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Nagaraju M
Department of Post-Harvest Process and Food Engineering, College of Agricultural Engineering, JNKVV, Jabalpur, Madhya Pradesh, India

Virendra Kumar Tiwari
Department of Post-Harvest Process and Food Engineering, College of Agricultural Engineering, JNKVV, Jabalpur, Madhya Pradesh, India

Ankita Sharma
Department of Post-Harvest Process and Food Engineering, College of Agricultural Engineering, JNKVV, Jabalpur, Madhya Pradesh, India

Corresponding Author
Nagaraju M
Department of Post-Harvest Process and Food Engineering, College of Agricultural Engineering, JNKVV, Jabalpur, Madhya Pradesh, India

Techno-economic feasibility study for production of finger millet-lentil extrudate

Nagaraju M, Virendra Kumar Tiwari and Ankita Sharma

Abstract
The main objective of this study was to determine the economic feasibility of development of finger millet and lentil extrudate in a commercial scale. To determine the economic feasibility of any start-ups, the basic assumptions and calculations are important. It was found that, in order to produce 54 lakh units of 20g pouches of ready to eat extruded snacks of finger millet-lentil in the blend ratio of 90:10 with the identified infrastructure, the break even production comes to 19.2 lakh units, BEP is 35.55%. In order to clear the total project cost, about 5-year 3 month 25 days is required. The benefit cost ratio is found to be 5.33 therefore, every one rupee invested in the project is expected to earn 5.33 rupees. This analysis helps in set up of new start-ups at commercial level for producing finger millet-lentil extruded snacks.

Keywords: techno-economic feasibility, production, finger millet-lentil extrudate

Introduction
Food is an essential part of mankind. Nutrients, micronutrients and vitamins are very essential for proper body functioning. Cereals, millets and pulses are rich in protein, fibre and carbohydrates. Amino acids, vitamins and minerals which are not secreted by the body needs to be consumed daily for proper body functioning. Pulses are second most important group of crops after cereals which have been a vital ingredient of balanced human diet (Bhadana *et al.*, 2013) [1] and recognized as second most valuable plant source for human and animal nutrition (Bhatt and Karim, 2009) [2]. In the global food production India is the world's second largest producer of food next to China and has the great potential to feed the world. India ranks first in the global millet production, producing around 11.59 million tons in 8.83 million ha area during 2019 (FAO, 2020) [5]. On the other hand, though the abundance of food is produced, people of the country are not getting nutrient rich food. In the developing countries like India, malnutrition among under-five children and women is a major public health problem and that lead to their death. Of all the deaths, 50% of children deaths are due to undernourishment. Calcium deficiency is common in pregnant women and new-born infants. The foods (Rice based secondary processed products) which have been consuming daily are rich in carbohydrates containing not much of protein, fibre and minerals. In addressing malnutrition India's performance is also very weak and ranked 94th place out of 107 countries in recent Global Hunger Index (2020 data).
There is saying that "let food be thy medicine, medicine be thy food". This exactly suits to the finger millet (Ragi) food because of its abundance nutritional and medicinal values. The protein content of millet can be comparable to that of rice, wheat and maize. The nutritional values and health benefits of finger millet has played instrumental role in the gradually increasing demands for this millet (Mathanghi *et al.*, 2012) [7]. Finger millet contains about 5-8% protein, 1-2% ether extractives, 65-75% carbohydrates, 15-20% dietary fibre and 2.5-3.5% minerals. Of all the cereals and millets, finger millet has the highest amount of calcium (344mg %) and phosphorous (283mg %). The millet has low fat content (1.3%) and contains mainly unsaturated fat (Chandra *et al.*, 2016) [3]. Finger millet has slightly lower protein content but is in fact nutritionally superior because protein quality generally as good as or better than cereals (Yenagi *et al.*, 2007) [11]. Being no glutinous, finger millet is safe for people suffering from gluten allergy and celiac disease. It is non-acid forming, and hence easy to digest. Lentil is naturally gluten-free, its low glycemic index (low GI) values and resistant starch content make it suitable for a diabetic diet. Number of extruded snacks are available in the global food market. But these products are of rice and maize based, lack in micronutrients like calcium, iron, phosphorous, *etc.* hence it is required to develop nutrients (protein, fibre calcium and iron) rich food products by using the finger millet and lentil to address the

