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A study on techno-economic feasibility for production of brown rice-quinoa-green gram extrudate

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Abstract
The main objective of this analysis was to study on Techno-Economic Feasibility for Production of Extruded Snacks prepared by brown rice, quinoa and green gram. To determine the techno-economic feasibility three economic parameters i.e. break even quantity, break even sales and break even period were analyzed. It was found in breakeven analysis that in order to produce 54 lakh units of 20g pouches of ready to eat extruded snacks of quinoa, brown rice and green gram in the blend ratio of 50:35:15 with the identified infrastructure, the break even production comes to 3024000 units, break even sales is Rs. 15120000/- and break even period comes out to be 2.8 yrs. This analysis helps in set up of new start-ups at commercial level for producing brown rice, quinoa and green gram extruded snacks.

Keywords: Techno-economic feasibility, nutrition, production, brown rice-quinoa-green gram extrudate

Introduction
Food and nutrition are the fuel for our body to function properly. Fat, protein and carbohydrates all are required for body. To maintain good health, it is very important to maintain key vitamins and minerals within the body. Absence of these may lead to micronutrient deficiencies and many diseases. In India stunting rate, wasting rate and undernourishment among children are respectively 36%, 19% and 32% (NFHS 5, Health ministry). Owing to high nutritive value, quinoa could solve the problem of protein malnutrition among children. Apart from high quality proteins, quinoa has higher levels of energy, fiber, calcium, phosphorus, iron and B-vitamins than barley, oats, rice, corn or wheat (Dini *et al*. 2005) [5].

Rice is a staple food, which has been widely consumed for centuries by many Asian countries. It has been studied that brown rice is associated with a wide spectrum of nutrigenomic implications such as anti-diabetic, anti-cholesterol, cardio protective and antioxidant owing to the presence of various phytochemicals mainly located in bran layers of brown rice. Brown rice contained the essential nutrients like iron, zinc, thiamine, niacin, vitamin E, dietary fiber, protein and carbohydrate (Pascual *et al.*, 2013) [11]. So Brown rice has potential to reduce the prevalence of malnutrition and chronic disease (Anderson *et al.*, 2009; Dipti *et al.*, 2012) [1, 4]. Presence of green gram in the blend have crucial role in dealing with malnutrition as Green gram is an excellent source of protein (25%), high in dietary fiber, rich sources of vitamin and minerals and essential amino acids (El-Adawy, 1996; Fan & Sosulski, 1974) [6, 7]. Its low glycemic index and high folate content reduce blood glucose level and neural tube defects in newborn babies (GRDC, 1994; USDA Nutrient Database for Standard Reference, 2001) [8, 12]. Green gram provides energy, dietary fiber, protein, minerals and vitamins required for human health.

Extrusion cooking technology is a high-temperature, short-time, versatile and modern food operation that converts agricultural commodities, usually in a granular or powdered form, into fully cooked, shelf-stable food products with enhanced textural attributes and flavour. Due to the processing flexibility offered by extrusion cooking technology, it has become a cornerstone of the food industry, primarily in the cereal, dairy, bakery, confectionery and pet food industries (Berrios *et al* 2010; Patil *et al* 2007) [2, 3, 11]. Extrusion cooking technology permits preparation of ready to eat nutritious foods of desirable taste, flavour, and texture. During extrusion the product undergoes glass-transition state, the starch gets gelatinized, the protein gets denatured and the antinutritional factors such as trypsin-inhibitors and hemagglutinin get degraded and microorganisms are destroyed, so overall digestibility and acceptability of product is enhanced (Malleshi, 1997) [9].

Extruded snacks available in the Indian market are generally made from cereal flours and having high carbohydrate and fat contents while lower protein content. Nowadays, consumer demand for natural and functional foods has been growing, so puffed snacks created with quinoa, brown rice and green gram flours may appeal to the consumer interested in healthy foods.

