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Economic evaluation of sweet potato distilled beverage produced by alternative route

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Abstract

Shochu is the most consumed distilled beverage in Japan, produced from sweet potato, one of the most cultivated vegetables in Brazil. *Tchêchu* is a similar distillate, produced by an innovative process, whose economic viability is the object of study of this work. The cost of producing a bottle (750 mL) of *Tchêchu* was estimated at US$ 2.56. The economic evaluation was based on economic indicators that resulted in positive net present value (US$ 530,501.42), internal rate of return (26% p.y.) higher than the minimum acceptable rate of return (9.25% p.y.) and payback of 2.44 years, indicating that the implantation of the distillery is economically viable.

Keywords: Economic Evaluation; Distilled Beverage; Sweet Potato; Shochu; Alternative Process

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1. Introduction

Sweet potato (*Ipomoea batatas*) is a crop of high economic and food value and can be considered one of the sources of food security for population as a subsistence crop. It is a rustic food with great potential for technological development, originated in the tropical regions of Central and South America (EMBRAPA, 2008). This crop presents high adaptability to the tropical environment, with great importance in human food, mainly as a source of carbohydrates, besides its expressive potential for animal feed, starch industrialization and ethanol production (Silva et al., 2002).

Of the 111 countries that produce sweet potatoes, approximately 90% of the production comes from Asia, mainly from China, the world's largest producer, with an annual production of about 70 million tons (FAO, 2017). The Brazilian production of sweet potatoes is the 20th in the world ranking, with a production of 525,814 tons in 2014, obtained in an area of 39,705 ha and an average yield of 13,243 kg.ha^{-1}, ranking 6th among the most planted vegetables. Among the Brazilian sweet potato producing regions, the South region stands out with an annual production of 233,515 tons, which corresponds to 44.41% of the national production, especially Rio Grande do Sul, responsible for 30.68 % of the country's production (IBGE, 2014; FAO, 2017).

Considering its nutritional composition and agricultural potential, sweet potatoes can be used as raw material to obtain industrialized products with higher added value. Through processing, it is possible to supply the market with various sweet potato products, such as dehydrated chips, cereals, jams, jellies, flour, pasta, alcoholic and non-alcoholic beverages (Figure 1). Examples of sweet potato alcoholic beverages include vodka, liquor and shochu. The sweet potato presents an excellent production of biomass and carbohydrates per unit area, which makes the crop an excellent source of starch for the production of ethanol (Echer et al., 2015). In this way, alcoholic beverages from sweet potatoes tend to add a high value to this raw material, as is the case of shochu.

Figure 1. Sweet potato products

Shochu (Figure 2) is a traditional Japanese distilled beverage that can be obtained from the fermentation of various raw materials such as rice, barley, wheat and sweet potatoes, and subsequent distillation. The alcoholic strength can vary from 15% to 45% in volume, but the most traditional ones have 25% in volume. It is the oldest distilled alcoholic drink in Japan and is closely connected to the subtleties of Japanese cuisine, appreciated both as an aperitif as alongside a meal, as well as being widely used in cocktails (Pellegrini, 2014). The consumption of shochu has a significant market share in Japan (10.6%), being more consumed than sake (6.8%) and whiskey (1.3%) (National Tax Agency, 2013). In particular, imo-shochu, which is made from sweet potatoes, is preferred by consumers in Japan since it has a preferable flavor associated with cooked sweet potatoes (Okutsu et al., 2016).

Figure 2. Commercial shochu

Previous studies in GIMSCOP (Masiero, 2012; Risso, 2014; Schweinberger, 2016) have improved the process of using sweet potato on ethanol production, reaching a production cost of US$ 0.39 per liter of hydrous ethanol fuel. It reaches the market at an average price of US$ 0.82, which is economically viable but has a return lower than it could achieve by making products that could generate a greater added value to this raw material.