problem of malnutrition affected areas especially tribal areas. The enriched protein, fibre and minerals (calcium, phosphorus and iron) extrudate may fulfil the nutrient requirement of children and women. In modern food industry, extrusion processing has become promising technique for manufacturing ready to eat extruded snacks because of its cost effective, versatility and environment friendly (no process effluents) nature (White 1994; Ficarella *et al.*, 2006) [10, 6]. It is necessary to develop the technical and economic feasibility of extrusion process because of the material/ energy and money required in the production of extruded food products (Kurkure) catches a high cost (Kuruba *et al.*, 2017) [4]. In any start-ups knowledge on break-even analysis is also very important because it determine the minimum output that must be exceeded for a business to profit. Further it gives an idea about the earnings impact of any marketing activity. This paper is deals with the study on economic feasibility of development of finger millet and lentil extrudate in a commercial scale.

Methodology

The raw material used for production of ready to eat extruded snacks were finger millet and lentil flours at 90:10 ratio. The various unit operations *i.e.*, cleaning, grinding, drying and conditioning, extrusion-cooking and packaging *etc* involved during production of RTE extrudates were performed. The economics of preparation of finger millet-lentil extrudates was worked out by considering some assumptions, which are as follows:

1.	Life of machine	10 years
2.	Life of building	30 years
3.	Salvage values	10%
4.	Rate of interest per annum	14%
5.	Selling price (20 gm packet)	Rs. 2.5

In order to determine the techno-economic feasibility of production of RTE extruded product of finger millet-lentil, the economic parameters *i.e.*, break even production, breakeven point, payback period and benefit cost ratio were worked out as follows (Tiwari, 2011; Nagaraju, 2017; Kuruba *et al.* 2017) [9, 8, 4]:

$$Q = \frac{F_C}{(U_P - V_C)} \quad \dots (1)$$

Where;
Q = Break-even production, i.e., Units of production (Q)
F_C = Fixed Costs
U_P = Unit Price
V_C = Variable Costs per Unit

$$\text{Break Even Point} = \frac{\text{Break even production}}{\text{Total production}} \times 100 \quad \dots (2)$$

$$\text{The absolute margin of safety} = \text{Actual production} - \text{Break even Production} \quad \dots (3)$$

$$\text{Profit} = \text{Total return per year} - \text{Total working capitalper year} \quad \dots (4)$$

$$\text{Payback period} = \frac{\text{Total Investment}}{\text{Profit}} \quad \dots (5)$$

$$\text{Benefit Cost Ratio} = \frac{\text{Tatal Cost}}{\text{Benefit}} \quad \dots (6)$$

Results and Discussion

The fixed and variable costs involved in producing finger millet-lentil RTE extrudate were worked out and presented in Table 2 and Table 3. The total fixed cost per year was found to be 9.60 lakh and total variable cost per year was found to be 105.6 lakh. The break even production was 19.2 lakh units. The breakeven point was 35.55% means up to this point there is no loss as well as no profit. Benefit Cost Ratio, 5.33 > 1 is good and accepted. In order clear the total project cost of 156.6 lakh, the calculated payback period was 5-year 3 month 25 days.

Table 1: Analysis of Cost of Land, building and machinery

I.	**Fixed cost**	
(A)	**Cost of Land and Building**	**Cost (Rs.)**
i.	Land area 1 Acre (4046.86 sq. m @ Rs.49/sq. m)	2000000
ii.	Construction cost Including Godown, office and toilets 100 sq. m (@ Rs.12400/sq. m	1240000
iii.	Painting, Pipelines for electricity and water	250000
iv.	Bore well/Tube well	300000
	Total	3790000
(B)	**Cost of machinery and equipment**	
i.	Machine/Equipment	
ii.	Food Extruder (with accessories)	600000
iii.	Destoner Cum Dehuller	150000
iv.	Hammer Mill	50000
v	Dhal Mill	50000
vi	Sieve Set	20000
vii	Pouch Packing Machine	100000
viii	Weighing Balance	20000
ix	Moisture Meter	30000
x	Crates	30000
xi	Miscellaneous	50000
xii	GST @ 18%	198000
	Total	1298000

