Economic feasibility analysis of a frozen fruit pulp industry

Lucas Martins da SILVA[1] ⓘ, Alcimar das Chagas RIBEIRO[1] ⓘ, Eder Dutra de RESENDE[1]* ⓘ

Abstract

The production of frozen pulp is widely adopted in the industry. The aim of this study was to evaluate the economic viability of a medium-sized agro-industry producing frozen fruit pulp. The effects of different processing parameters on the company's financial performance were assessed under alternative cash flow scenarios. The analysis included the effective cash flow of the industry under current operating conditions and a sensitivity analysis considering increases in operating capacity. The net present value, internal rate of return, and payback indicators were determined. Results showed that small changes in operating capacity had a significant impact on economic performance. At the current operating capacity (33%), the return on investment (payback) was 79 months, whereas at 99% operating capacity the payback decreased by 89.7%, reaching 8.1 months. These findings demonstrate that even small changes in operating capacity strongly affect the industry's economic viability indicators.

Keywords: fruit pulp industry; economic viability; operational capacity; economic indicators.

Practical Application: Technological parameters and economic viability of a frozen fruit pulp processing plant based on data collected in the industry

1 INTRODUCTION

Passion fruit stands out among the fruit pulps processed in agro-industries. In 2024, Brazil produced 736,585 tons of passion fruit, with a total production value of R$ 2,557,151.00 (Instituto Brasileiro de Geografia e Estatística [IBGE], 2025). It is a fruit widely produced in the tropical and subtropical zones of the Americas; it is related to the economic performance of this sector in Brazil, especially considering domestic consumption, which is subdivided into two market segments: agro-industries (frozen pulp, concentrated juice, nectars, ice cream, etc.) and fresh fruit (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA], n. d.).

According to Pimentel et al. (2009), passion fruit destined for the pulp industry accounts for 40% of Brazilian production. During the industrialization of passion fruit, two basic products can be obtained: frozen pulp and pasteurized juice. Frozen pulp is usually sold for direct consumption or incorporated into other products, such as drinks, dairy products, ice cream, and the like (Serviço Brasileiro de Apoio às Micro e Pequenas Empresas [SEBRAE], n. d.).

Brazil's fruit pulp industries have grown significantly in recent years, mainly targeting the international market while supplying the domestic market (Rodrigues, 2021). According to Regis et al. (2015), the small- and medium-sized industries producing passion fruit pulp in Brazil process between 10 and 100 tons daily.

Even with a high production and sales capacity for frozen fruit pulp, many industries face adversity, including off-season periods, adverse weather events, lack of interest from local producers, the high cost of acquiring raw materials produced in regions far from the industry, marketing aspects, and market competition. In this way, robust economic analysis is a valuable tool to help with decision-making (Rezende & Oliveira, 2013).

One of the crucial points for a successful economic viability analysis is to describe, detail, and quantify the project expenditure and income, such as the value of infrastructure and equipment, labor costs, consumption of raw materials, production inputs, maintenance costs, energy, and the like. Revenues are obtained from the sale of products (Gomes, 2013).

Economic feasibility analysis normally considers the internal rate of return (IRR), net present value (NPV), payback, and sensitivity analysis (SA) indicators within the project horizon. They make it possible to distinguish the profitability of investments associated with different project expenditures and revenues (Mellichamp, 2017). According to Arora et al. (2018), the market price of the product can strongly affect the economic viability of the project.

In an analysis of the economic viability of a fruit processing industry with different production capacities (100 tons, 500 tons, 1000 tons, and 5000 tons per year), Araújo et al. (2002) found that increasing the amount of fruit processed increases the industry's economic viability.

It is important to note that few studies detail the cost components of a food industry's cash flow and its economic viability. These include economic feasibility studies in the dairy industry (Aydiner et al., 2014; Cox et al., 2022; Lauer et al., 2018), beverages (Souza et al., 2016), compound extraction (Chalermthai et al., 2022), and fermentation (Chen et al., 2022; Deng et al., 2024).

In a study by Araújo et al. (2002), the industry cash flow data only referred to one month of the year. In addition, this study did not consider important technological criteria such as harvest and off-season variations, raw material freight costs, and losses. In this way, the study does not achieve an effective sensitivity to carry out an economic feasibility analysis of a fruit pulp industry, mainly because it does not have enough data to represent a robust cash flow within a project horizon.

