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Estimation of Production Cost for Omega-3 Fatty Acid Incorporated Processed Cheese Spread

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Abstract: ***In the present study production cost of functional cheese spread, where ω-3 fatty acid (addition @ 2%) was incorporated, has been estimated. The processed cheese spread was manufactured in a cheese plant with an assumption of 1000 kg cheese spread production per day. Cost for land and building, plant and machinery, other fixed assets, manpower, utilities, raw material, laboratory charges, cleaning and sanitizing, maintenance and repair, interest, depreciation, insurance and taxes, advertisement, marketing and distribution etc. were calculated. It was estimated that the production cost of ω-3 fatty acid incorporated cheese spread (₹ 26.75/100 g) was 32.68% higher as compared to control cheese spread (₹20.16/ 100 g).***

Keywords: Processed cheese spread, Functional cheese, ω-3 fatty acid, Cost, Cheese plant

1. Introduction

Today, foods are not only intended to satisfy hunger and provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers. In this regard, functional foods play an outstanding role. The market for spreadable products is undergoing radical change the world over. Functional cheese spreads are becoming prominent among these categories of products. Butter, the traditional table spread essentially for bread is now avoided due to poor spreadability, high saturated fat and cholesterol content. The annual growth rate of cheese production in India is 10-15% and 30% cheese is consumed in the form of processed cheese spread [1]. Processed cheese spread contains not only the protein and fat that are in pre-digested form, in addition to calcium, phosphorus, riboflavin and other vitamins in a concentrated form and also contains health beneficial bioactive peptides [2]. Not only that, cheese spread contains higher amount of protein and lower amount of fat as compared to any low fat table spread. So, cheese spread provides nutritionally superior spreadable product and further certain functional ingredients can be incorporated in it to make the product healthier. In this direction it is expected that there will be inspiring demand in the market for functional cheese spread. Omega-3 fatty acid which is a well known functional ingredient plays a crucial role in brain function as well as normal growth and development. It becomes popular because it reduces the risk of heart disease [3]. Also it has beneficial effect on cancer, eye health, rheumatoid arthritis etc. So, objective of the study was to estimate the cost of production of newly developed ω-3 fatty acid incorporated processed cheese spread (OPCS) to be produced in a cheese plant.

2. Material and Methods

Cheddar cheese was manufactured according to the method described by Kosikowski [4] and using this cheddar cheese OPCS was manufactured according to the method given in Figure 1 [5]. The manufacturing cost of OPCS was worked as per the guidelines suggested by Prajapati et al. [6, 7]; Chauhan et al. [8] and Choudhery et al. [9]. The cost of different components used in the manufacture of OPCS was taken as on January, 2012. In order to arrive at a reasonable realistic cost of processing and that of the end product, certain assumptions were made.

2.1 Techno-Economic Feasibility

The information given below was of a cheese making plant with rated capacity of 1,000 kg of control processed cheese spread (CPCS) or OPCS per day on the basis of two shifts working for 8 h duration in a day. It was also assumed that the production was based on 80% of the installed capacity and an expected yield of CPCS was 15.5% of milk. In this project, it was assumed that the cheese plant would be an extension of an existing dairy plant from where standardized pasteurized milk would be taken for cheese manufacturing.

