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Acceptability and Commercial Viability of Soursop (Annona muricata L.) Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast

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Abstract

Soursop is a tropical fruit which can be eaten raw when ripe. Soursop thrives well in the Philippines planted in a large scale or as a backyard fruit. Surplus of fruits however may occur when season favours flowering and fruiting of the crop. To minimize wastage of ripe soursop, processing such into vinegar has potential possibilities. Thus, this study was conducted to determine the acceptability and commercial viability of soursop vinegar as influenced by the period of fermentation and varying levels of yeast, laid out in a 4 x 3 factorial experiment in a Completely Randomized Design (CRD) with number of days of soursop fermentation as Factor A and levels of yeast as Factor B. Treatments for Factor A were as follows: A1- 20 days of fermentation, A2- 25 days of fermentation, A3 30 days of fermentation, A4- 35 days of fermentation while B1 - 2.5 mg of yeast, B2- 5mg of yeast, B3- 7.5 mg of yeast as Factor B. Result showed significant differences among all parameters tested. Number of days and levels of yeast of soursop fermented for 30 days with 7.5mg of yeast showed better results than other periods of fermentation. Soursop vinegar fermented for more than 30 days was not preferred by the evaluators. Moreover, interaction effect between the period of fermentation and the amount of yeast showed significant results. Fermentation of soursop with 7.5 mg yeast was the most favoured in all the sensory evaluation.

Keywords: Sensory qualities, acceptability, soursop, yeast, fermentation

1. Introduction

Background of the Study

Vinegar is a multipurpose ingredient that is important in many areas, such as cooking, cleaning, health, and agriculture. It adds brightness and tanginess to food, balances flavor in marinades, sauces, and dressings, and its acidity inhibits the growth of bacteria, making it necessary for pickling and preserving foods.

Vinegar also used to make sauces, condiments, and canned goods. Its many uses make vinegar an indispensable part of daily life, providing eco-friendly, reasonably priced, and efficient solutions for a variety of needs. Its natural qualities also fit in well with sustainable living practices, reducing the needs for a synthetic chemical. Studies indicate that vinegar can lower blood sugar levels after meals and improve insulin sensitivity. (Johnstone et al., 2006).

Vinegar is a sour liquid produced from the fermentation of ethanol (alcohol) by acetic acid bacteria, particularly Acetobacter species. These bacteria break down ethanol to produce acetic acid. Its use dates back thousands of years, both for culinary purposes and for its putative medicinal properties. Generally, vinegar is prepared from any raw materials, from fruits, grains, and wines, depending on the type of vinegar. (Roushdy, & Morsy, 2017)

Vinegar is defined as a liquid product made by fermenting any suitable food first with alcohol and then with acetic acid. It must contain at least 4% acetic acid and may also contain approved preservatives, caramel for coloring, and spices for flavoring. Different fermentation procedures have been developed for the manufacturing of vinegar in Europe and Asia in recent years, and a variety of popular vinegars have been produced (Chen et al., 2013).

The tropical fruit known locally as Guyabano, or soursop, is grown extensively throughout the Philippines, including the Davao Region. A cup of soursop contains 52% of the daily value of vitamin C and 27% of the daily value of dietary fiber. It's also a source of potassium and niacin. Because of its possible health benefits, such as its anti-inflammatory and antibacterial qualities, soursop has been utilized historically. In the Philippines, soursop is still underutilized despite its advantages. To match customer expectations and increase its market presence, the supply chain must improve its quality (Carmen et al., 2020).

Due to its high perishability and susceptibility to damage, soursop fruit is currently produced in various products to extend its shelf life (Quek et al., 2013). The ideal and undesirable pH will affect the generation of vinegar. The pH range in which *S.cerevisiae* can grow is between 4.0 and 5.5 (Narendranath & Power, 2005). In addition, the length of the fermentation process may have an impact on the quality of the vinegar that is produced since the longer the fermentation period, the more ethanol is generated (Dung et al., 2014). Therefore, this study will be conducted to determine the acceptability and commercial viability of soursop vinegar as influenced by the period of fermentation and level of yeast.

Additionally, the research on soursop vinegar conducted in Bagumbayan aims to explore its potential economic, health, and sustainability benefits for local communities. Soursop (*Annona muricata*) is a fruit that grows well in tropical areas like Sultan Kudarat. Utilizing soursop beyond its fresh fruit could open new economic opportunities for farmers and local businesses. Converting soursop into vinegar can create a value-added product, which could help increase the market value of the fruit and diversify its uses. In this regard, it is vital for local economies that rely on agriculture to have new products for local markets or even for export. Vinegar production from the fruit could be made sustainable and lessen the waste of underutilized soursop and other fruits during peak season.