The beverage industry is an important industrial sector in Brazil, being responsible for 3% of the manufacturing industry production in 2014 (IBGE, 2014). According to the Brazilian Association of Food Industry (ABIA, 2017), the Brazilian beverage industry invoiced US$ 34.00 billion in 2016, which is equivalent to 1.9% of the Brazilian GDP of that year. Factors such as globalization, technological advancement, and deregulation of the most diverse economic sectors have profoundly altered the beverage market in Brazil in recent years, causing per capita consumption of beverages to increase, providing a series of business opportunities to companies and strong competition in the sector (Venturini Filho, 2011).

The alcoholic beverage market in Brazil is represented by distilled (cachaça, whiskey and vodka) and fermented beverages (beer and wine). According to data released by Brazilian Beverage Association (ABRABE, 2017), based on the market surveys of ACNielsen and IWSR, the national beverage market is divided among beer (88.8%), followed by cachaça (6.6%), leaving the rest of the market for other beverages (4.6%). Despite the dominance of beer in the total market share of alcoholic beverages, Brazil officially produces between 1.2 and 1.3 billion liters of cane brandy per year. It is the second most consumed alcoholic drink in the country - about 7 liters per inhabitant/year - and the third most drunk distilled in the world, behind only vodka and soju (Silveira, 2007).

Regardless of the differences between beverage categories, some features in common directly influence the performance of the industry and the size of the market. Among these characteristics can be mentioned the innovations in production processes and marketing techniques, the need for large and efficient distribution channels, high advertising expenses and the choice of packaging, which are fundamental elements that determine the productive dynamics of the sector (Rosa et al., 2006). Predictions on the behavior of the world market for alcoholic beverages for the coming years indicate that growth will be moderate, slightly above 2%

per year by 2020 (Technavio, 2017). The growing demand for premium alcoholic beverages is considered one of the main factors for the growth of this market.

In this context, considering the high productivity of sweet potatoes and the growing influence of Japanese culture in Brazil, there is a great opportunity to add value to this raw material through the production and commercialization of a sweet potato distillate similar to shochu in Brazil, but with a production process faster than the traditional one, aiming to reduce costs and make the final product more competitive in the market. Thus, it is proposed to use the process of production of fuel ethanol already developed in the group (GIMSCOP) with some modifications, which lasts only one day instead of the 14 days required in the traditional process of shochu manufacturing, for the production of alcoholic beverages. The objective of this work is to evaluate the economic viability of implanting a distillery to produce *Tchêchu*, name given to distillate similar to shochu produced by the alternative process in this work, by estimating production costs, projecting the cash flow and calculating economic indicators.

2. Material and methods

2.1. Economic indicators

Techniques for analyzing investments can be understood as methodologies for measuring return on investments. There are several methodologies with varying levels of complexity and sophistication. Among the available methods, the following stand out: payback, net present value (NPV) and internal rate of return (IRR), which were used in this work.

2.1.1. Payback

Payback refers to the time for the investments made to be fully recovered. The recovery time must be within the defined horizon for the project, so that it is considered viable. Payback can be simple or discounted. In simple payback, the value of money in time is not considered. In the discounted payback, the present value of the cash flow is calculated for each period, considering the cost of capital, applying a discount rate. The calculation of this indicator is done by means of the accumulated value of the cash flows from the initial investment to each of the periods under analysis. The time of return of capital is identified in the period in which the accumulated cash flow becomes positive (Beber, 2015).

2.1.2. Net Present Value (NPV)

The net present value method allows estimating the net value of the project at the end of its useful life. Its calculation considers the amount invested, the cash flow in the project horizon and the risk associated with the project, by applying a discount rate corresponding to the cost of capital:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} \qquad (1)$$

where CF_t is the value of the cash flow in period t, i is the cost of capital (minimum acceptable rate of return (MARR)) and t is the period, ranging from 1 to n. The project should be considered feasible when NPV> 0; this value represents how much the investment income exceeds the expected income, which means that the investment income rate is higher than the MARR used. The project should be rejected when NPV <0; this value represents how much the investor's income needs to reach the desired income, being, in this case, the income rate that the investment provides less than the MARR used. When NPV = 0, the project can be rejected or accepted, since it offers neither gain nor loss, and the investment income rate will coincide exactly with the MARR used (Beber, 2015).

