

Technical and Financial Estimation of Vacuum Frying Unit

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Abstract— Deep frying is the oldest and most popular cooking methods in existence. Frying in vacuum condition is a technology that can be used to improve the quality of vacuum fried snacks because it is done in low temperatures and use minimum oxygen content. Vacuum fried snacks are popular in South-East Asian nations. This popular alternative food technique has made food technologist, scientists and professors in India to take this to large scale food processing enterprise. The main purpose of this paper is to estimate the financial and technical parameters of setting up a Model Vacuum Frying unit to be setup at Amrita University in Ettimadai, Coimbatore. The unit would offer training and support to farmers within 12km radius of the campus. For this purpose a survey was done among 53 producers in Ettimadai and Chavadi to understand the major crops grown and the reasons for growing these crops. The overall capital cost of project was estimated on the basis of top horticulture crops grown around the campus.

Index Terms— Vacuum Frying, Technical Feasibility, Financial Feasibility.

I. INTRODUCTION

Present day consumer's preference for fat-free and low-fat products has been the driving force for the food processing industry to produce lower oil content products that still retain the desirable texture and flavor [1].

Vacuum frying is recourse for production of fried fruit and vegetable snacks with low oil content and desired texture and flavor characteristics. It is a frying process that is carried out at pressures well below atmospheric level. It has been used for variety of fruits and vegetables that include apple, banana, jackfruit, green and gold kiwifruits, carrot, mushroom, potato, sweet potato and purple yam [2]. Vacuum frying offers an alternative technique to improve the quality of fried fruit and vegetables other than by atmospheric deep frying process (Dueik and Bouchon, 2011a).

Vacuum frying posses some advantages that include: (1) low oil content in a fried snack (2) preserves flavor and natural color of the fried snack and (3) minimal untoward effects on quality of refined oil (Shyu, Hau, & Hwang, 1998).

No studies are available on the feasibility of setting up vacuum frying unit based on techno-economic and financial aspects. The main objective of this study was to carry out these assessments for a model vacuum frying unit to be setup for training and development of near-by farmers to add value to their products through this process. The project was based on horticulture crops grown within 12 km radius of the campus.

II. LITERATURE REVIEW

Three types of vacuum fryer were reported by Andres-Bello *et al.* (2011) in terms of size and of processing requirements. Their review paper discussed about three different configurations in vacuum frying systems.

Vacuum fryer machine used by Diamante (2009) in preparation of Jackfruit chips consist mainly of a vacuum frying chamber, a condenser that is water-cooled and liquid ring vacuum pump. After the chips are fried in the chamber, the fried chips are taken from the chamber and centrifuged at an atmospheric pressure in a distinct machine. Also, vacuum fryer system used by Diamante *et al.* (2011) for processing slices of gold kiwifruit, consisted of a frying chamber that is steam-heated, a condenser that is water-cooled and an oil-sealed vacuum pump. The fried kiwifruit is then centrifuged at normal pressure using different machine.

Vacuum fryer system used by Yamsaengsung *et al.* (2011) in processing bananas had a vacuum frying chamber which is gas-heated, a condenser that is water-cooled and a liquid ring vacuum pump. The fried bananas are then centrifuged at 460 rpm within the fryer chamber. On the other hand, Sothornvit (2011) discussed various configurations of fryer systems used in processing of bananas that consist of a vacuum frying chamber provided with heated oil, a condenser that is water-cooled, and an oil-sealed vacuum pump. The fried bananas can then be centrifuged at either 150 or 290 rpm within the frying chamber.

An analysis on batch of crispy potato chips by vacuum fryer system was reported by Moreira and Pandey (2012). The duo

used a fryer system which has a vacuum chamber that is electric-heated, an oil-sealed vacuum pump and a condenser that is refrigerated.

III. METHODOLOGY

This study focuses on the questionnaire-based surveys for producers of Chavadi and Ettimadai region through exploratory research. The survey consisted of both closed and open questions. In order to get an indication of the top fruits and vegetables grown by the producer community in Chavadi and Ettimadai region, a total of 53 farmers were surveyed. 53% of farmers were taken as a random selection from farms operating in the Ettimadai region, and 47 % were farmers met by chance while travelling in the Chavadi region of Coimbatore respectively.