In view of the lack of studies for the agro-industries, this work aimed to analyze the technological parameters and economic viability of a medium-sized frozen fruit pulp processing plant, using data provided by the company for 2022, projected for a project horizon of 120 months.

1.1 Relevance of the work

This study assesses the technological parameters and economic feasibility of a frozen fruit pulp processing plant, based on industry data. The influence of processing parameters on financial performance was evaluated under different cash flow scenarios.

2 MATERIAL AND METHODS

2.1 Data Source

The data was collected in a medium-sized industry that processes fruit to produce frozen pulp. The factory has 47 employees divided into sectors and a monthly processing capacity of 500 tons of raw material. This study considered processing yellow passion fruit (PRM) and other fruits (ORM). The main focus was on passion fruit processing, but the industry processes 23 types of pulp: pineapple, acai, acerola, blackberry, cocoa, caja-manga, cashew, guava, soursop, orange, mango, strawberry, tangerine, grape, pineapple with mint, detox (mixture of pineapple, kale, ginger), acerola with orange, mixed (mixture of mango, strawberry, papaya, pineapple, acerola, cocoa, guava, and passion fruit), lemon, cupuaçu, caja-mirim, and pitanga.

The industry cash flow expenditure and income schedule for 2022 was collected from the company accounting office and through a data survey from the industry production line. The industry currently processes 165.1 tons of fruit per month, of which 43.8 tons represent PRM and 121.3 tons represent ORM. The data was related to the mass of raw material processed in the industry, and the company's total turnover was distributed with 30% from the sale of passion fruit pulp and 70% from other fruit pulps.

This study includes a more detailed analysis of the technological parameters of PRM processing, considering harvest season (December to May) and off-season (June to November) factors, raw material freight costs, losses during the process, the effective amount of pulp processing, and waste disposal. A more general economic analysis involving pulp yield data was carried out for ORM.

2.2 The Industry's operational capacity and the cost of raw materials

The industry's OC (operating capacity) was set at 500 tons/month, considering a 5-tons/hour processing line that operates 5 hours/day, with 3 hours for sanitizing the factory and 20 days of activities per month. However, in 2022, the industry only processed 165.1 tons of raw material per month, 43.8 tons of which were passion fruit. Notably, there are usually 10% losses during the selection of passion fruit on the processing line, reaching 39.5 tons of processed passion fruit, making it possible to obtain 12.9 tons of frozen passion fruit pulp. In the case of other fruit pulps, the pulp yield of each fruit was used to obtain the amount of ORM processed in the industry, since the industry also buys a small amount of frozen pulp from other agro-industries, making it possible to produce 109.9 tons/month of frozen pulp.

In the survey of the proportions of quantities of fresh fruit processed in 2022, 26.5% of passion fruit, 14.6% of soursop, 15.6% of acerola, 12.1% of mango, 11.8% of pineapple, 9% of guava, 3.1% of caja-manga, 2.4% of strawberries, 1.0% of grapes, and 0.2% of blackberries were obtained, giving a total of 159 tons/month. However, the extraction yield varies depending on the raw material; for example, pineapple is 70% and acerola is 85%. The purchase of frozen pulp as a raw material amounted to 6 tons/month, or 3.6% of the total raw material purchased by the industry. The total amount of raw material is presented in Table 1.

The industry's OC variation studies were carried out with increases in the proportion of raw materials processed in the industry (GRMV), starting from its current processing condition, which represents 165.1 tons/month of general raw materials (GRM). This equals 33% of the plant's OC. The increase in OC was carried out up to a limit of 99% of the plant's OC (Table 1). Thus, for 99% OC, there is a 200% increase in GRMV, reaching 495 tons/month of GRM, with PRM contributing 60% of GRMV and producing 142.9 tons/month, while ORM contributes 140%

Table 1. Variations in the plant operational capacity for processing frozen pulp obtained from the general variation in raw materials and the quantity of general raw materials, passion fruit raw materials, and other raw materials.

