150	590.00	88,500.00
				Total	3,28,48,152.00

Table 4

Table 4						
	Direct cost of personnel for producing 150 tonnes CM per annum					
S.No.	Staff	Number	Monthly salary	Monthly cost (Rs)	Annual cost (Rs)	
1	Labourers	02	4000.00	8000.00	96,000.00	
2	Skilled technical workers	02	5000.00	10000.00	1,20,000.00	
3	Mechanic/electrician	01	7500.00	7500.00	90,000.00	
4	Boiler attendants	01	7500.00	7500.00	90,000.00	
5	Lab analyst	01	7500.00	7500.00	90,000.00	
6	Lab attendant	01	4000.00	4000.00	48,000.00	
7	Technical Supervisors/In charge	01	10,000.00	10,000.00	120,000.00	
				Total	6,54,000.00	

Table 5					
S.No.	Type of packaging materials	Requirement (kg)		Rate (Rs/kg)	Annual cost (Rs)
		Daily	Annual		
1	PP bags for FCM (for packing 500 g)	5	1500	300.00	4,50,000.00
2	HDPE pouches for ghee	0.15	45	300.00	13,500.00
3	Corrugated box (5 kg/box) for CM	100	30000	15	4,50,000
4	Corrugated box (5 kg/box) for ghee	-	10	15	150
				Total	9,13,650.00

Packaging: In this costing exercise, 500 g packaging in polypropylene (PP) sachets for CM and 1 kg packaging in HDPE pouches for ghee were envisaged for retail selling of the product. Considering the packaging charges for 500g packing for *chhana-murki* as Rs. 300 per kg PP sachets, for 1 kg packing for ghee as Rs. 300 per kg sachets and Rs. 15 for one corrugated box for 5 kg of the product being packed, the total cost of packaging for 150 tonnes of CM and 10.9 tonnes of ghee was reckoned to be Rs. 9,13,650.00 (Table 5). Since the cost of packaging depends on the size and cost of packaging materials, the total cost incurred in the packaging has to be assessed separately for a given size of packaging in a given type of system.

Utilities: Individual items of utility services were determined and itemized in Table 6. It may be seen that the total cost of utilities worked out to be Rs. 4,33,244.61 per

annum. The extent of various utility services depends upon the efficacy of the plant. The cost of utilities, therefore, varies from plant to plant and thus needs to be figured out for a given situation.

Indirect Cost

The indirect costs are situation specific and are proportioned to the volume of production. Therefore, depending upon the existing facilities, the indirect costs need to be computed individually for a particular situation.

Detergents and chemicals/glasswares: Under this category, the expenditure incurred as common detergents such as caustic soda, teepol etc. are considered. The estimate for detergents is presented in Table 7.

Manpower (Adm.): The total indirect cost for administrative personnel was calculated keeping in mind the manufacture of other products as well (Table 8).

Table 6
Electricity, steam and refrigeration requirement for the CM production unit

a.	Electricity requirement for the	e CM production unit	Ţ		
S.No.	Particulars	Motor (HP) (I)	Total working hours (II)	kWh (units/day) (III) = $I*II*0.746^{1}$	kWh Annually (III*300)
01	Reception	2	1	1.492	447.60
02	Pasteurizer	2	0.5	0.746	223.80
03	Cream separator	2	1	1.492	447.60
04	Delivery of processed milk	1	0.5	0.373	111.90
05	Agitator for storage tank (2)	1	1	0.746	223.80
06	Agitator for cream tank	1	2.5	1.865	559.50
07	Cream pump	1	0.5	0.373	111.90
08	Steam kettle with agitator (02)	1	3*2	4.475	1342.50
09	Compressor(2)	5	6	44.76	13,428.00
10	Fan, A/C, Tube light, etc.			50.00	15,000.00
11	Packaging	2	1	1.492	447.60
12	ForETP	2	2.5	3.73	1119.00
	Total			111.55	33,463.20
b.	Steam requirement				
S.No.	Particulars			Daily (kg)	Annual (kg)
01	<i>Ghee</i> making (once in a week)			30.70	1473.6
02	Paneer preparation			356.70	1,07,010.00
04	Chhana-murki			25.75	7725.00
	Total			413.18	1,16,208.6
c.	Refrigeration requirement				
S.No.	Particulars			Daily (kJ)	Annual (kJ)
01	Chilling of milk (27 to 40 °C)			23392.6	1,40,35,566.0
02	Cool (85 to 75 °C)			19765.7	1,18,59,420.0
03	Cold Storage			3586.25	21,51,750.0
04	Storage tank			2034.15	12,20,466.0
	Sub Total			48778.7	2,92,67,220.0
	Assume 20% loss			3902.30	58,53,444.0
	Total			58534.4	3,51,20,664.0 ¹
a.	Charges on power and utilitie	S			
S.No.	Particulars	Quantity required	,	Rate (Rs)	Annual cost (Rs)
	D	aily	Annual		
01	Electricity 11	1.55	33463.20	5/unit	1,67,316.00
02	Steam 49	95.78	116208.60	325/1000 kg	37,767.75
03	Refrigeration 58	3534.40	35120664.00	18/100000 kJ	3160.86
04	Water 15	5000 L	4500000.00	10/1000 lit.	2,25,000.00
	Grand Total				4,33,244.61

 1 1HP = 0.746 kW

	Table 7						
Cost of detergents and chemicals							
S.No.	Items	Daily cost	Annual cost				
		(Rs)	(Rs)				
1	Caustic soda, teepol, etc.	8.33	2500.00				
2	Glass wares/chemicals	10.00	3000.00				
	Total	18.33	5500.00				

