

BREAK EVEN ANALYSIS OF PDKV UV-ASSISTED TREATMENT DEVICE FOR POST HARVEST DECAY CONTROL OF NAGPUR MANDARIN FRUITS IN INDIA

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Abstract

Nagpur Mandarins has GI-tag for Nagpur region of India and occupy 135,000 ha area in Maharashtra, the leading producer of this Vitamin-C rich delicious fruit. Due to 20-30% losses caused by fungal rots fruits are coated with edible wax to improve their shelf life. Despite rich taste Nagpur Mandarins are not getting enough international market space due to seeds and fungicide residues contributed by field sprays and wax coatings. This constraint is removed by developing “PDKV UV-Assisted Treatment Device” for fungicide free post-harvest disease management of Nagpur Mandarins. UV-treatment reduces fungal diseases by surface sterilization of fruits and by improving their innate immunity by ‘hormesis’. Break even analysis of this machine shows the potential to provide viable business to mandarin processing units. This business gives higher benefit beyond breakeven point by lower initial investment and higher throughput capacity; and has a higher margin of safety in quantitative and monetary terms.

Introduction

India is the second largest producer of fruits in the world. Nagpur mandarin is grown in India with GI-tag (APEDA 2019). Maharashtra is a leading producer of Nagpur mandarins that occupy 135 thousand hectare area and has 742.50 thousand tons annual production (APEDA 2022). This fruit faces 20-30% losses during storage due to fungal rots (Charpe *et al.* 2017). Cuts and bruises caused due to improper handling provide sites of entry to germinating fungal spores and improper storage conditions provide favorable conditions for their colonization inside the fruit, leading to huge losses (Tiwari 2014, Charpe *et al.* 2021 and 2022). Edible coating is an effective method to solve this problem (Baldwin 1994). The main advantage of edible wax coatings over traditional synthetics is that edible coatings can be consumed with the packaged products (Bourtoom 2008, Charpe *et al.* 2019). Edible coatings developed indigenously in India are not commercially available hence imported edible coatings are used. The imported edible coating is costly and they mostly contain or are used with fungicide. Their fungicide components are not evaluated in Indian conditions hence may / may not be effective against post harvest rots prevailing on Indian fruits including Nagpur mandarins (Charpe *et al.* 2019). At the same time when Indian fruits are to be exported there are stringent laws to prove that the fruits do not contain fungicide residues that become a hindrance in exporting Nagpur mandarins, as per the feedback obtained from processing units operational in Central India. Therefore, there is great need to opt for eco-friendly management practices. With this view, “PDKV UV-assisted treatment device” that is a continuous type fruit packing line, is developed by our team of All India Coordinated Research Project on Post Harvest Engineering and Technology at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India to facilitate fungicide free wax coating operation to Nagpur Mandarin fruits (Nigro *et al.* 1998, Bintsis *et al.* 2000, Guerrero-Beltran and Barbosa-Canovas 2004) with increase in shelf life due to UV-C treatment. Analysis of breakeven point (BEP) is a part of practice in

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feasibility analysis of post harvest machine operations to work out the viability of the business and is critical for bridging the adoption gap to improve implementation and sustenance of the economically beneficial post harvest machines (Suzuki 1990, Dillon 1993, Johl and Kapoor 2017, Subba Reddy and Raghu Ram 2018). This study is a systematic cost analysis conducted to workout BEP of “PDKV UV-assisted treatment device” for controlling post harvest decay in Nagpur Mandarin fruits.