Raw material variation				
OC (%)	GRMV (%)	GRM (t)	PRM (t)	ORM (t)
33	0	165.1	43.8	121.3
36	10	181.6	48.8	132.9
40	20	198.1	53.7	144.4
43	30	214.6	58.7	156.0
46	40	231.2	63.6	167.5
50	50	247.7	68.6	179.1
66	100	330.2	93.3	236.9
83	150	412.8	118.1	294.7
99	200	495.3	142.9	352.5

GRMV: general raw material variation; OC: operating capacity; GRM: general raw material; PRM: passion fruit raw material; ORM: other raw materials.
Source: Authors (2023).

of GRMV and produces 352.5 tons/month. This is due to the pulp extraction yield and the use of the ratio of 30% PRM and 70% ORM in the industry turnover. The monthly cost of the raw materials is presented in Table 2. The data collected for the cost of raw materials showed that the average value of passion fruit is R$ 2.50/kg in the harvest season and R$ 3.50/kg in the off-season. In the industry, 90% of the raw materials are supplied by local producers and 10% from other regions. The cost of transportation was calculated based on fuel, driver expenses, and truck maintenance. In this way, the cost of the PRM raw material amounted to R$ 3,827.50/ton in the harvest and R$ 4,827.50/ton in the off-season, corresponding to a total cost of R$ 167,644.50/month in the harvest season and R$ 211,444.50/month in the off-season, at the current processing capacity (33% OC). The ORM cost amounted to R$ 226,474.11/month (Table 2).

2.3 Company infrastructure

The value of the industry infrastructure was budgeted at R$ 2,000,000.00, which refers to the value of the land and the construction of the industry. This value is similar to that described by Silva and Andrade (2014) for setting up a macauba processing industry (R$ 2,214,147.55). The industry is located on a 15,000 m² site, with a built-up area of 2,500 m², including areas for receiving and sanitizing raw materials, processing, filling, freezing, storing, packaging, and shipping, as well as a warehouse and administrative and employee hygiene areas, as well as rooms for analysis laboratories. The industry collects all its water from an artesian well and has its own effluent treatment and solid waste composting systems.

2.4 Equipment

The industry equipment line was budgeted at R$ 2,185,000.00 and includes one scale, two sorting conveyors with their respective washing devices, two sanitizing tanks, one set of fruit cutting and pulping equipment, one mechanical waste transportation system, one waste reception silo, one pulp collection tank with connecting pipes, three pulp stirring and mixing tanks, five pulp filling machines, three freezing tunnels, three cooling chambers, one packaging line, two cold chambers for shipping packaged products, as well as two refrigerated trucks for transporting products.

2.5 Other fixed costs and other inputs

Other fixed costs are expenditures made by the industry for its full operation and are not normally identified in the industry's cash flow balance sheet, with an average value of R$ 20,000.00/month.

Expenditure on other inputs refers to the purchase of chemical additives, waste disposal, hygiene and sanitizing materials, office supplies, and other costs (not specified by the company), with an average value of R$ 13,471.00/month, which represents 1.6% of monthly expenditure for the year 2022.

2.6 Maintenance of infrastructure and equipment

The cost of maintaining the industry infrastructure in 2022 was R$ 6,455.46/month. The cost of maintaining equipment was R$ 15,524.40/month, used to process 165.1 tons/month of raw materials, equivalent to R$ 112.46/ton/month. This cost was used in the SA calculations.

2.7 Labor

The labor cost survey divided employees by industry sector, as shown in Table 3. The total labor cost in 2022 was R$ 87,666.99

Table 2. Determination of the monthly cost of passion fruit raw materials (PRM) in the harvest and off-season and the value of other raw materials (ORM) according to the variations in raw materials processed in the industry.

RAW MATERIAL VALUE (R$/month)			
OC (%)	Value of PRM (harvest)*	Value of PRM (off-season)**	Value ORM***
33	R$ 167,644.50	R$ 211,444.50	R$ 226,474.11
36	R$ 186,603.26	R$ 235,356.56	R$ 248,051.22
40	R$ 205,562.01	R$ 259,268.61	R$ 269,628.34
43	R$ 224,520.77	R$ 283,180.67	R$ 291,205.45
46	R$ 243,479.52	R$ 307,092.72	R$ 312,782.56
50	R$ 262,438.28	R$ 331,004.78	R$ 334,359.68
66	R$ 357,232.06	R$ 450,565.06	R$ 442,245.25
83	R$ 452,025.84	R$ 570,125.34	R$ 550,130.83
99	R$ 546,819.62	R$ 689,685.62	R$ 658,016.40

OC: operational capacity; PRM: passion fruit raw material; ORM: other raw materials; *Value of PRM in the harvest season: R$ 3827.50/t; **Value of PRM in the off-season: R$ 4827.50/t; Average currency conversion value for the year 2022: 1 US$ = 5.16 R$ (Instituto de Pesquisa Econômica Aplicada [IPEA], 2022).
Source: Authors (2023).