Methodology

The raw material used for production of ready to eat extruded snacks were brown rice–quinoa–green gram flours at 50:35:15 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 brown rice–quinoa–green gram 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. 5

In order to determine the techno-economic feasibility of production of RTE extruded product of brown rice–quinoa–green gram, the economic parameters *i.e.*, break even production, breakeven point, break even sales, absolute margin of safety and break even period were worked out as follows:

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

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

$$\text{Break-even point} = \frac{\text{Break even production}}{\text{total production}} \times 100 \quad \text{...(2)}$$

The absolute margin of safety = Actual production – Break even production ...(3)

$$\text{Break even sales} = \frac{\text{Total fixed cost}}{\text{Cost of per pack} - \text{Variable cost per pack}} \times \text{Cost of per pack} \quad \text{...(4)}$$

$$\text{Break even period} = \frac{\text{Break even sales}}{\text{Total no of unit produced}}$$

Results and Discussion

The fixed and variable costs of preparing Brown rice-quinoa-green gram RTE extrudate have been calculated and are shown in Tables 2 and 3. The total fixed cost per year was found to be 60.48 lakh and total variable cost per year was found to be 147.78 lakh. The break even production was 30.24 lakh units. The breakeven point was 56% means up to this point there is no loss as well as no profit. The calculated break even period for clearing the whole project cost of 208 lakh was 2-years and 8 months.

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	6048000

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 brown rice is available @ Rs. 60/kg, quinoa @ Rs. 80/kg and green gram @ Rs. 45/kg.		
(A)	**Material cost**	**Cost (Rs.)**
Total raw material required for a month (25 days × 8h/day × 50 kg/h = 10000 kg) brown rice, quinoa and green gram required per month (50:35:15) is 5000, 3500 and 1500 kg per month, respectively.		
a.	Cost of raw material (Brown rice @ Rs. 60/kg, quinoa @ Rs. 80/kg and green gram @ Rs. 45/kg) (5000╳60+3500╳80+1500╳45)	647500
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	908500
(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)	983500 ≈ 984000

Assuming that 10% of the loss of finished product due to machine and environmental factors and one pouch of 20 gm brown rice-quinoa-green gram extrudate will be sold @ Rs. 5/piece from the factory;

Total sale of 4,50,000 unit per month @ Rs.5/unit: Rs. 2250000

Variable cost per unit (984000/450000): Rs. 2.19

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

(Rs. 2.19 ×0.25) = Rs. 0.55

Then, total variable cost per unit (Rs. 2.19+0.55) = Rs. 2.74 ≈ Rs. 3

Therefore, total working capital (Variable cost) per month including labelling, transportation, distribution, marketing and advertisement (984000+247500) = Rs. 1231500

Total Working Capital per year (1231500×12months) = Rs. 14778000

Total cost (Fixed cost + Variable cost) per year = 6048000+ 14778000 = Rs. 20826000

Total return of selling 5400000 pouches @ Rs. 5 per unit

Total return = Rs.5 × 5400000 units = Rs. 27000000/ year

Break Even Production (Q) = $\frac{\text{Fixed cost}}{(\text{Unit price} - \text{Variable unit cost})}$

Break Even Production (Q) = 6048000 / (5-3) = 3024000 units of 20 gm each

Break Even Point = 3024000 / 5400000×100= 56 %

The absolute margin of safety = Actual production – Break even production

= 5400000 – 3024000 = 2376000 units

Break even sales = 3024000×5 = Rs. 15120000/-

Break even period = $\frac{\text{Break even sales}}{\text{Total number units produced}}$

= $\frac{15120000}{5400000}$ = 2.8 yrs

Conclusion

Therefore, from the break even analysis it was found that in order to produced 54 lakh units per year of 20 g packets of ready to eat extruded snacks of blended flour consisting of blend of Brown rice-Quinoa-Green gram in the blend ratio of 50:35:15 with identified infrastructure the break even quantity is 30,24,000 units, the break even sales is Rs.1,51,20,000/- and Break even period comes out 2.8 yrs.

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