Materials and Methods

Break Even Point (BEP) is the point at which total cost equals the total revenue. Break even analysis is done in two ways (i) by linear approach and (ii) by curvilinear approach. In a linear approach, total cost curve as well as revenue curve develops as a straight line and point at which they dissect is called BEP. Whereas in the curvilinear approach total cost curve develops as a straight line and the revenue curve has curvature, here the most distant point of revenue curve from the cost curve denotes the BEP. In this analysis we have followed linear approach in which BEP is computed by algebraic method using following formula (Subba Reddy and Raghu Ram 2018) –

$$BEP = \frac{F}{(P-V)} \dots\dots\dots (1)$$

Where, F = Fixed costs in Rs. per Unit of UV-Device

P = Price per quintal of Nagpur Mandarin Fruits in Rupees,

V = Variable costs per quintal of Nagpur Mandarin Fruits in Rupees

Fixed cost is worked out by adding the Establishment Cost (10%), Depreciation of machine (10%), Depreciation of shade (10%), Maintenance Cost and Interest on Fixed Capital (10%) for 6 months duration when machine is operational.

Variable cost included costs of Labour requirement per annum, Nagpur mandarin fruits, Edible wax, Repair & maintenance, Miscellaneous charges and Electricity charges i.e. Utility per annum (ICAR-AICRP 2022).

Where,

$$Utility\ Per\ Annum\ (Power\ Kwh) = Horsepower\ of\ Motor\ (hp) \times time\ (hr) \times 0.746\ (Kw) \times duration\ of\ machine\ operation\ (days) \times Rs.9\ (Electric\ Consumption\ Per\ Unit) = Rs.\ Per\ Annum\dots\dots(2).$$

Further BEP is also calculated in monetary value that will be helpful in making the decision to initiate this business. Difference between total revenue generated by the unit and revenue generated at BEP is indicated as margin of safety. This is an indicator that reveals the shock absorbance capacity of the enterprise. For monetary analysis margin of safety has been computed in units and in rupees and as the percentage of margin of safety using following formulas (Subba Reddy and Raghu Ram 2018) –

$$Margin\ of\ Safety\ (in\ Quintals) = Total\ output - Output\ at\ BEP \dots\dots\dots (3)$$

$$Margin\ of\ Safety\ (in\ Rs.) = Total\ Revenue - Revenue\ at\ BEP\dots\dots\dots (4)$$

$$Percentage\ of\ margin\ of\ safety = \frac{BEP\ output}{Volume\ of\ output} \times 100 \dots\dots\dots(5)$$

Or

$$\text{Percentage of margin of safety} = \frac{\text{BEP in Monetary Value}}{\text{Total Revenue}} \times 100 \dots\dots\dots (6)$$

Results and Discussion

Break even analysis of “PDKV UV-Assisted Treatment Device” for post harvest decay control in Nagpur mandarins is done with following assumptions –

- I. The project is proposed to function for about 6 months with a capacity of 2 tonnes per day.
- II. The unit would run for 180 days per year with 80 Percent utilization efficiency
- III. The annual rate of interest was assumed @ 6%
- IV. The rates of raw material, personnel, utility, products are as prevailing in the market.

A detailed financial analysis of the business, including costs, revenues, break-even points, and margin of safety essential for assessing the viability and profitability of the business venture is presented in Table 1 and Fig.1.

Table 1. Break even estimates of “PDKV UV-Assisted Treatment Device” for post harvest decay control in Nagpur mandarins.