2.1.3. Internal rate of return (IRR)

The internal rate of return is an indicator that allows to evaluate the return of the project in function of the cost of capital. The method consists of calculating the rate that cancels the net present value of the cash flow of the investment analyzed:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} = 0 \qquad (2)$$

If the MARR is smaller than the IRR, the NPV is positive, so the project is accepted. The inverse happens when the MARR is larger than the IRR; the NPV is less than zero, indicating the rejection of the project. When the MARR equals IRR, the indicator becomes indifferent to the judgment of the project. A project should be profitable enough to pay interest on the debt contracted to finance it, and also to generate a higher-than-expected rate of return on capital invested (Beber, 2015).

2.2. Costs

Based on the economic analysis carried out by Masiero (2012) on the economic feasibility of the production of hydrous ethanol from sweet potato in micro plants in the state of Rio Grande do Sul, it was possible to evaluate the final cost of the liter of hydrous ethanol. Although they have different purposes, hydrous ethanol fuel and ethanol for human consumption have the same production processes of fermentation and distillation and, therefore, the process parameters can be compared.

2.2.1. Considerations

The base unit for ethanol production was the same one studied by Weschenfelder (2011), with productive capacity of 1000 liters per day of distillate.

It was considered that the agricultural producer already owns or rents the machinery necessary for agricultural production. In this way, the initial investment of the project is the purchase of the production unit, construction of its facilities and assembly services. Knowing that the preparation of the wort takes 1.5 hours, the fermentation lasts 24 hours, and the distillation takes 2.5 hours, it is necessary to acquire 5 tanks of 1.000

liters, allowing to maximize the productive capacity in 8 hours per day of operation, totaling 40 hours per week. The schedule of operations per tank is shown in Figure 3.

	Tank 1	Tank 2	Tank 3	Tank 4	Tank 5
8:00 AM	Mashing		Fermentation		
8:30 AM			Started 9:30 a.m.		
9:00 AM	8:00 - 9:30 a.m.		(day before)	Fermentation	
9:30 AM					
10:00 AM			Distillation		
10:30 AM					Fermentation
11:00 AM		Mashing		Started 12:00 a.m.	
11:30 AM		10:30 - 12:00 a.m.	9:30 - 12:00 a.m.	(day before)	
12:00 PM					
12:30 PM				Distillation	
1:00 PM	Fermentation		Mashing		
1:30 PM				12:00 - 2:30 p.m.	Started 2:30 p.m.
2:00 PM			1:00 - 2:30 p.m.		(day before)
2:30 PM		Fermentation			
3:00 PM					Distillation
3:30 PM			Fermentation		
4:00 PM					
4:30 PM					2:30 - 5:00 p.m.
	Until 9:30 a.m.	Until 12:00 a.m.	Until 2:30 p.m.		
	(next day)	(next day)	(next day)		

Figure 3. Schedule of operations by tank

The estimated initial investment is US$ 172,614.66. In addition, an additional expense of US$ 58,454.00 is planned with marketing and advertising, a highly necessary investment because it is a new product in the Brazilian alcoholic beverages market. Therefore, the total initial investment is US$ 231,068.66.

Weber (2017) achieved a yield in alcoholic fermentation using sweet potato peel cream and cream pulp of 53.88%. As a result, it was decided to adopt a value of 55% for the yield of alcoholic fermentation for the calculation of economic viability. As in Masiero (2012), the yield for recovery of ethanol from distillation was 90%.