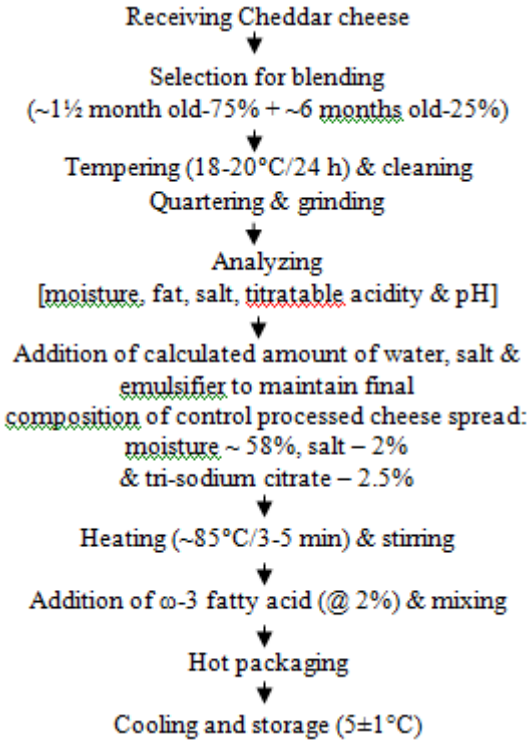

Figure 1: Process flow diagram for manufacture of ω-3 fatty acid incorporate processed cheese spread

2.1.1. Location
The plant should be situated near the source of supply of raw material especially for milk. It should also be well connected by transport so as to supply the final products to distributors/retailers.

2.1.2. Land and building
An industrial shed of ~ 7500 m^2 covered area would be adequate for the project and it should have all facilities for the production and packaging of cheese as well as for its storage.

2.1.3 Capacity
The rated capacity of feasible cheese plant could be 1,000 kg of cheese/day. Total working days per year have been taken as 365 since milk procurement cannot be stopped even for a single day. The capacity could be increased to 1,500 kg/day if the plant was operated on three-shift working basis.

2.1.4 Raw Material
Milk was the main raw material and its total requirement worked out to about 6,000-6,500 kg/day. Other raw materials were starter, rennet, salt, emulsifier, ω-3 fatty acid, nisin (bio-preservative), packaging material, etc.

2.1.5 Plant and Machinery
The plant and machinery included milk storage tank, milk can, cheese vat, cheese table, cheese knives, cheese hoops, pneumatically cheese press, Stephan cooker, weighing balance, milk pump, plate heat exchanger (PHE), whey storage tank, milk pasteurizer with accessories, curd milling machine, vacuum packaging machine, cheese tubs filling and sealing machine, batch and price printing machine, box strapping machine, air curtain, boiler, refrigeration unit, generator etc.

2.1.6 Power
The total power requirement worked out to 420 unit and it was assumed that the cost of power was Rs. 5/unit. Coefficient of performance (COP) of compressors equipped with refrigeration system of the plant was calculated as suggested by Arora [10] as following:

$$COP = \frac{H2-H1}{H3-H2}$$

Where, H_1 = Enthalpy of ammonia vapour at suction pressure and temperature; H_2 = Enthalpy of ammonia vapour at discharge pressure and temperature; H_3 = Enthalpy of saturated liquid ammonia

Refrigeration load = M x S x T

Where, M = Quantity of product to be cooled; S = Specific heat of the product; T = Temperature difference in centigrade

2.1.7 Water
Daily water requirement was about 50,000 l/day and it should be sweet and soft. Provision should be made for storage tank.

2.1.8 Steam
The requirement for steam would be 150 kg/h or 1434 kg/day. It was assumed that the cost of steam was Rs. 2/unit.

Steam requirement (kg) = $\frac{M \times S \times T}{L}$ [11]

Where, M = quantity of the product to be heated (kg); S = specific heat of product; T = Temperature difference of initial and final temperature of the product in centigrade; L = Latent heat of steam

It was assumed that for generator ~ 20 l light diesel oil (LDO) was used daily and the cost of LDO was Rs. 83/l.

2.1.9 Effluent
Attempt should be taken to ensure that the effluent is rendered harmless and non-toxic as per requirements of the pollution control board.

2.1.10 Marketing
With institutional buyers, direct consumer market should also be tapped, because cheese will be produced in consumer packs. Distributors interested must be contacted in advance for smooth marketing arrangements. The thumb rule provides 20% commission shared between distributors, stockiest and retailers.

