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Evaluating the techno-economic feasibility of buckwheat extrudates production using twin screw extruder technology

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Abstract
The techno-economic feasibility of producing ready-to-eat extrudates using the optimal blend of raw materials (Buckwheat and Bengal-gram) with a blend ratio of 70:30 was assessed in this study. Three key economic parameters, namely break-even volume/quantity, break-even sales, and break-even period, were analyzed. The break-even analysis revealed that to manufacture 10,40,000 units of 20-gram packets of ready-to-eat extruded snacks, formulated from Buckwheat and Bengal-gram with a blend ratio of 70:30, the break-even quantity was determined to be 26,60,950 units of 20g each. The corresponding break-even sales amounted to 1,33,04,721/-, and the break-even period was projected to be 1 year and 4 months. This study provides valuable insights for the commercial production of extruded snacks.

Keywords: Techno-economic feasibility, extrudates, buckwheat, Bengal-gram, break even analysis

Introduction

Globally, the snack food industry has undergone substantial growth and gained heightened significance in the past decade. This surge can be attributed to shifts in lifestyle and dietary patterns, resulting in a continuous increase in the demand for snack foods. Snack products offer the opportunity to elevate the intake of essential amino acids and other crucial nutrients, particularly in developing nations. The development of a value-added food product, specifically an extrudate, utilizing Buckwheat and Bengal-gram, stands as a crucial initiative to enhance nutritional value and foster better health for society. Anticipated market growth is driven by evolving lifestyles and an increasing awareness of the importance of healthy eating. Our nation currently faces a severe challenge of protein-energy malnutrition, especially among a sizable and vulnerable population. Effectively addressing challenges related to food insecurity and malnutrition trends has become increasingly vital. This involves harnessing the potential of creating enriched extrudates with elevated levels of protein, fiber, minerals, and nutraceutical components. The mission to create a value-added food product based on buckwheat and Bengal gram (chickpea) goes beyond mere nutrition; it aspires to actively promote overall well-being and health.

Materials and Methods

The extrudates were manufactured using raw materials, specifically Buckwheat and Bengal-gram flour, with an optimal blend ratio of 70:30 in the laboratory model BPTL Twin Screw Extruder. Several unit operations were undertaken in the process of preparing these extruded snacks, including grinding of raw materials, drying, conditioning, extrusion-cooking, spicing, and packaging. To assess the techno-economic feasibility of producing ready-to-eat extrudates from this raw material blend, three economic parameters—break-even volume/quantity, break-even sales, and break-even period—were analyzed using the following formulas:

$$\text{Break even quantity/production} = \frac{\text{Total Fixed Cost}}{(\text{Cost per packet} - \text{Variable cost per packet})}$$

Break even sales per month = $\frac{\text{Total Fixed Cost x Cost of per packet}}{\text{(Cost per packet– Variable cost per packet)}}$

Break even period = $\frac{\text{Break even sales per month}}{\text{Total no.of units production per months}}$

Salvage value: The salvage value is an approximation of the worth an asset is expected to retain at the conclusion of its useful life. It signifies the potential proceeds a company might receive from selling the asset once it has undergone complete depreciation.

$Sv = p (1-i)^y$

Where,
SV = Salvage value
I = Depreciation rate
Y = No. of year

Results and Discussion
Break Even Analysis
A cost-benefit analysis was conducted to evaluate the production economics of ready-to-eat extrudates using the optimal blend of Buckwheat and Bengal-gram flour, with a blend ratio of 70:30. The predetermined cost for one unit weighing 20 grams was established at Rs. 7, while the retail selling price at the factory outlet was determined to be Rs. 5. The break-even analysis was conducted based on the following assumptions:

Analysis Fixed Cost

Table 1: Cost of machines/equipment

S. No.	Machine / equipment	Cost (Rs.)
1.	Food extruder with accessories	21,80,000
2.	Millet dehusker	1,35,000
3.	Pulverizer for dry grinding	38,000
4.	packing machine for pouch	1,40,000
5.	Spice coating drum for flavor	85,000
6.	Sieve set	25,000
7.	Digital moisture meter	7,000
8.	Containers for raw materials and finished product	50,000
9.	Miscellaneous	40,000
	Total	27,00,000

Table 2: Cost of land and building

S. No.	Items	Cost (Rs.)
1.	Land area 2000 ft^2 @ 600 per ft^2	12,00,000
2.	Construction cost for building including storage room, office and let- bathroom@1150 ft^2	23,00,000
	Total	35,00,000

Total Fixed cost = cost of machines / equipment + Cost of land and building
= 27,00,000 + 35,00,000
= Rs. 62,00,000 /-

The process of calculating depreciation for machinery/equipment and buildings entailed performing specific computations.
Assumptions:
1. Useful life of machines/equipment = 10 year
2. Machine/equipment depreciation rate = 10%
3. Useful life of building = 25 year
4. Building depreciation rate = 10%