The variable costs involved in obtaining ethanol are related to agricultural production and processing of raw materials in the ethanol production unit. In order to estimate the agricultural inputs, the same quantities used by *Usinas Sociais Inteligentes* (USI), which produce sweet potatoes for ethanol production in São Vicente do Sul, RS, were used to estimate the agricultural inputs reported in Junior (2009). Regarding the costs of crop management, the technical coefficients (hour.machine^{-1} and man.day^{-1}) were defined by Masiero (2012) based on literature and interviews with professionals in the area. For the mechanized operations, it was considered the lease of agricultural machinery, a model that is very widespread among rural producers. For manual operations, the use of hired labor was considered in order to reach a larger number of business models.

In addition, an annual cost of maintenance of the production unit was considered. This cost was defined as a percentage of the investment value in equipment and facilities. An increasing percentage was adopted for the 10 years of operation evaluated, starting at 1% in the first year and increasing 1% each year.

For the construction of cash flows and subsequent economic feasibility analysis, the initial investment, the total revenue for the period, the total expenses for the period and the payment of taxes were evaluated. Income tax of 15% and social contribution of 1.08% of the billing was set. Taxes imposed on sales revenue were discounted totalizing 21.65% added to a fixed value tribute of US$ 0.85 per bottle (Maccari, 2013).

Cash flow was determined over a 10-year period, with the construction of the distillery being considered in the year prior to the first. It was considered 8 hours of daily operation, totaling 40 hours per week. It was considered that 100% of the initial investment would be financed and a working capital amount of US$ 46,763.20. The interest rate adopted is 8% per annum with grace period in the first year and payment term of 5 years. Depreciation costs were determined based on the straight-line method, following the Federal Revenue Regulation SRF 162 (Brasil, 1998). The maximum allowed depreciation rates were used: 20% per year for vehicles in general; 10% per year for machinery and equipment; and 4% per year for buildings and constructions.

The resources were quantified by the one-day operation period for the processing of sweet potatoes. For quantification of the resources manpower and electric energy, it was necessary to define the time demanded for each activity.

It was considered that the transportation time of the raw material from the field to the unit would take 10 minutes, suggested by Weschenfelder (2011), and that the amount transported per trip was 2 t. Thus, the time was calculated based on the amount of raw material processed per day. For the reception (unloading, weighing and washing) of the sweet potato, the times reported by Fabricio (2011) were considered. Then, taking the capacity of the conveyor belt, the washer/peeler and the mill of 2 $t.h^{-1}$, it was possible to estimate the daily time demanded by the activity.

In the case of the amylaceous raw materials, there is a need for the hydrolysis, which was performed together with the fermentation. These activities are repeated three times a day, since this is the number of batches prepared to achieve the desired production.

For some activities, labor is not required for the entire duration of the activity. The fermentation takes place during 24 hours, however, it was considered that the employee spends only 1.5 hours per day in analyzes in this activity. At the same time, distillation was described by Weschenfelder (2011) as a step that requires almost continuous monitoring. The same author reported a demand of only 3 hours per day for the operation of the steam generation system. The use of hired labor was considered, requiring 5 employees. The remuneration adopted was the national minimum wage with social charges, 13^{th} salary and paid vacations. The total of this resource was distributed among activities in function of the time demanded to realize them.

In the laboratory-scale process, 0.8 g of yeast was used per 240 g of sweet potato. Therefore, for 3.31 t, 11.03 kg of yeast is used, which, at US$ 18.85 per kilo, totals a daily expenditure of US$ 207.99. For the amount of enzyme, values similar to those recommended by an enzyme manufacturer (GENENCOR) for granular starch hydrolysis were adopted. The ratio used was 1 L of enzyme to 1 t of sweet potato. Thus, for 3.31 t of sweet potato, the consumption of 3.31 L of enzyme Stargen 002, at a price of US$ 9.26 per kilo, totaling US$ 30.67 per day. Furthermore, 0.15 $g.L^{-1}$ potassium metabisulfite solution was added to the broth. At laboratory scale, 20 mL of solution was added to each 240 g of sweet potato. Then, at 3.31 t, 275.83 L of potassium metabisulfite solution 0.15 g.L^{-1} is added, which is equivalent to 41.37 g of potassium metabisulfite. Each pound costs US$ 37.35, thus totaling US$ 1.55 per day. The expenses related to consumption of water, electricity, firewood, grease, oil and diesel were also recorded.