2.1.11 Cheese whey
It was assumed that during Cheddar cheese manufacture yield of the Cheddar cheese and whey were 10% and 90%, respectively. So, the total production of cheese whey would be 6452 x 0.9 = 5807 kg. The cheese whey would be given back to the dairy plant for blending purposes. It was assumed that 2/3 of whey produced will be used for blending.

3. Results and Discussion

Different cost such as land and building (Table 1), plant and machinery (Table 2), other fixed assets (Table 3) to produce 1000 kg processed cheese spread in a cheese plant have been estimated. The total fixed capital was of ₹ 3,12,26,500 included land and building ₹ 74,62,500, plant and machinery ₹ 1,94,99,000 and other fixed assets ₹ 42,65,000. The annual expenditure for man power (Table 4), utilities (Table 5), maintenance and repair (Table 7) were ₹ 40,20,000; 24,55,720; and ₹ 12,80,075, respectively. The cost of control processed cheese spread and OPCS, in case of raw material (Table 6), laboratory charges, cleaning and sanitizing (Table 7) were ₹ 4,80,78,785 and 6,72,45,224; ₹ 94,272 and 1,06,303 and ₹ 47,136 and 53,152, respectively indicated that the enhancement of the functionality of cheese spread as the ω-3 fatty acid was incorporated into the cheese spread, the raw material cost, laboratory charges, cleaning and sanitizing cost increased as compared to control. Finally, the estimated product cost of CPCS and OPCS were ₹ 20.16 and 26.75, respectively for 100 g product. It was found that the cost of production of OPCS was 32.68% higher as compared to control. Further, it was observed that in CPCS contribution of raw material, advertisement, marketing and distribution, fixed charges, maintenance and repair, power-fuel-water charges and manpower cost of total production cost were 59.0, 18, 13, 2, 3 and 5%, respectively (Figure 2), whereas in OPCS these costs were 64.0, 18, 10, 1, 3 and 4%, respectively.

Table 1: Cost for land and building

Items	*Rate (₹/m²)*	*Quantity (m²)*	*Total cost (₹)*
Land (Assuming land=10 times of building area)	750	7,500	56,25,000
Building			
Production area	2,500	375	9,37,500
Cheese storage room	2,500	150	3,75,000
Boiler and refrigeration area	2,000	100	2,00,000
Office	3,000	50	1,50,000
Toilet	3,000	25	75,000
Effluent treatment plant	2,000	50	1,00,000
Total (Land and building)			74,62,500

Table 2: Cost for plant and machinery

Items	*Rate (₹)*	*Qty. rec. (No.)*	*Total cost (₹)*
Milk storage tank (Insulated), 10,000 l	10,00,000	1	10,00,000
Milk can (Aluminium), 40 l	2,000	10	20,000
Cheese vat (Closed, Jacketed, SS), 3000 l	14,00,000	2	28,00,000
Cheese vat (Closed, Jacketed, SS), 250 l	4,00,000	2	8,00,000
Cheese cutting table (4mX2m, SS)	60,000	1	60,000
Cheese knives 1/2" (Vertical and Horizontal both)	1,00,000	2	2,00,000
Cheese hoops, 20 kg	8,500	40	3,40,000
Pneumatically cheese press, Horizontal	5,00,000	2	10,00,000
Stephan cooker	30,00,000	2	60,00,000
Weighing balance platform type, 500 kg	40,000	2	80,000
Weighing balance, 10 kg	4,000	1	4,000
Milk pump, 10,000 l/h	45,000	1	45,000
PHE (Double section with all accessories; 4°C to 32°C; 10,000 l/h)	5,50,000	1	5,50,000
Whey storage tank, 5000 l	30,000	1	30,000
Pasteuriser with accessories, 5000 l/h	10,00,000	1	10,00,000
Curd milling machine, 1000 kg/h	3,60,000	1	3,60,000
Vacuum packaging machine	4,00,000	1	4,00,000
Cheese tubs filling and sealing machine; 25-30 tubs/min	8,00,000	1	8,00,000
Batch and price printing machine	15,000	2	30,000
Box strapping machine	50,000	1	50,000
Air curtain	15,000	2	30,000
Boiler (oil fired) and accessories 500 kg steam/h	10,00,000	2	20,00,000
Complete set of refrigeration unit for 2 cold stores	12,00,000	1	12,00,000
Generator	7,00,000	1	7,00,000
Total (Plant and machinery)			1,94,99,000