| Sl. No. | Economic indicators | Value |
|---------|--------------------------------------------------------------------------------------|--------------------|
| 1 | <i>Capital Investment (Establishment cost) / Capital Outlay</i> | |
| A | Cost of Land (250m ²) | 1,00,000/- |
| B | Cost of Shed (6m x10m) | 2,50,000/- |
| C | Cost of Machinery (UV-Assisted Treatment Device) | 2,50,000/- |
| D | Cost of Electric Installation | 50,000/- |
| | Total Capital Investment | 6,50,000/- |
| 2 | <i>Variable Cost</i> | |
| A | Labour Requirement Per Annum | |
| | 4 Unskilled Labours @ Rs.350 per day = 4 x 350 x 180 | 2,52,000/- |
| | 1 Skilled Labour @ Rs.1000 per day = 1 x 1000 x 180 | 1,80,000/- |
| | Total Labour Cost Per Annum | 4,32,000/- |
| B | Utility (Power Kwh) Per Annum | |
| | Power (Kwh) = 1 (hp) x 8hr x 0.746 (Kw) x 180 (days) x Rs.9 | 9,669/- |
| | (Electric Consumption Per Unit) = Rs.9,669 Per Annum | |
| C | Nagpur Mandarin Fruits @ Rs.1,000/q = Rs.1000 x 2880 q/Annum | 28,80,000/- |
| D | Edible Wax @ Rs.300/lit (as per 1.00 lit/q, total quantity required 2,880 lit/Annum) | 8,64,000/- |
| E | Repair & Maintenance | 20,000/- |
| F | Miscellaneous Charges | 20,000/- |
| | Total Variable Cost | 42,25,669/- |
| 3 | <i>Fixed Cost</i> | |
| A | Establishment Cost (10%) | 65,000/- |
| B | Depreciation of machine @10% | 25,000/- |
| C | Depreciation of shed @10% | 25,000/- |
| D | Maintenance Cost | 1,00,000/- |
| E | Interest on Fixed Capital (10%) for 6 months | 10,750/- |
| | Total Fixed Cost | 2,25,750/- |

| | | |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| 4 | <i>Cost of Processing Per Annum (180 days)</i> | |
| A | Cost of Nagpur Mandarin Fruits | 28,80,000/- |
| B | Cost of Edible Wax | 8,64,000/- |
| C | Labour Charges (180 days) | 4,32,000/- |
| D | Utility (180 days) | 9,669/- |
| E | Depreciation of machine @10% | 25,000/- |
| F | Depreciation of shed @10% | 25,000/- |
| G | Interest on Working Capital (6%) for 6 months | 1,27,070/- |
| | Total Cost of Processing Per Annum | 43,62,739/- |
| 5 | <i>Cost of Processing Per Quintal</i> | |
| A | Total Quantity Processed Per Annum (q) | 2,880 q |
| B | Cost of Processing Per Quintal | 1,515/- |
| C | Annual Gross Return for Processing @ Rs.6,000/q | 1,72,80,000/- |
| D | Annual Net Return | 1,29,17,261/- |
| E | Net Return Per Quintal | 4,485/- |
| F | B:C Ratio | |
| | =Annual Gross Return/Total Cost | 1 : 3.54 |
| 6 | <i>Break Even Point</i> | |
| | Total Cost = Capital Investment + Variable Cost | 48,75,669/- |
| | Total Income Per Annum | 1,72,80,000/- |
| | Total Quantity Processed Per Annum (q) | 2,880 q |
| | Sale Price of Processed Fruits Per Quintal | 6,000/- |
| | Variable Cost | 42,25,669/- |
| | Variable Cost Per Quintal | 1,467/- |
| | Break Even Point, Quintals = Total Fixed Cost / (Sale Price of Processed Fruits Per Quintal – Variable Cost Per Quintal) = 2,54,000/(6000-1467) = 49.8 q | 49.8q Rounded as 50 q |
| | Pay Back Period in Year = BEP/Total Quantity Processed Per Annum (q) = 0.02 Year | 0.02 Year (Approximately 7 Days /1 wk) |
| 7 | Margin of Safety (in Quintals) | 2,830 q |
| 8 | Margin of Safety (in Rs.) | Rs. 1,69,80,000 /- |
| 9 | Percentage of margin of safety on the basis of output (%) | 1.74% |
| 10 | Percentage of margin of safety on the basis of monetary value of the output (%) | 1.74% |

It is worked out that the total capital investment done by the owner at the initial stage as cost of land, cost of shed, PDKV UV-Assisted treatment device, cost of electrical fitting etc. was Rs. 6,50,000/-. However, variable cost consisted of labour charges, repairs, maintenance charges, raw material charges are estimated to be Rs. 42,25,669/-. Thus, the total cost estimated by adding the fixed cost (Rs. 2,25,750/-) and variable cost (Rs. 42,25,669/-) was Rs. 44,51,419/-. The depreciation on machinery was calculated @10%, depreciation of shed was worked out @10%, whereas, the interest on fixed capital was calculated @ 10% for six months. For calculating interest on working capital, the expenditure on items included in variable cost was taken into consideration. Interest on working capital was calculated @6% for six months as discussed by Shende (2013).