Conceptual Framework of the Study

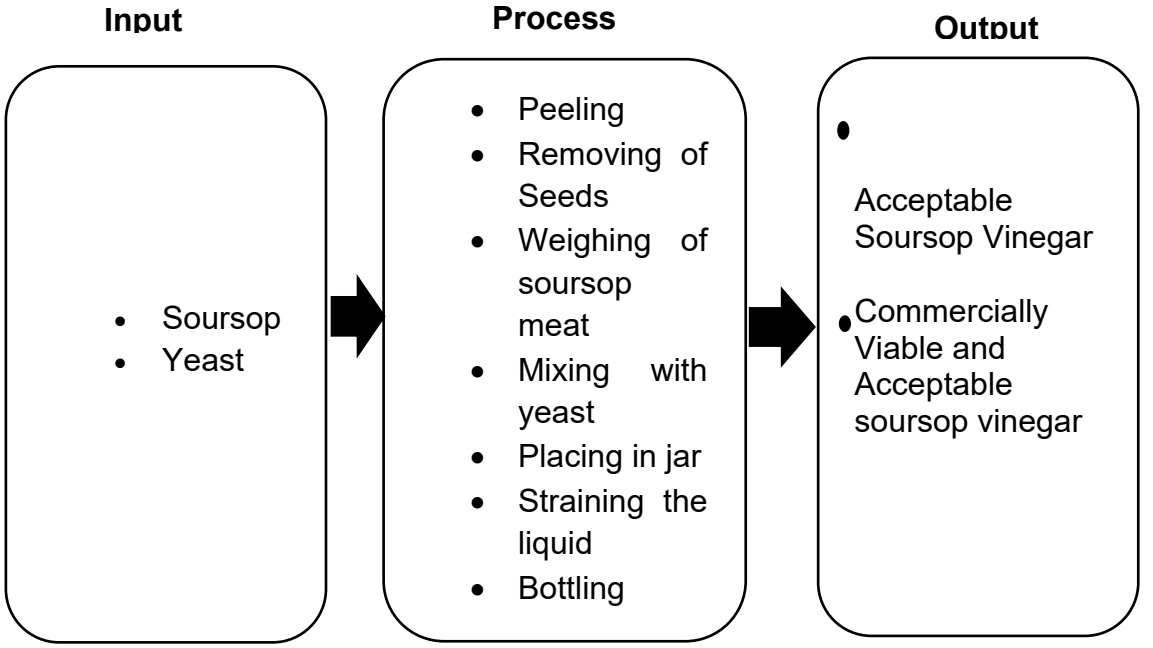


Figure 1: The Conceptual Framework of the Study

The conceptual framework used in this study was the input-process-output model wherein a series of boxes are connected. The first step showed the problems that occurred in the soursop industry in which there was no available soursop vinegar in the market, more underutilized fruits, and high perishability and susceptibility to damage. The second was utilizing soursop fruit into vinegar influenced by periods of fermentation and varying levels of yeast and conducting data gathering. The last was the output, where the acceptable soursop vinegar was the output of the study.

Objectives of the Study

Generally, the study was conducted on the acceptability and commercial viability of soursop vinegar as influenced by the period of fermentation and varying levels of yeast.

Specifically, the study aimed to:

1. Determine the acceptability of soursop into vinegar as influenced by the period of fermentation and levels of yeast in terms of:

    2.1. taste;
    2.2. color;
    2.3. aroma;
    2.4. appearance;
    2.5. texture;
    2.6. consistency; and
    2.7. general acceptability.

2. Determine the interaction effect between the period of fermentation and the level of yeast on the acceptability and commercial viability of soursop vinegar.
3. Determine the cost and return analysis of soursop vinegar as influenced by the period of fermentation with varying levels of yeast.

Scope and Delimitation of the Study

The study was limited only to the acceptability and commercial viability of Soursop Vinegar as influenced by period of fermentation and varying levels of yeast. The soursop used in the study is fully ripe and free from damage pH level of the soursop vinegar was tasted using the pH test strips. Product packaging and Product leveling are not included in the study.

Time and Place of the Study

The study was conducted at Purok Macapagal Poblacion, Bagumbayan, Sultan Kudarat from January 2025 to March 2025 with a duration of 40 days.