Qty. rec. - Quantity required

Table 3: Cost for other fixed assets

Items	*Rate (₹)*	*Quantity required (No.)*	*Total cost (₹)*
Computer and other accessories	60,000	5	3,00,000
Furniture			6,00,000
Fire fighting	5,000	10	50,000
Laboratory equipment			20,00,000
Trolley	20,000	4	80,000
Exhaust fan	5,000	7	35,000
Steam and water pipeline			5,00,000
Cold store racks			5,00,000
Electrification			50,000
Installation nd erection @ Rs. 7.5% of equipment cost			50,000
Miscellaneous			1,00,000
Total (Other fixed assets)			42,65,000

Table 4: Cost for man power/month

Items	*Salary (₹)*	*No. of persons required*	*Total salary (₹)*
Operational supervisors			
Shift supervisor	21,000	3	63,000
Operating labour			
Lab analyst	10,500	3	31,500
Lab attendant	5,000	2	10,000
Electrician	10,500	2	21,000
Boiler attendant	10,500	2	21,000
Skilled worker	7,500	3	22,500
Unskilled worker	5,000	15	75,000
Administrative			
Plant Manager	45,000	1	45,000
Clark-cum-accountant	10,500	1	10,500
Store keeper	10,500	1	10,500
Attendant	5,000	1	5,000
Security staff	5,000	4	20,000
Total salaries			3,35,000

Table 5: Cost for utilities

Item	*Daily use*	*Annual use*	*Rate (₹)*	*Annual cost (₹)*
Electricity, unit	420	1,53,300	5	7,66,500
Steam, kg	1,434	5,23,410	2	10,46,820
Fuel, l	20	7,300	83	6,05,900
Water, 1000 l	50,000	1,82,50,000	2	36,500
Total				24,55,720

Table 6: Cost of raw material required/day

Items	*₹/kg or No.*	*CPCS*		*OPCS*	
		Quantity	*₹*	*Quantity*	*₹*
Milk (~4% F, 9% SNF; Fat @ ₹ 430/kg)	18.00	6,450	116,100.00	6,323.58	1,13,824.40
Starter			150.00		150.00
Rennet (@ 0.002% of milk)	700.00	0.129	90.30	0.12647	88.53
Salt (@ 2% in CPCS)	10.00	20	200.00	19.6	196.00
Emulsifier (@ 2.5% in CPCS)	350.00	25	8,750.00	24.51	8,578.50
ω-3 fatty acid (addition @ 2%)	458.00	-	-	19.6	18,933.60
Nisin (product contain 0.04%)	9,624.00	0.4	3,849.60	0.4	3,850.00
Packaging material, 10,000 container/day	3.50	10,000	35,000.00	10,000	35,000.00
Total			1,29,139.90		1,82,978.70
Operational loss @ 2% of raw material and packaging material			2,582.80		3,612.42
Total (Raw material/day)			1,31,722.70		1,84,233.50

CPCS: Control processed cheese spread; **OPCS:** ω-3 fatty acid incorporated processed cheese spread

Table 7: Production cost (₹) of control and ω-3 fatty acid incorporated processed cheese spread