The rationale was that all participants surveyed lived within 12 km radius of the university campus practiced farming throughout the course of the year.

TABLE I: NUMBER OF FARM RESPONDENTS

Location	Farmers	Laborers
Chavadi	9	16
Ettimadai	15	13

IV. RESULTS, DISCUSSION AND FUTURE RESEARCH

A. Farm Size

Of the producer community surveyed in the Ettimadai region, 54% respondents had farms between 2 and 4 acres. 25% respondents had farms between 4 and 6 acres, 22% had farms between 6 and 8 acres and none of them had farms less than 2 and greater than 8 acres respectively. The average farm size was only 4acres.

TABLE II: DISTRIBUTION OFFARMSIZE (% OF RESPONDENTS)

Land in acres	Chavadi	Ettimadai
0-2	0	0
2-4	36	54
4-6	36	25
6-8	20	22
>8	8	0

Of the producers surveyed in the Chavadi region, 36% respondents had farms between 2 and 4 acres, 36% respondents had farms between 4 and 6 acres, 20% had farms between 6 and 8 acres and 8% had farms more than 8 ac respectively. The average farm size was only 6ac.

B. Crops Grown

Vegetables are grown in much greater abundance than fruits in the Chavadi and Ettimadai region. Tomatoes and Banana in particular are the most popular crops grown by majority of farmers respectively. Chilli and Ladyfinger are the next most popular crops grown by farmers in this region.

TABLE III: TOP FRUITS AND VEGETABLES GROWN

Fruits and Vegetables	No: of Farmers	
	Chavadi	Ettimadai
Tomatoes	25	28
Banana	25	28
Ladyfinger	10	Nil
Chilli	10	17
Brinjal	7	9
Mango	3	4

Most crops are grown in farms below 8 acres and intercropping is common in these regions. Tomatoes and Bananas with strong market demand and better yield are mostly grown as mixed crops in both the regions. The higher value crops and those with strong market demand and better yield (Tomatoes and Bananas) are grown by both large and small farms (<4 acres).

The table below shows the reasons given for growing the most commonly grown crops, including Tomatoes and Bananas. Across every fruit and vegetable, the most cited reason was market demand and yield. The respondents valued high market demand and better yield, and therefore an almost guaranteed market for their produce, as the most important reason.

TABLE IV: REASONS FOR GROWING PARTICULAR CROPS IN CHAVADI (% RESPONDENTS CITING REASON)

Fruits & Vegetables	Chilli	Tomato	Brinjal	Banana	Mango	Ladyfinger
Market demand	82	89	55	92	75	58
Ease of seed availability	88	92	67	96	50	85
Diseases/ pest Resistant	82	86	77	72	25	54
Yield	77	96	55	96	50	72
Less labor requirement	58	64	66	78	75	57

TABLE V: REASONS FOR GROWING PARTICULAR CROPS IN ETTIMADAI (% RESPONDENTS CITING REASON)

Fruits & Vegetables	Chilli	Tomato	Brinjal	Banana	Mango
Market demand	82	89	55	92	75
Ease of seed availability	88	92	67	96	50
Diseases/ pest Resistant	82	86	77	72	25
Yield	77	96	55	96	50
Less labor requirement	58	64	66	78	75

C. Type of VFM selection

The table below is formed based on the literature review discussing the fruits and vegetables to be fed into different vacuum fryer machines. Many studies focus on the type of vacuum frying chamber, condenser and vacuum pump to be used for different inputs fed into the fryer machine.