Deprecation of Machine/equipment
Machinery/equipment salvage value
= 27,00,000 (1- 10/100)10
= 941431.788

$$\text{Depreciation of machinery/ equipment per year} = \frac{\text{FC of machinery/equipment – SV of machinery/equipment}}{\text{useful life of machinery/equipment}}$$

$$= \frac{27,00,000 - 941431.788}{10}$$

= 175856.821
~ Rs. 1,76,000 /-

Depreciation of Building
Building salvage value
= $3500000 (1-10/100)^{25}$
= 251264.296

Depreciation of building per year = (FC of building– SV of building)/(useful life of building)

$$= \frac{3500000 - 251264.296}{25}$$

= 129949.428
= Rs. 1,30,000 /-

Total depreciation per year = Deprecation of Machine/equipment + Depreciation of Building
= 1,76,000 +1,30,000
= Rs. 3,06,000 /-

Interest @ 12.5% per year on total fixed cost = Total Fixed Cost X 12.5/100
= 62,00,000 x 12.5/100
= 7,75,000 /-

Total fixed cost per year = Total depreciation per year + Interest @ 12.5% per year on total fixed cost

= Rs. 3,06,000 /- + Rs. 7,75,000/-
= 10,81,000

Analysis of variable cost
Assumptions
1. Capacity of commercial extruder = 100 kg/day
2. Working hr/day = 9 hr/day
3. Working days = 26 days
4. Total material required per month = 26 days x 8 hr/day x 100 kg/hr
   = 20,800 kg
5. Blend ratio of BW and BG = 70:30
6. Quantity of buckwheat required
   = 20800x(70/100)
   = 14,560 kg
7. Quantity of Bengal-gram = 20800x30/100
   = 6,240 kg
8. Price of buckwheat = Rs. 150/kg
   Price of Bengal-gram = Rs. 50/kg
   Total price of raw material = (14560x150) + (6240x50)
   2184000+312000
   Rs. 10,40,000/-
9. Cost of spice at 2%@rs 400/kg = 20800x(2/100)x400
   =Rs.1,66,400/-

10. weight per packet = 20 g
Total no. of packets = 10,40,000
11. Packaging@ Rs. 0.25 per pack =10, 40, 000x0.25
=Rs. 2, 60,000
12. Repair and maintenance @10% of machine cost per year
= 27,00,000 x 10/100
For one month = 2,70,000 /-
= 2,70,000 /12
= Rs. 22,500 /-

Table 3: Labour requirement

S. no.	Labour	required	Cost (Rs.)
1.	Manager	1	15,000
2.	Accountant	1	12,000
3.	Operator	2	14,000
4.	Helper	4	20,000
5.	Security guard	2	12,000
	Total		73,000

Table 4: Total Variable cost

S. No.	Items	Cost (Rs.)
1.	Labour charge	73,000
2.	Total material required (raw material + spices)	12,06,400
3.	Packaging material	2,60,000
4.	Repair and maintenance @10% of machine cost per month	22,500
5.	Electricity bill 6000kw per month @ 6.90 per kw	41,000 /-
6.	Insurance @ 10% of TFC per year	1,08,100
	Total	Rs. 17,11,000/-

Consider that loss of finished product due to machinery and environmental factors = 20%
Cost of one packet of 20 g = Rs. 5
Therefore,
Total no. of packet produced per month
=10, 40, 000- 10, 40, 000 x 20/100
= 832000

Variable cost per packet = Total variable cost / Total no. of packet produced per month
= 17, 11, 000/832000
= Rs 2.05 /-

Take into consideration the expenses related to labeling, transportation, distribution, marketing, and advertising, amounting to 30% of the variable cost per unit packet
= 2.03 x 0.30 = 0.615

Then, total variable cost per unit = 2.05 + 0.615 = Rs. 2.67 /-

Break even quantity/production = (Total fixed cost)/((Cost per packet- Variable cost per packet)
= 62,00,000/ (5- 2.67)
= 2660944.21
= 2660950 units of 20g each

Break even sales per month = (Total fixed cost x cost of per packet)/((Cost per packet- Variable cost per packet))
= 62,00,000X5/ (5- 2.67)
= Rs. 13304721/-

Break even period = (Break even sales per month)/(Total no. of units production per months)
= 13304721/ 832000
= 15.99 month
= 16 months
= 1 year 4 months

Conclusion

A break-even analysis was employed to assess the techno-economic viability of producing ready-to-eat extrudates using the optimal blend of Buckwheat and Bengal-gram flour, with a blend ratio of 70:30. The findings indicated a break-even quantity of 26,60,950 units, generating break-even sales of Rs. 1,33,04,721/-. The break-even period for this study was determined to be 1 year and 4 months, providing insights for the production of extruded snacks.

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