Fixed Cost

Interest on capital investment: Under the fixed costs, the elements included are interest on total capital outlay that comprises fixed capital and working capital. The working capital was calculated on the basis of one month cost of raw materials and one month salary of the staff who would be directly involved in the production of 150 tonnes CM per annum. The total fixed and working costs and their

 Table 8

 Indirect cost for administrative staff* for producing 150 tonnes CM per annum

S.No.	Staff	Number	Monthly salary	Monthly cost (Rs)	Annual cost (Rs)
1	Factory Manager	01	25000.00	25000.00	3,00,000.00
2	Assistant Manager	01	15000.00	15000.00	180,000.00
3	Clerks	01	5000.00	5000.00	60,000.00
4	Store keeper	01	7500.00	7500.00	90,000.00
5	Accountant	01	7500.00	7500.00	90,000.00
6	Attendants	01	4000.00	4000.00	48,000.00
7	Security staff	01	4000.00	4000.00	48,000.00
8	Driver	01	4000.00	4000.00	48,000.00
9	Helper	01	2000.00	2000.00	24,000.00
	Total				8,88,000.00

*Calculation was made keeping in mind the production of CM only

interests at the rate of 12% are given in Table 9. The total interest on these capitals was computed to be Rs. 40,91,771.64 per annum.

T.L.L. 0

	Table 9							
Interest on capital								
S.No.	Particulars	Amount (Rs)	Annual interest					
	(<i>a</i>) 12%							
1	Fixed capital (land, building, plant and machinery)	5,63,500.00	67,620.00					
2	Installation cost	32,445.00	3,893.40					
3	Working capital (being the value of raw materials, salaries and utilities for one month)	3,35,02,152.00	40,20,258.24					
	Total		40,91,771.64					

Maintenance: The estimate for maintenance of equipment, building and other expenses is shown in Table 10. Rs.12,500 has been allocated towards the maintenance cost keeping in mind the production of CM only.

Total Direct and Indirect Costs

The various direct, indirect and fixed costs involved in the production of 150 tonnes of CM per annum are elucidated in the preceding sections. The total of direct, indirect and fixed costs is shown in Table 10. The grand total of direct, indirect and fixed costs was ascertained to be Rs. 3,98,80,968.25 per annum.

Revenue from Sale of Ghee (from Surplus Fat)

The surplus fat resulting from standardization of buffalo milk for desired fat and SNF in the milk for CM, was contemplated for making ghee. In the process of manufacturing 150 tonnes of CM, 3,270 kg of ghee would be obtained which was expected to generate a revenue of

Table 10

Direct, indirect and fixed costs for handling producing 500 kg CM per day

S.No.	Component	Annual cost (Rs)
	A. Direct costs	
1	Raw materials	3,28,48,152.00
2	Packaging	9,13,650.00
3	Manpower	6,54,000.00
	(labour and supervision)	
4	Uatilities	4,33,244.61
	Sub-total	3,48,49,046.61
	B. Indirect costs	
1	Manpower (Administrative)	8,88,000.00
2	Estimated expenditure on	5,500.00
	detergents, glass wares and	
	chemicals for quality control	
	Sub-total	8,93,500.00
	C. Fixed costs	
1	Depreciation	34,150.00
2	Interest	40,91,771.64
3	Maintenance	12,500.00
	(equipment, building, etc.)	,
	Sub-total	41,38,421.64
	Total (A+B+C)	3,98,80,968.25

Rs. 18,96,600 per annum (Table 11).

The revenue obtained through the sale of ghee would reduce the cost of CM. Since the sale price of ghee fluctuates over a period of time, the net revenue through the sale of ghee need to be evaluated from time to time with a view to evaluate the actual cost of the product.

Net Manufacturing Cost

With a view to compute the net manufacturing cost, the total direct, indirect and fixed costs involved in the production of 150 tonnes CM per annum and the revenue

 Table 11

 Revenue generated through the sale of the by-product (ghee)

 from the manufacture of 150 tonnes of chhana-murki

S.No.	Particulars	Sales (kg)		Rate	Annual
		Daily	Annually	(Rs/kg)	sales (Rs)
1	Ghee	10.9	3,270	580.00	18,96,600
				Total	18,96,600

obtained through the sale of by-product (ghee) were considered. The total manufacturing cost was calculated to be Rs. 3,98,80,968.25 per annum. Since the revenue obtained from the sale of by-product ghee accounted for Rs. 18,96,600 per annum, the net production cost was estimated to be Rs. 253.22 per kg CM (Table 12).

Table 12 Net manufacturing cost and returns from packaged chhana-murki

Cintana-marki					
Item	Amount (Rs.)				
Annual total manufacturing costs	3,98,80,968.25				
Less revenue obtained from sale of by-product (ghee)	18,96,600.00				
Estimated Net cost of production of <i>chhana-murki</i> /kg	253.23				
Market Price of chhana-murki/kg	350.00				
Net returns from <i>chhana-murki</i> /kg	96.77				

CONCLUSIONS

The cost of production and net returns per kg of *Chhana-murki* in 500 g polypropylene pouches was

estimated as Rs. 253.23 and 96.77, respectively. Since the estimate was made using the operational cost data of the Experimental Dairy plant at NDRI, Karnal, which is not exclusively a commercial unit meant for production of CM, the cost projections shown here are on the liberal side. Under commercial conditions at higher scale of handling, the cost of production is expected to be lower. The economic viability of production of this product thus appeared to be quite promising.

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