The revenue is the result of the sale of sweet potato distillate. For the calculation of revenue, it was considered that all production was sold.

3. Results and discussion

Based on the process mass balance, reference values for one day of operation are shown in Table 1.

Table 1. Reference values for one day of operation

Reference values for one day of operation	
t sweet potato.day^{-1}	3.31
Ethanol in wine (% v.v^{-1})	4.75
L Distillate.day^{-1}	999.85
L Tchêchu.day^{-1}	1.183.82
m^3 vinasse.day^{-1}	4.00

Therefore, operating in the theoretical maximum productive capacity of 1000 L of distillate per day, we have a daily production of 1,183.82 L of *Tchêchu*. This volume, packed in 750 ml bottles, is equivalent to approximately 1578 bottles of *Tchêchu* daily. Knowing that each bottle costs US$ 0.91, there is a daily expenditure with bottles in the amount of US$ 1,429.73.

The daily costs raised for the processing of sweet potatoes can be seen in Table 2.

Table 2. Daily costs for the processing of sweet potatoes

Resources / Activity	Labor (U$$)	Electric energy (U$$)	Water (U$$)	Enzymes. yeast and antibiotic (U$$)	Firewood (U$$)	Diesel. grease and oil (U$$)	Bottles (U$$)	**TOTAL per activity** (U$$)	**% per activity**
Transport	28.06	-	-	-	-	3.00	-	31.07	0.78
Receiving	101.51	0.51	0.94	-	-	-	-	102.97	2.59
Milling	101.51	0.77	2.76	-	-	0.26	-	105.30	2.65
Mash preparation	371.39	0.46	2.10	240.21	-	-	-	614.16	15.44

Hydrolysis and Fermentation	371.39	7.61	-	-	-	-	-	379.00	9.53
Distillation	618.98	2.52	-	-	-	-	-	621.50	15.62
Steam generation	247.59	1.89	2.85	-	25.72	-	-	278.05	6.99
Cooling	-	0.32	-	-	-	-	-	0.32	0.01
Distillate dilution	123.80	0.17	0.36	-	-	-	-	124.33	3.13
Bottling	123.80	0.13	-	-	-	-	1,429.52	1,553.45	39.05
Lettering	123.80	0.06	-	-	-	-	-	123.86	3.11
Vinasse disposal	41.27	0.63	-	-	-	2.06	-	43.95	1.10
TOTAL per resource	2,253.08	15.08	9.01	240.21	25.72	5.33	1,429.52	**3,977.95**	
% per resource	56.64	0.38	0.23	6.04	0.65	0.13	35.94		

Considering the costs obtained by activity it is realized that the packaging represents almost 40% of the total cost of processing, which is mainly due to the high cost of the bottles for packaging of the final product. The second largest representative of the costs per activity is distillation, with 15.62%. Is also highlighted the preparation of the must, with 15.44% of the costs per activity, in which labor and the use of enzyme, yeast and antibiotic are the biggest cost generators.

Evaluating the expenses by resource, the labor presents the greater percentage of the costs, with 56.64% of the total resources. This result indicates the importance of pursuing an inexpensive but automated drive design to reduce the need for employees to operate the same. Another highlight is for bottled containers, representing 35.94% of the total. This fact indicates the need to search for suppliers with lower prices or to change the type of bottle used by cheaper models.

With the costs of agricultural production and processing raised and the respective daily mass balances, it is possible to calculate the costs in US$.$L^{-1}$ for *Tchêchu* production from sweet potato (Table 3).

Table 3. Cost per liter of *Tchêchu*

	Cost per liter of *Tchêchu*
Agricultural production (US$.$L^{-1}$)	0.05
Processing (US$.$L^{-1}$)	3.36
TOTAL (US$.$L^{-1}$)	3.41

From Table 3, it is estimated that the unit cost for the production of 1 liter of *Tchêchu* is US$ 3.41. Therefore, each bottle (750 mL) has a unit cost of US$ 2.56.