Table 3. Monthly payroll for the different industry sectors and the number of employees according to the number of raw materials processed in the industry.

		Number of employees				
Sectors	Unit salary/employee	165.1 t	247.7 t	330.2 t	412.8 t	495.3 t
Reception/processing	R$ 1,423.41	6	8	9	10	11
Preparation/filling	R$ 1,857.20	8	10	11	12	13
Storage/packaging	R$ 1,686.92	16	16	16	18	19
Administrative	R$ 2,173.35	13	13	13	13	13
Transport	R$ 2,256.14	4	4	4	4	4
Total value		**R$ 87,667.0**	**R$ 94,303.5**	**R$ 97,621.7**	**R$ 104,169.7**	**R$ 109,102.8**

t: tons. Average currency conversion value for the year 2022: US$ 1 = R$ 5.16 (IPEA, 2022).
Source: Authors (2023).

for processing 165.1 tons/month of raw materials. The increase in the number of employees due to the increase in the industry's operational capacity was carried out in the fruit reception and processing sector, the product preparation and filling sector, and the storage and packaging sector, while maintaining the same number of employees in the administration and transportation sectors, which have idle load capacity.

Table 3 shows that in the reception and processing sector and the product preparation and filling sector, progressive increases in the number of employees were considered due to the increase in the industry's OC. Employees were kept constant in the storage and packaging sector until 66% of the industry's OC was reached (330.2 tons/month). This was considered possible due to observations of the different sectors that operate with internal rearrangements of support among employees.

2.8 Data energy

The cost of energy consumed by the industry was based on average data for the year 2022. It should be noted that the cost of water consumption was included in the total amount of energy consumed, as the company uses water from artesian wells. The company considers the amount spent on energy consumption to be 40% for the fruit reception, hygiene, and processing sectors and 60% for the other sectors of product preparation and filling, storage, and packaging. Energy consumption also includes lighting in the industry and energy used in the administration and employee hygiene sectors, but with little impact on the industry's total energy consumption.

The processing of fresh fruit accounted for 96.4% of the raw material used in the industry (165.1 tons/month) in 2022, while only 3.6% comes from the purchase of frozen pulp, which does not pass through the fruit processing sectors and requires a lower proportional energy consumption. The total energy consumed in 2022 was R$ 70,849.63/month, as shown in Table 4.

Regarding passion fruit processing (PRM), which represents 26.5% of the total raw material used in the industry as fresh fruit, the energy cost is R$ 18,775.15/month. The same

calculation of energy expenditure can be made for the ORM, considering their proportions in the total amount of pulp produced by the industry.

The energy consumption costs due to the increase in the industry's OC, calculated according to the GRMV variation (Table 4), considered an average cost of R$ 429.13/ton per month, obtained for the reference year 2022. So, for example, a 50% increase in GRMV compared to the industry's initial OC resulted in an energy cost of R$ 106,274.45/month.

2.9 Packaging costs and outsourced services

Table 4 shows the data on packaging costs due to the increase in the proportion of raw materials processed in the industry. The data collection included all the costs of purchasing packaging used in the production and marketing of all the frozen pulp sold in 2022, representing an average monthly cost of R$ 516.3/ton. In this case, the total cost of packaging the pulp processed in 2022 was R$ 63,402.13/month. In addition, the packaging cost values obtained for the increases in the industry's OC were obtained according to the proportion of the increase in the processing of all raw materials (GRMV), also considering the pulp extraction yields of each raw material.

The values for outsourced services relate to the costs of the accounting office and the laboratories for microbiological and physicochemical analysis carried out on the frozen pulps. The average amount spent on these services was determined according to the amount of raw materials processed in 2022, reaching R$ 103.31/ton/month, with a total cost of R$ 17,057.82/month. Table 4 shows the cost data for outsourced services due to the increased proportion of raw materials processed in the industry.

2.10 Taxes, investment payments, and entrepreneur remuneration

The total taxes paid by the company currently represent 8.5% of the industry's gross sales. Thus, the increase in the value of taxes is proportional to the increase in the variation of raw

Table 4. Calculation of monthly costs (R$) for packaging, outsourced services, and energy consumption associated with the increased amount of raw material processed in the industry.