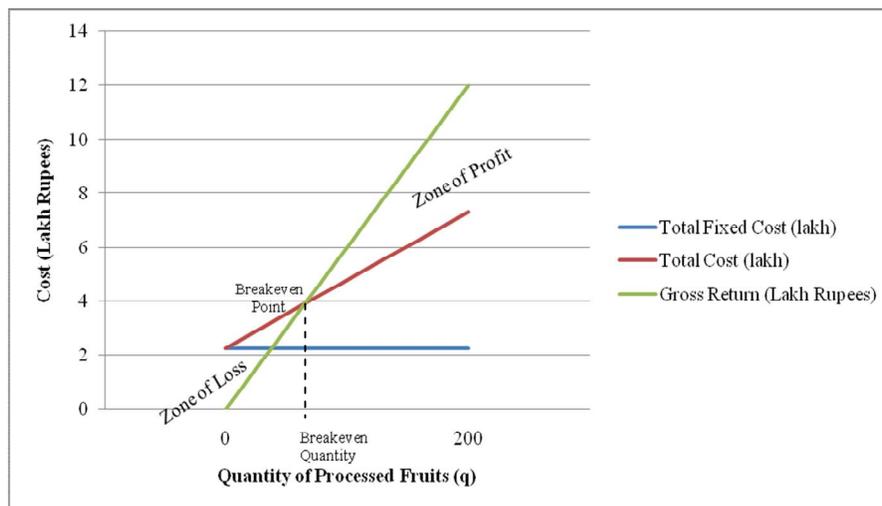


Fig. 1. Break Even Diagram of PDKV UV-Assisted Treatment Device for Post Harvest Decay Control in Nagpur Mandarins.

Analyses indicate that the machine will be operational for 180 days during the season when Nagpur Mandarins are harvested in India. The cost per quintal of processing is calculated to be Rs. 1,515/-, along with the annual gross return and net return based on the processing of a certain quantity of fruits. The Net Return Per Quintal is found to be Rs. 4,485/-. In this case, the cost benefit ratio is 1:3.54, indicating that for every unit invested, there's a return of 3.54 units, indicating viability of the business and it was in profit. Break-even point, which is the level of production at which total income equals total costs is calculated in terms of quintals and indicates that the business needs to produce approximately 50 quintals to break even. The positive figure of breakeven point reflects that the business will sustain during events of fluctuation in returns against anticipated returns due to any unforeseen eventuality (Subba Reddy and Raghu Ram 2018). The margin of safety represents the amount by which sales can drop before the business reaches the break-even point. In this case, there's a margin of safety of 2,830 quintals, equivalent to Rs. 1,69,80,000/- or approximately 1.74% of output and monetary value. These results provide indications of more profitability and less riskiness, whereas, cash flow and overall profit indicates the suitability of the business for mandarin growing regions of India. The higher benefit beyond the breakeven point is attributed to lower initial investment and higher throughput capacity (Sarker *et al.* 2015). Singh and Mehta (2015) and Sarker *et al.* (2015) have obtained similar results for machinery in use for other farm operations as well. Future research should include the derivation of breakeven concepts analyzing the fluctuating costs of raw material and processed fruits as well as output loss due to fungal rotting of fruits.

Break Even analysis of "PDKV UV-assisted Treatment Device" indicates it can provide a viable mandarin processing business with a good margin of safety. The eco-friendly treatment provided by the machine may help fetch the international market to the delicious Nagpur Mandarins.

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