Table 2: Fixed Cost involved in production of RTE finger millet lentil extrudate

(C)	Depreciation and interest	Cost (Rs.)
i.	Depreciation on building (3% salvage value)	113700
ii.	Depreciation of machine (10% salvage value)	129800
iii.	Interest at rate of 14% per annum on value of fixed cost	712320
	Total (a + b + c) fixed cost	955820≈960000

Table 3: Analysis of Variable Cost

II.	Variable Cost	
Considering commercial extruder with 50 kg/h capacity, 8h working/day and 25 working days in a month. Assuming raw finger millet is available @ Rs. 35/kg and lentil @ Rs. 45/kg		
(A)	**Material cost**	**Cost (Rs.)**
Total raw material required for a month (25 days × 8h/day × 50 kg/h = 10000 kg) Finger millet and lentil required per month (90:10) is 9000 and 1000 kg per month, respectively		
a.	Cost of raw material (Finger millet @ Rs. 35/kg and lentil @ Rs. 45/kg) (9000 kg × Rs. 35 + 1000× Rs. 45)	360000
b.	Spice at 2% @ Rs. 500/kg (200 kg × Rs. 500)	100000
c.	Packing material @ 0.30 per pcs. (500000 × 0.30)	150000
d.	Repair and maintenance @ 10% of Machine cost per year, For one month (129800/12 months)	11000
(A)	Total	621000
(B)	**Labor Charges**	**Cost (Rs.)**
i.	Manager/Supervisor (01)	12000
ii.	Operator (01)	10000
iii.	Helper (02)	16000
iv.	Security guard (02)	12000
	Total	50000
(C)	**Electricity charges**	**25000**
II.	Total Variable Cost (A+B+C)	696000≈700000

Assuming that 10% of the loss of finished product due to machine and environmental factors. And one pouch of 20gm finger millet-lentil extrudate will be sold @ Rs. 2.5/piece from the factory;
Total sale of 4,50,000 unit per month @ Rs.2.5/unit: Rs. 1125000
Variable cost per unit (700000/450000): Rs. 1.56

Assuming cost of Labelling, Transportation, Distribution, Marketing and Advertisement as 25% of the variable cost per unit pouch;

(Rs. 1.55 ×0.25) = Rs. 0.40

Then, total variable cost per unit (Rs. 1.56+0.4) ≈ Rs. 2
Therefore, total working capital (Variable cost) per month including labelling, transportation, distribution, marketing and advertisement (700000+180000) = Rs. 880000
Total Working Capital per year (8800000×12months) = Rs. 10560000 and
Total cost (Fixed cost + Variable cost) per year = 960000+ 10560000= Rs. 11520000
Total return of selling 5400000 pouches @ Rs. 2.5 per unit
Total return = Rs. 2.5×5400000 units = Rs.13500000/ year

$$\text{Break Even Production (Q)} = \frac{\text{Fixed Cost}}{(\text{Unit Price} - \text{Variable Unit Cost})}$$

$$\text{Break Even Production (Q)} = \frac{960000}{(2.5 - 2)} = 1920000 \text{ Units}$$

The margin of safety or break even sale is;

$$\text{Break Even Point} = \frac{1920000}{5400000} \times 100 = 35.55\%$$

The absolute margin of safety = Actual production - Break even Production
The absolute margin of safety = (5400000 – 1920000) = 3480000 units
Therefore,

$$\text{Profit} = \text{Total return per year} - \text{Total working capitalper year}$$

Profit = Rs. 13500000 - Rs. 10560000 = Rs. 2940000

$$\text{Payback period} = \frac{\text{Total Investment}}{\text{Profit}}$$

$$\text{Payback period} = \frac{15660000}{2940000} = 5 \text{ year 3month 25 days}$$

$$\text{Benefit Cost Ratio} = \frac{\text{Tatal Cost}}{\text{Benefit}}$$

$$\text{Benefit Cost Ratio} = \frac{15660000}{2940000} = 5.33$$

Conclusion

It was found that, in order to produce 54 lakh units of 20g pouches of ready to eat extruded snacks of finger millet-lentil in the blend ratio of 90:10 with the identified infrastructure, the break even production comes to 19.2 lakh units, BEP is 35.55%. In order to clear the total project cost, about 5-year 3 month 25 days is required. The benefit cost ratio is found to be 5.33 therefore, every one rupee invested in the project is expected to earn 5.33 rupees.

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