The cost of processing proved to be important because it presented almost total share of the final cost of the sweet potato distillate, with 98.51%, which makes the cost of agricultural production practically insignificant.

Considering the factor of operational idleness, sweet potatoes have an important characteristic, resulting from their long harvesting period: 0% of idleness of the production plant, without the need to use a consortium with other crops.

After calculating all costs, it was possible to estimate the company's cash flow. The entries refer to capital, financing and billing considering the sale of all production of *Tchêchu*. Exits are composed of installments and interest on financing and production and maintenance costs. Depreciation is discounted, but again added to the cash flow value, since it is an expense that does not affect cash. Profit is calculated by the difference between inputs and outputs, and from this, taxes are discounted, resulting in net income. Thus, we calculate the cash flow and accumulated cash flow.

To determine the selling price of the product, values were estimated until the net present value (NPV) was zero, resulting in US$ 4.33 per bottle (750 mL). Therefore, this is the minimum sale price to cover all expenses, that is, so that no loss occurs. Desiring a profit of 80%, there is a unit sale price of *Tchêchu* of US$ 4.60. Thus, even if the seller wants a profit of 100%, the sale price of *Tchêchu* to the final consumer will be US$ 9.21. It is known that the sales price of *Original Hakkon*, sold in a 750 mL bottle, a direct competitor of *Tchêchu*, is US$ 10.52 on the website of *MN Própolis* (2017). Thus, it has been that the price of *Tchêchu* is in accordance with the market price.

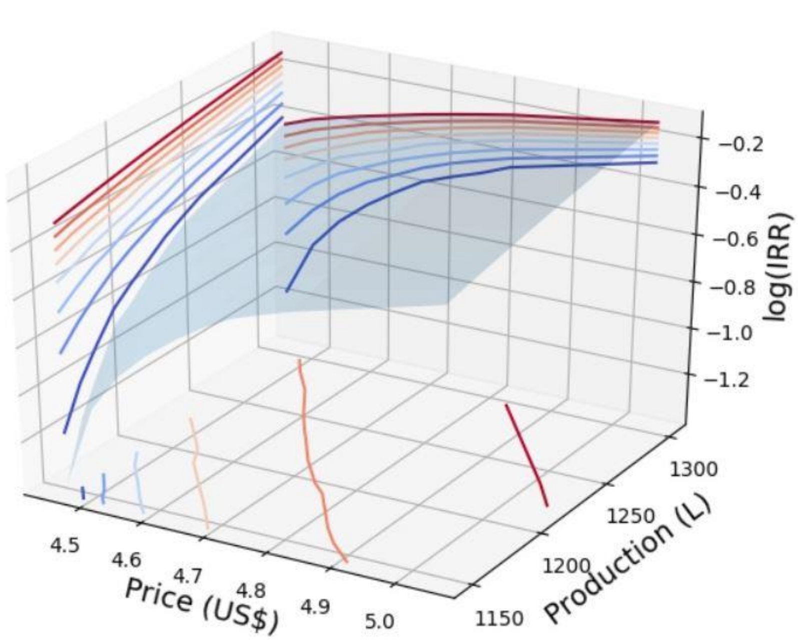

Figure 4. Sensitivity analysis of the IRR in relation to the volume of production and the price of *Tchêchu*

With the unit price of US$ 4.60 per bottle of *Tchêchu* and, considering that all production was sold, there is a sales revenue of US$ 2,398,090.17 per year.

The representative cash flow scheme can be seen in Table 4. Using the SELIC rate (9.25% p.y.) as the MARR rate, it was possible to calculate the NPV, IRR and payback indicators. The NPV calculated was US$ 530,501.42, the IRR was 26%, and the discounted payback was 2.44 years. The NPV was positive and the IRR was higher than the MARR, which shows that the implementation of the distillery to produce *Tchêchu* considering the yield assumed is an economically viable project.