Operational Definition of Terms

This are the definition of terms used in the study**.**

Acetic acid	It refers to a color-less, organic raw materials used in the production of vinegar
Acidity	It refers to the level of acid found in fermented vinegar
Acceptability	It refers to the **degree to which something is considered satisfactory**
Aroma	It is typically, pleasant and often associated with food or beverages.
Appearance	It is outward look of the liquid or something object.
Bubbles	Is a small globule that is typically a hollow and light or small body of gas in a liquid.
Consistency	It is the uniformity or thickness of the liquid if holds it or flow. It is the result of light reflecting interacting with object or liquid. It is a natural byproduct of plant fermentation or alcohol.

Color	
Ethanol	
Fermentation	It refers to the process in which yeast acts on sugar and converts it into alcohol and carbon dioxide which prime step for the fermentation of soursop vinegar.
Leveling	Putting the level on the top of the object for identification of the treatment used in the study.
Microorganism	It refers to the microscopic organism present during fermentation
Mixing	Combining of two or more substances.
pH strips	A paper instrument used to measure the acidity level of vinegar.
Refilling	It is the process of transferring liquid in the bottle.
Residue	The fine left after sorting vinegar
Sensory evaluation	It refers to the evaluation of output in terms of taste, texture, aroma, and palatability.
Soursop	It refers to the fruit that will be used for fermentation. Its scientific name of *Annona muricata* with the local name of Guyabano
Straining	It is the process of separating the solid and liquid particles
Texture	It is the physical structure on how you feel or touch
Testing	Is the process of trying good weather in good condition or not
Vinegar	It refers to the product of the study in which the soursop will undergo fermentation
	The process of measuring the exact amount of any substance needed in the

Weighing	experiment.
Yeast	It refers to the single-celled living organism that transforms sugar and starts into rbon dioxide and alcohol through fermentation. This will be used for rmentation.

2. Review Of Literature and Related Studies

This chapter presents the related literature and studies that are significant in this research. These come from readings of the book, journals, published and unpublished theses and dissertations, and articles from internet sources written by both foreign and local authors.

Soursop

Soursop *(Annona muricata L.)* is a tropical fruit known for its distinctive sweet-tart flavor and is native to Central and South America, though it is now widely cultivated in various tropical regions. The fruit is distinguished by its spiny, green exterior and soft, white pulp that contains numerous black seeds. Soursop has been used for centuries in traditional medicine to treat a variety of ailments, including fever, digestive issues, and inflammation (Perkins et al., 2020).

Products of Soursop

Being consumed fresh, soursop is processed into a variety of products such as juices, ice creams, teas, and dietary supplements. The fruit's versatile nature has led to the development of numerous soursop-based products aimed at enhancing health and wellness. These products are increasingly gaining popularity among health-conscious consumers due to the growing interest in natural, plant-based remedies and functional foods (Chakravarty et al., 2021).

The demand for functional foods, including soursop-based products, has been increasing, particularly among consumers seeking natural remedies and healthy alternatives to processed foods (González et al., 2020)

Fermentation

As a metabolic process that regenerates energy, fermentation uses the breakdown products of organic substrates as both a donor and an acceptor of hydrogen. Yeasts, bacteria, or exogenous enzymes start and regulate this methodical process (Ukwo & Ezcama, 2011).

According to Schlegel (2002), the process is known as oxidative fermentation when it occurs in the presence of oxygen. The end products include organic acids like acetate, gluconate, and keto acid, as well as alcohols, and the pH gradually drops. With the intended physiochemical characteristics, a different fermentation model system for making vinegar has been effectively created utilizing yeast and mushrooms, followed by the mother of vinegar and Kombucha inoculation (Isham et al., 2019).

While ethanol is produced from sugar, the amount of sugar decreases with time and is inversely proportional to the amount of ethanol. It was also discovered that acetic acid rose as fermentation time increased. There was no discernible difference in pH between the reduction of sugar and the ethanol production (Ho et al., 2020).

Higher antioxidant activities and more ethanol generation in soursop wine are the results of the

successful optimization of the alternative fermentation method utilizing yeast and mushrooms. In the end, this discovery holds great promise for use in the brewing sector to improve the fermentation process and create a novel niche product, which would cut down on waste by turning the highly perishable fruit into wine with a longer and more stable shelf life (Ho et al, 2019). According to *De Santi et al. (2019),* the process of producing fruit vinegar from different fruits takes about **4 weeks,** where the first two weeks involve alcoholic fermentation and the next two weeks for acetic fermentation. Additionally, research by *Lee et al. (2020)* mentioned that fruit vinegar fermentation time could be as short as **20 days**, depending on the microbial strains and fermentation conditions used.