		Costs (R$/month)		
OC (%)	GRMV (%)	Packaging	Outsourced services	Energy cost
33	0	R$ 63,402.13	R$ 17,057.82	R$ 70,849.63
36	10	R$ 69,742.34	R$ 18,763.60	R$ 77,934.60
40	20	R$ 76,082.55	R$ 20,469.38	R$ 85,019.56
43	30	R$ 82,422.76	R$ 22,175.16	R$ 92,104.52
46	40	R$ 88,762.98	R$ 23,880.94	R$ 99,189.49
50	50	R$ 95,103.19	R$ 25,586.72	R$ 106,274.45
66	100	R$ 126,804.25	R$ 34,115.63	R$ 141,699.57
83	150	R$ 158,505.31	R$ 42,644.54	R$ 177,124.08
99	200	R$ 190,206.38	R$ 51,173.45	R$ 212,548.90

OC: operating capacity; GRMV: general raw material variation; Average currency conversion value for 2022: US$ 1 = R$ 5.16 (IPEA, 2022).
Source: Authors (2023).

materials processed in the industry (GRMV), i.e., this rate relates to the total gross revenue from the sale of products.

The study includes an initial loan of R\$ 4,205,000.00 for the construction of the industry and the purchase of equipment, as well as fixed inputs for the start-up of the industry. This loan was to be paid back in 60 installments, with interest of 15% p.a. (accumulated SELIC for 2022—13.75% plus 1.15% bank services), according to data from the Banco Nacional de Desenvolvimento Econômico e Social (BNDES, n.d.).

The entrepreneur's monthly remuneration was initially set at R\$ 20,000.00/month for the first 60 months of the loan, tripling this amount over the remainder of the project horizon.

2.11 Products and revenues

According to company data, 75% of frozen fruit pulp is sold in 100 g packs, 20% in 1 kg packs, and 5% in drums (100 kg). However, the price of the quantity of frozen pulp is the same for any packaging. In 2022, frozen passion fruit pulp (PP) had an average sales price of R\$ 13,851.81/ton, and pulp from other fruits (OP) had an average price of R\$ 7,546.25/ton. Thus, considering the yields from extracting fruit pulp, the gross monthly revenue obtained in 2022 from the sale of PP was R\$ 178,688.39/month, while the revenue obtained from the other pulps was R\$ 829,332.74/month.

The revenues obtained from the sales of PP and other pulps (OP) produced in the industry, operating at different operational capacities, are shown in Table 5. The revenues from the sale of pulp due to the increase in OC were calculated based on the quantities of pulp obtained from the raw materials processed in the industry.

2.12 Analysis of the economic viability of the frozen pulp industry

The cash flows were obtained using the industry income and expenditure data for the year 2022. The net flow is the difference between income and expenditure (Noronha, 1987). In this study, a depreciation of 90% of the initial values of the equipment was calculated after a 120-month horizon and incorporated into the cash flow as a residual value.

This study used the economic result indicators represented by the NPV, the IRR, and the payback, which make it possible to assess the effect of correcting monetary values according to the project horizon (Gomes, 2013). Sullivan et al. (2011) pointed out that these indicators are useful for estimating the viability of a project.

2.12.1 Calculating the net present value

The NPV is used to verify the economic viability of the project. Thus, when the NPV exceeds zero, the project covers all costs and generates an economic return. The NPV is calculated according to Equation 1:

$$\text{NPV} = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - CF_0 \qquad (1)$$

where CF_0 is the initial capital investment (R\$/month); CF_t is the return on the cash flow each month (R\$/month); n is the number of cash flows over the project horizon; t is the project horizon (in months), and r is the minimum discount rate, which refers to the minimum attractive rate of return (MARR).

2.12.2 Internal rate of return

The IRR is the interest rate that equals the NPV to zero, i.e., it represents the return on investment, which can be positive or negative and can be recovered considering the project horizon. It is calculated according to Equation 2:

$$0 = -I + \sum_{t=1}^{n} \frac{CF_t}{(1+j^*)^t} \qquad (2)$$

where I is the capital investment at time zero (R\$/month); CF_t is the return on the cash flow each month (R\$/month); n is the number of cash flows over the project horizon; t is the project horizon (in months), and j^* is the IRR.

In this way, the IRR can be calculated and compared with the MARR to identify the viability of the project. If the IRR is lower than the MARR, the project is not viable, and investment in another economic asset is recommended. The MARR

Table 5. Calculation of gross revenue (R\$/month) for frozen pulp obtained from the passion fruit raw material and pulp obtained from other raw materials according to the increase in the industry's operating capacity.