In order to make a sensitivity analysis of the IRR, price and production were varied from 97 to 110%, the log(IRR) was calculated and, using Python software, the graph of Figure 4 was plotted.

Figure 4 shows that the production has less sensitivity if the price is high, presenting a smoother drop, that is, when the product has a lower price, the volume of production has a great impact on the IRR.

Table 4. Cash flow

Financing payment	Maintenance costs	Liquid profit	Cash flow	Cumulative cash flow	Discounted cash flow	Cumulative discounted cash flow
			-US$ 231,068.66	-US$ 231,068.66	-US$ 231,068.66	-US$ 231,068.66
US$ 64,699.23	US$ 2,310.69	US$ 111,298.47	US$ 111,298.47	-US$ 119,770.19	US$ 101,180.43	-US$ 129,888.24
US$ 61,002.13	US$ 4,621.37	US$ 112,161.79	US$ 112,161.79	-US$ 7,608.41	US$ 92,695.69	-US$ 37,192.54
US$ 57,305.03	US$ 6,932.06	US$ 113,025.11	US$ 113,025.11	US$ 105,416.70	US$ 84,917.44	US$ 47,724.89
US$ 53,607.93	US$ 9,242.75	US$ 113,888.42	US$ 113,888.42	US$ 219,305.12	US$ 77,787.33	US$ 125,512.22
US$ 49,910.83	US$ 11,553.43	US$ 114,751.74	US$ 114,751.74	US$ 334,056.87	US$ 71,251.80	US$ 196,764.02
	US$ 13,864.12	US$ 144,392.35	US$ 144,392.35	US$ 478,449.22	US$ 81,505.72	US$ 278,269.74
	US$ 16,174.81	US$ 142,953.49	US$ 142,953.49	US$ 621,402.71	US$ 73,357.74	US$ 351,627.48
	US$ 18,485.49	US$ 141,514.62	US$ 141,514.62	US$ 762,917.33	US$ 66,017.62	US$ 417,645.10
	US$ 20,796.18	US$ 140,075.76	US$ 140,075.76	US$ 902,993.09	US$ 59,405.80	US$ 477,050.90
	US$ 23,106.87	US$ 138,636.90	US$ 138,636.90	US$ 1,041,629.99	US$ 53,450.52	US$ 530,501.42

Year	Investment	Depreciation	Income
0	-US$ 231,068.66		
1		US$ 17,261.47	US$ 2,398,090.17
2		US$ 17,261.47	US$ 2,398,090.17
3		US$ 17,261.47	US$ 2,398,090.17
4		US$ 17,261.47	US$ 2,398,090.17
5		US$ 17,261.47	US$ 2,398,090.17
6		US$ 17,261.47	US$ 2,398,090.17
7		US$ 17,261.47	US$ 2,398,090.17
8		US$ 17,261.47	US$ 2,398,090.17
9		US$ 17,261.47	US$ 2,398,090.17
10		US$ 17,261.47	US$ 2,398,090.17

4. Conclusions

The study of the economic potential of *Tchêchu* confirms that producing and marketing this distillate in Brazil, besides adding value to sweet potatoes, is a great opportunity for the country's alcoholic beverage industries.

Evaluating the daily costs for the processing of sweet potatoes, it is estimated that the packaging represents 39.05% of the total cost per activity, mainly due to the high cost of the bottles; and that labor has the highest percentage of costs per resource (56.64%). The cost of producing a bottle (750 mL) of *Tchêchu* was estimated at US$ 2.56 and the sale price to the final consumer will be US$ 9.21, which is in accordance with the market price.

The economic evaluation carried out resulted in favorable indicators, with positive net present value (US$ 530,501.42), internal rate of return (26% p.y.) higher than the minimum acceptable rate of return (SELIC = 9.25% p.y.) and term for investments to be fully recovered (discounted payback) of 2.44 years. These results show that the implementation of a distillery to produce *Tchêchu* is economically viable.

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