TABLE VI: TYPE OF VFM SELECTION

	Machine 1	Machine 2	Machine 3
	Gas vacuum fryer	Steam vacuum fryer	Electric vacuum fryer
a. VFM components			
Vacuum frying chamber	Gas-heated	Steam type	Electric-heated
Condenser	Water-cooled	Water-cooled	Refrigerated
Vacuum pump	Liquid ring	Oil-sealed	Oil-sealed
b. Input selection to VFM			
Inputs (Fruits and Vegetables)	Banana	Jackfruit , Gold kiwifruit	Potato, Sweet Potato, Apple
Products available	Banana	Nil	Nil

Based on the producer survey, it is evident that the majority of farmers grow banana and tomatoes in Chavadi and Ettimadai region. Even though tomatoes are widely grown in these regions, they cannot be fed into different vacuum fryers. Hence Gas vacuum fryer is chosen as banana is an input to fryer machine due to strong market demand and better yield to producers.

Processing capacity for Vacuum Fried Bananas

The studies indicate that the processing capacity for potato, sweet potato, etc is 25,50,100 kg/hr for Pilot-Type, Twin- One and Twin- Turbo whereas the processing capacity for Apple, Pineapple, Banana, Green bean, etc is 10, 20~25, 40~55 kg/hr for Pilot-type, Twin- Single and Twin- Turbo respectively.

TABLE VII: PROCESSING CAPACITY FOR VACUUM FRIED BANANAS

Gas vacuum fryer	Pilot-Type	Twin-One	Twin-Turbo
Capacity (Kg/Hr Chips) Apple, Pineapple, Banana, etc	10	20 ~ 25	40 ~ 55
Capacity for Vacuum Fried Bananas			
Maximum material	3.6 kg		
Frying duration	60 - 70 minutes		
Banana crispy produced	1.4 - 1.7 kg		
Output produced per annum	25,714.3 kg	59,142.85 kg	1,15,800 kg
Input required per annum	51,428.5 kg	1,18,285.7 kg	3,00,000 kg

The values obtained for input required and output produced per annum are based not only on maximum material and duration of frying but also on Techno-Economic parameters such that the unit would operate in single shift of 8 hours for 252 days, capacity utilization, power and fuel cost, labor charges etc.

Project Implementation-Individual components

The major components of a vacuum frying unit of fruits and vegetables are land in acres and land development, building and civil works, etc and individual items are discussed under this section.

Land and land development

For a fryer unit, a total built-up of 4000 sqft area is well adequate. The piece of land shall be mortgage able and be free from any encumbrance. Land cost is not considered as the project is going to be implemented within the campus. Land development cost of Rs.8.0 Lakh is required in setting the unit.

Building and civil structures

For establishing a fryer unit, a building is constructed within the campus with a total built-up area of 4,000 sqft is adequate. The cost of construction is assumed to be Rs. 900 per sqft. The fryer unit will have 1000 square feet of area, 1000 square feet of storage area for raw material, 1000 square feet of storage area for finished product, 500 square feet of washing area, 300 square feet of latrines, and 200 square feet of security cabin.

Plant and machinery

Selection of machinery is critical in setting up a fryer unit. The cost of the machinery is estimated to be Rs.31.08 lakh. The criterion for smooth operation of labour is that the machine should not occupy more than one-third of the total floor area. The machinery used for a fryer unit is discussed below.

Fruit/Vegetable washing machine: The purpose of the machine is to remove the microbes by washing fruits and vegetables with chlorinated water. Water need to be replaced for cleaning fruits and vegetables at regular interval of 2 to 3 hours. The washing machine having capacity of 1.0 MT per hour costs Rs.2.0 Lakh.

Sorting conveyer: The purpose of the equipment is for cutting, inspection and sorting fruits and vegetables. The conveyer belt is estimated to cost Rs.1.75 Lakh.

Screw feeder: The purpose of equipment is used to feed sorted and cut fruits and vegetables to fryer machine. The capacity of the screw feeder of 1.5 MT per hour is proposed. The machine cost is estimated to be Rs.3.33 Lakh.

Gas type Vacuum Fryer: The gas type fryer produces crispy fried snacks with original colour and crispy texture. The specification of the gas type fryer given below is taken from [3] .