VARIATION IN REVENUE							
OC (%)	GRMV (%)	GRM (t)	PRM (t)	PP (t)	ORM (t)	OP (t)	PP revenue/month	OP revenue/month
33	0	165.110	43.8	12.9	121.3	109.9	R\$ 178,688.39	R\$ 829,332.74
36	10	181.621	48.8	14.2	132.9	120.9	R\$ 196,695.75	R\$ 912,341.48
40	20	198.132	53.7	15.4	144.4	131.9	R\$ 213,317.92	R\$ 995,350.22
43	30	214.643	58.7	16.7	156.0	142.9	R\$ 231,325.28	R\$ 1,078,358.96
46	40	231.154	63.6	18.0	167.5	153.9	R\$ 249,332.64	R\$ 1,161,367.69
50	50	247.665	68.6	19.3	179.1	164.9	R\$ 267,339.99	R\$ 1,244,376.43
66	100	330.220	93.3	25.7	236.9	219.8	R\$ 355,991.60	R\$ 1,658,665.49
83	150	412.775	118.1	32.2	294.7	274.8	R\$ 446,028.38	R\$ 2,073,709.17
99	200	495.330	142.9	38.6	352.5	329.7	R\$ 534,679.99	R\$ 2,487,998.23

OC: operating capacity; GRMV: general variation in raw materials; GRM: general raw materials; PRM: passion fruit raw materials; ORM: other raw materials; PP: pulp obtained from passion fruit raw materials; OP: pulp obtained from other raw materials; Average currency conversion value for the year 2022: US\$ 1 = R\$ 5.16 (IPEA, 2022).
Source: Authors (2023).

for this study was set at 1.079% p.m. (accumulated SELIC for 2022—13.75%), according to data from the BNDES (n.d.).

2.12.3 Determining payback

Payback represents the return on investment and considers each month's NPV within the project horizon. The calculation considers the MARR interest rate, as Assaf Neto (2012) described.

2.12.4 Analysis of the industry's current economic viability

The current economic feasibility analysis was formulated based on the cash flow items relating to the industry expenditure and income in 2022, making it possible to determine the NPV, IRR, and payback indexes within a project horizon of 120 months.

2.12.5 Cash flow sensitivity analysis

The cash flow SA was conducted to understand how other expenditure and revenue scenarios might influence the industry balance sheet. To do this, we calculated the increase in the values of the items that make up the company's cash flow, as described by Gomes (2013).

SA was carried out based on the industry cash flow items for 2022. To do this, their proportions were increased according to the proportions of pulp quantities obtained from the raw materials processed in the industry (Table 6).

The proportions shown in Table 6 were used to determine the NPV, IRR, and payback to analyze the project's economic viability over 120 months. Note that the variations in the proportions of PP (PRM) and ORM are different due to the effect of pulp extraction yield. In the case of increases in the labor

item (LB), new employees are hired from a 50% increase in the amount of raw material processed in the industry (GRMV).

2.13 Data analysis

The cash flows for this study were drawn up based on data collected from a medium-sized frozen fruit pulp industry for 2022. The values of infrastructure, equipment, maintenance, inputs, energy, human resources, outsourced services, taxes, raw material costs, and revenues were considered. Expenditure on loans, monetary corrections, and the entrepreneur's remuneration are also considered.

To study the industry's economic viability, this study developed a calculation program involving the inventoried items applied to construct cash flows within a 120-month project horizon. This calculation was developed in the Microsoft Excel® software.

3 RESULTS AND DISCUSSION

The NPV and IRR data, representing the present values of the total cash flow over a 120-month horizon, are shown in Figure 1. The results were calculated for each increment in the industry's raw material processing capacity (GRMV).

The industry's current processing capacity is 33% of the total amount of raw materials that can be processed in the industry. This gives an NPV of R$ 2.179 million/month and an IRR of 1.7%. When OC reaches its maximum (99%), the NPV attains R$ 58.063 million/month, while the IRR reaches 21.7%. As shown in Figure 1A, there is a direct correlation between the increase in the industry's OC and the NPV values, with each 1% OC increase corresponding to an increase of R$ 0.8467 million/month in NPV. A similar correlation is observed for change in IRR (Figure 1B), where each 1% increase in OC corresponds to a 0.30% increase in IRR.

Table 6. Proportions of the increases applied to cash flow items for sensitivity analyses according to the expanded raw material processing capacity in the industry.