Items	*CPCS*	*OPCS*
A. Manufacturing cost / annum		
a. Direct product cost		
Raw material	4,80,78,785	6,72,45,224
Man power	40,20,000	40,20,000
Power, fuel, water (calculated)	24,55,720	24,55,720
Maintenance and repair, @ 5% of fixed capital	12,80,075	12,80,075
Laboratory charges, @ 0.2% of cost of raw material (excluding packaging and operational cost)	94,272	1,06,303
Cleaning and sanitizing machine, @ 0.1% of cost of raw material (excluding packaging and operational cost)	47,136	53,152
Total (Direct product cost)	5,59,75,988	7,51,60,474
b. Fixed charges		
Interest on total capital investment (16.5% of TFC and TWC of 3 months)	73,75,578	81,55,363
Depreciation on capital investment, [Building @ 2.5%; (30 years), equipment @ 6% (15 years)]	14,71,778	14,71,778
Insurance and taxes (@ 2% of TFC)	6,24,530	6,24,530
Total (Fixed charges)	94,71,886	1,02,51,671
Manufacturing cost (A = a+b)	6,54,47,873	8,54,12,145
B. Advertisement, marketing and distribution @ 20% of manufacturing cost / annum	1,30,89,575	1,70,82,429
It was assumed that 2/3 of whey produced will be used for blending		
C. Whey cost (assuming Rs 50/kg of milk solids and whey containing 7% solids) / annum	49,43,925	48,47,024
Total cost / annum (A +B-C)	7,35,93,523	9,76,47,550
Per annum cheese spread production = 365000 kg		
Cost of 1 kg cheese spread	201.63	267.53
Cost of 100 g cheese spread	20.16	26.75
% Cost increase compare to control cheese spread		32.68

CPCS: Control processed cheese spread; **OPCS:** ω-3 fatty acid incorporated processed cheese spread; **TFC:** Total fixed capital; **TWC:** Total working capital (Cost of raw material, utilities and man power)

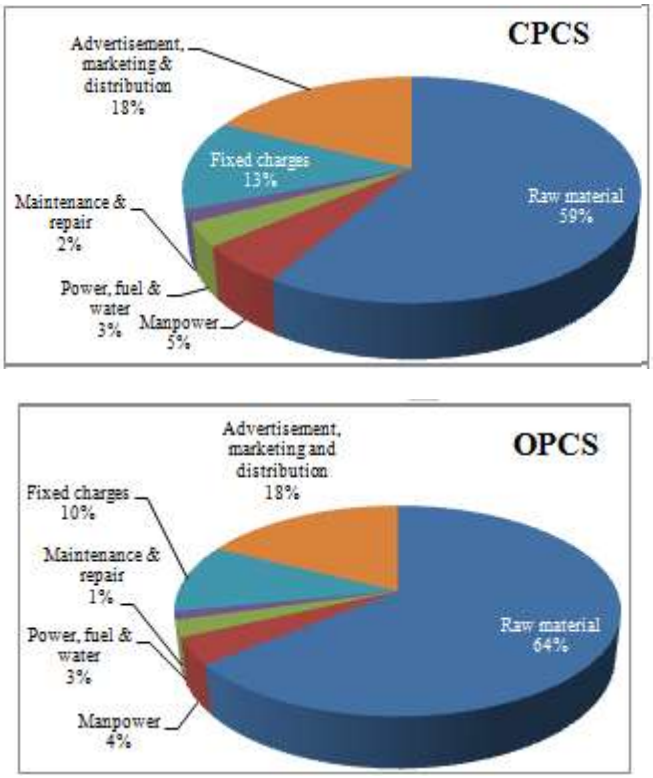

Figure 2: Contribution of different production cost for control (CPCS) and ω-3 fatty acid incorporated cheese spread (OPCS)

4. Conclusions

It was found from the study that the major contribution of production cost was raw material in case of both CPCS and OPCS. The higher cost of OPCS as compared to control cheese spread was due to mainly increased expenditure in raw material. The raw material cost, laboratory charges, and cleaning and sanitizing cost increased due to ω-3 fatty acid addition as compared to the control. Though, addition of ω-3 fatty acid addition increased the production cost, but the production cost of this functional cheese spread was not that much high as functional food concerned.

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