Capacity	3 - 3.5 kg/process		
Volume of cooking oil	30-40 liters		
Gas for LPG	0.2 - 0.4 kg/hour		
Size of machine	Pilot Type	Twin - One	Twin - Turbo
	L. 2000 W. 1500 H. 2600	L 4000 W. 1500 H. 2800	L. 4500 W. 3000 H. 3500
Pump power (Hp)	8	20	38
Total power (Hp)	12	30	50

Miscellaneous equipments: A fryer unit would require supporting equipments like retort, working table, steam boiler, trolleys, knives etc. These equipment's will cost the unit approximately Rs. 20.0 Lakh

Miscellaneous fixed asset: For setting up a fryer unit, some physical assets are required for which an allocation of Rs.2.0 lakh is provided. The specification for some plant and machinery given below is taken from [4].

TABLE VIII PLANT AND MACHINERY

Machine	Capacity	Qty.	Rs (in lakh)
Fruit washing machine	1.0 MT per hour	1	2.0
Sorting conveyer			1.75
Screw type feeder	1.5 MT per hour	1	3.33
Gas type vacuum fryer		1	4.0
Miscellaneous equipment			20.0
Total			31.08

Manpower requirement

Vacuum Fryer unit is an excessive labor operation. The majority of workforce is engaged on contract during peak season. These workforce are highly skilled and mostly women force.

TABLE IX: MANPOWER REQUIREMENT

Salary of workforce	Number of workforce	Salary (Per Month)	Total (Rs. Lakh)
Manager - Plant	1	25,000.00	3.0
Manager- Technical	1	15,000.00	1.8
Overseer	3	10,000.00	3.6
Accountant	1	12000.00	1.44
Electrician	2	8000.00	1.92
Peon	1	5000.00	0.6
Sentry	2	5000.00	1.2
Total			13.56

Working Capital

Working capital is vital for promoters to set up vacuum fried snacks unit. Since the raw materials being seasonal in nature, vacuum fryer units must maintain high level of inventories. The banks would finance short-term loans based on need of the borrowers. There is adequate provision for short-term needs to be considered by the scheduled banks. The estimated working capital for fryer unit is given below

TABLE X: ASSESSMENT OF SHORT TERM LOAN FOR F&V UNIT

S. No.	Particulars	Duration (in days)	Yr1	Yr2	Yr3
1	Raw materials stock	6	1.2	1.44	1.73
2	Work in progress	28	7.2	10.08	10.38
3	Finished goods	15	3.6	5.04	5.2
4	Debtors		7.2	10.08	10.4
5	Total current assets		8.0	16.00	21.00
6	Creditors (current liabilities)	0	0.00	0.00	0.00
7	Working capital gap		8.0	16.00	21.00
8	Margin money for W.C.	25%	2.0	4	5.25
9	Bank loan (CC Limit)		6.0	12.0	15.75

Capital Cost of Project

The overall estimated capital cost of project for food processing to be implemented at the university campus based on techno-economic parameters and financial aspects is 1.03 cr. Some of the individual component figures were estimated based on the current market rate

TABLE XI: CAPITAL COST OF PROJECT

S. No.	Particulars	Unit	Qty.	Rate (Rs.)	Amount (Rs. Lakh)
1	Land in acres				
2	Land Development				8.0
3	Building and Civil works	Sq ft	4000	900	36.0
4	Machinery				31.08
5	Miscellaneous Physical Assets				4.0
6	Preliminary and Preoperative Expenses				2.0
7	Vehicles		1		17.0
8	Margin money for W.C				5.0
	TOTAL				103.08

In order to finance fryer unit, the firm promoters need to bring margin as per working capital assessment employed by commercial banks. The fryer unit has assumed promoters to bring in 25 per cent capital in setting up the processing unit.

V. CONCLUSION

The exploratory research shows that majority of the producer community grow bananas and tomatoes in the Ettimadai and Chavadi region respectively. 96 per cent yield and 93 per cent market demand are the main reasons for growing bananas in Ettimadai and Chavadi whereas 96 per cent yield and 85-89 per cent market demand are the main reasons for growing tomatoes in Ettimadai and Chavadi respectively. Gas vacuum fryer is chosen as type of Vacuum Fryer unit as bananas that are input to the machine are mainly grown due to above reasons by farmers within 12 km radius of university campus.

VI. REFERENCES

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