	Group of sensitivity variations (%)								
OC*	33	36	40	43	46	50	66	83	99
GRMV*	0	10	20	30	40	50	100	150	200
PRM*	0	3	6	9	12	15	30	45	60
ORM*	0	7	14	21	28	35	70	105	140
InfraE*	n/a*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Equip*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
OFC*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ITM*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Mequip*	0	10	20	30	40	50	100	150	200
Labor*	0.0	0.0	0.0	0.0	0.0	7.5	11.2	18.8	20.7
Energy	0	10	20	30	40	50	100	150	200
Packaging*	0	10	20	30	40	50	100	150	200
OS*	0	10	20	30	40	50	100	150	200
OI*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Taxes	0	10	20	30	40	50	100	150	200
Revenue	0	10	20	30	40	50	100	150	200

*OC: operational capacity of the industry; GRMV: general variation in raw materials; PRM: passion fruit raw materials; ORM: other raw materials; InfraE: infrastructure; Equip: equipment; OFC: other fixed costs; ITM: infrastructure maintenance; Mequip: equipment maintenance; OS: outsourced services; OI: other inputs; *n/a: not applicable.
Source: Authors (2023).
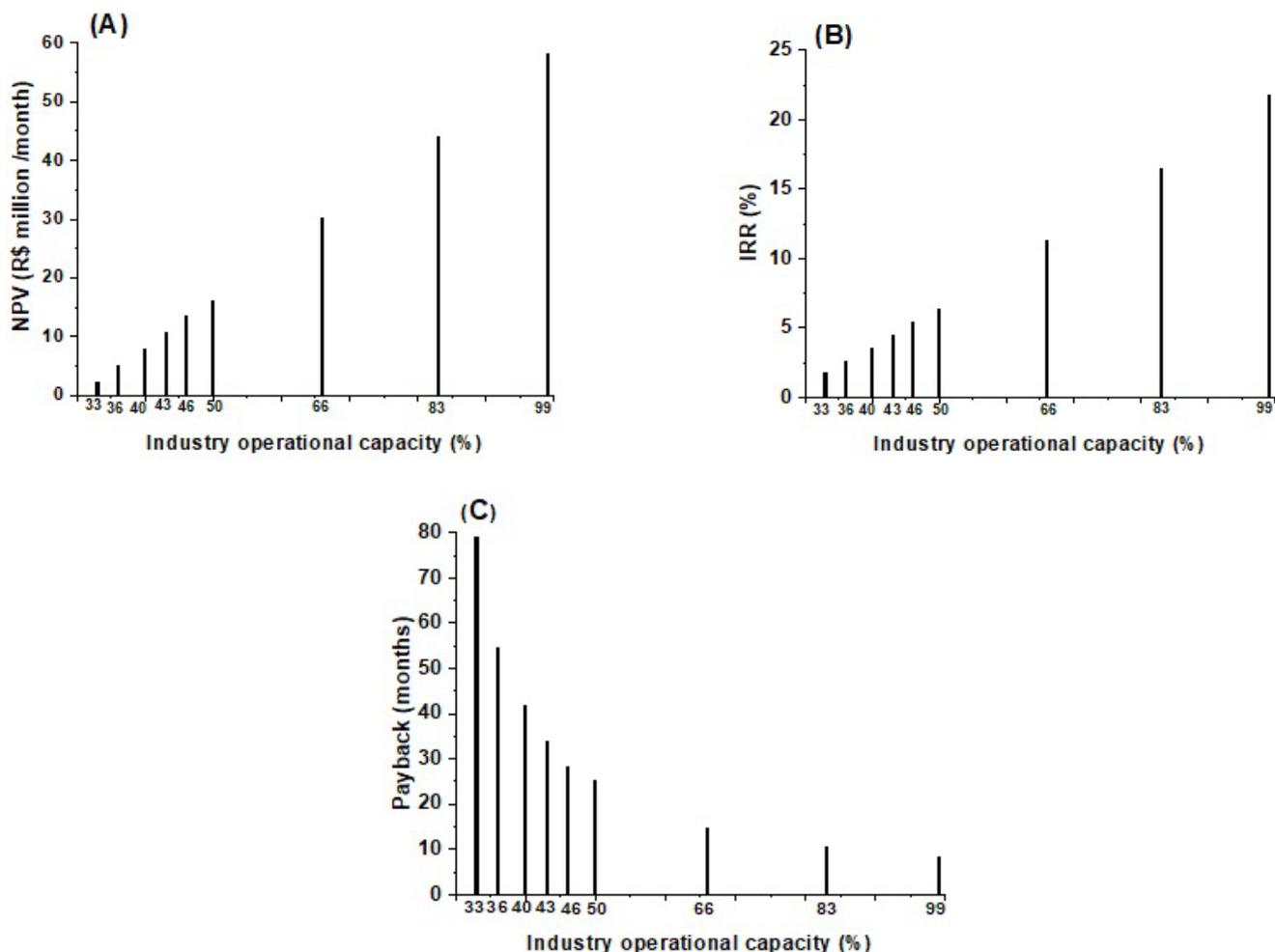
NPV: net present value; IRR: internal rate of return.

Figure 1. Results of net present value **(A)**, internal rate of return **(B)**, and payback **(C)** for the total cash flow over a 120-month horizon. The results were calculated for each raw material processing capacity of the industry.

The results presented in Figure 1B show that all industry's OCs provide IRR values higher than the MARR, which was 1.079% p.m., according to the real savings interest rate for 2022 (BNDES, n.d.). In addition, positive NPVs were obtained for all the industry operating conditions (Figure 1A), demonstrating its economic viability, according to Gomes (2013).

With an investment ceiling of R$ 850,000 and a 10-year horizon, Souza et al. (2016) also analyzed the NPV and IRR in a study of four business scenarios in the craft beer market. Their analysis considered both the current processing conditions of the industries and a SA in which the MARR, the unit input cost per liter, the unit sales price, and the quantity of product sold were varied. They found that even small 10% changes in the cash flow items of the four companies resulted in positive increases in the economic viability indicators. In the economic feasibility analysis conducted by Araújo et al. (2002) on fruit production and pulp extraction in industries in the southeastern region of Bahia, Brazil, PP presented the second-highest average production cost due to its relatively low extraction yield (30%), compared with other fruits processed in the industry, whose yields range from 40 to 100% when the raw pulp is purchased as input.9629185919

Moreira (2012) and Sabbadini et al. (2006) observed that OC should be aligned with consumer demand, since operating under capacity conditions different from those required by the market may lead to a distorted SA of the industry scenario in relation to the consumer market.

There are a few studies that describe financial indicators for fruit pulp industries. Some focus more specifically on crop-level economic viability, such as Rosa et al. (2019), who evaluated the profitability of passion fruit cultivation on a 5-hectare area over a 3-year horizon, reporting an NPV of R$ 67,645.55 and an estimated IRR of 160%. The higher magnitude of the IRR compared with the present study can be attributed to the time required for crop development until the onset of production, which affects both expenditure and revenue items in the project's cash flow.

In this study, a payback analysis was conducted to determine the recovery period of the resources invested in infrastructure, equipment, fixed inputs, and other cash flow items that comprise the company's expenditures and revenues, as shown in Figure 1C. Notably, the payback period exhibited an exponential reduction with the increase in the industry's OC.

The SA of the industry's economic viability shows that, at the company's current OC (33%), the project would have a payback period of 79 months. Increasing OC to 50% reduced the payback period to 25 months. When the industry operates at full capacity (99% OC), the payback period decreases by 89.7%, reaching 8.1 months.

According to Souza and Clemente (2008), the greatest project risk occurs when the payback period approaches the end of the project horizon. Therefore, the faster the return on investment, the greater the reliability of the economic feasibility analysis regarding the company's returns.

Lee et al. (2020) reported a reduction in the payback period of a biochar-based biodiesel production project by adjusting the selling price of biodiesel. Similarly, Arora et al. (2018) evaluated the profitability of processing mango waste in a biorefinery and found that its use for producing pectin and seed oil—products with the highest market value—led to improved economic performance, with a payback period of 2.4 years (28.8 months).

4 CONCLUSIONS

This study demonstrated the economic viability of a medium-sized frozen fruit pulp industry operating at 33% of its total capacity, with an NPV of R$ 2.179 million/month, an IRR of 1.7%, and a payback period of 79 months.

The analysis of the industry's economic performance metrics showed a direct correlation between increases in OC and the values of NPV and IRR, with each 1% increase in OC resulting in an additional R$ 0.8467 million/month in NPV and a 0.30% increase in IRR. The payback period exhibited an exponential reduction as OC increased.

The SA of cash flow income and expenditure items over a 120-month horizon showed that operating at maximum capacity (99% OC) enables an 89.7% reduction in the payback period, reaching 8.1 months, with a maximum NPV of R$ 58.063 million/month and an IRR of 21.7%.

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