Yeast

Fruit pulps' potential health benefits can be enhanced by carefully regulated yeast fermentation, creating new fermented functional foods (Martinez-mendoza et al., 2023). In these habitats, yeasts—*Saccharomyces cerevisiae* in particular—usually take center stage. The capacity of these yeasts to quickly convert carbohydrates to ethanol under both anaerobic and aerobic settings is one of their most notable and distinctive characteristics, and it's probably a winning quality (Dashko et al., 2014).

These yeasts are crucial in determining the finished product's sensory quality. The fermentative behavior of certain non-Saccharomyces yeasts is being thoroughly investigated in light of these findings to determine the best strain and the most ideal circumstances for use in the production of fermented beverages (Maicas, 2020).

Compared to fructose, the yeast strain is more attracted to glucose. The uptake of either glucose or fructose was not suppressed by growth on either sugar. According to D'Amore et al. (1989), fructose decreased glucose uptake by 40%, whereas glucose inhibited fructose uptake by 60%.

Yeast is primarily used to convert sugars present in the fruit juice into ethanol (alcohol) and carbon dioxide. This is the first step in vinegar production, where yeast strains like *Saccharomyces cerevisiae* or *Candida* are used to ferment the sugars into alcohol. This is essential for the subsequent acetic acid fermentation by acetic acid bacteria (Zhang et al., 2021).

Días et al. (2016) stated that some traditional vinegar production methods, yeast is used in the first stage to produce alcohol, and during the second stage, a mixed fermentation environment including both yeast and acetic acid bacteria is maintained to help control the rate of ethanol conversion and ensure the proper alcohol content for the acetic acid bacteria to work effectively. This two-stage fermentation process can be critical for the quality and yield of vinegar.

Marchant & de Bruijn (2013) stated that for the Active Dry Yeast the typical dosage is around 1-2 grams of active dry yeast per liter (1000 ml) of fruit juice. For liquid yeast, the recommended amount is generally **5-10 ml per liter** of fruit juice

Vinegar

According to Budak et al. (2014), vinegar is said to have strong antioxidant activity, antibacterial and antidiabetic benefits, and therapeutic qualities that may help consumers maintain a healthier body. Aside from that, vinegar is frequently used as a food dressing to enhance digestive health, increase appetite, lower cholesterol, and control blood pressure (Fushimi et al. 2001; Qui et al. 2010).

Kondo et al. (2009) showed that vinegar consumption could help reduce body weight and improve insulin sensitivity in obese individuals. **Bishop** (2000) found that vinegar can reduce the growth of some pathogens, making it a natural cleaning agent. **Matsushita et al.** (2012) explain the optimal environmental

conditions for both stages of vinegar fermentation, emphasizing the importance of oxygen and temperature for acetic acid bacteria.

Both alcoholic and acetous fermentations are processing that vinegar, a liquid substance, goes through. In alcoholic fermentation, the sugar source was transformed into ethanol, while in acetous fermentation, the ethanol was oxidized to acetic acid (Ho et al, 2021).

According to Roushdy and Morsey (2017).to enable alcoholic fermentation to take place in anaerobic conditions, where table sugars would be converted to ethanol. (Tesfaye et al., 2002), juices are typically infected with Saccharomyces cerevisiae. (Pooja & Soumitra., 2013) The second stage of fermentation, known as acetous fermentation, is the inclusion of Acetobacter species. This process enables ethanol to undergo aerobic oxidation (Pooja & Soumitra., 2013), converting it to acetic acid and vinegar (Tesfaye et al., 2002).

According to Chen et al. (2013), the microbial diversity and its dynamic fluctuations have a major impact on the quality and properties of vinegar.

3. Methodology

This chapter presents the methodology that the researcher was followed to successfully carry out the study. This include the materials was use, methods, layout, data analysis, and procedure of the study.

Materials

The materials were used in the study were the following: ripe soursop, yeast, weighing scale, jar, marker, packing tape, cloth, rubber band, calculator, strainer, plastic bottle.

Methods

Experimental Design and Treatments

The study was laid out in 4 x 3 factorial experiment in a Completely Randomized Design (CRD) with Period of Fermentation of Soursop as Factor A and Levels of Yeast as Factor B

Factors and their treatments were as follows:

Factor A - Period of Fermentation

A_1 - 20 days (Control)

A_2 - 25 days

A_3 - 30 days

A_4 - 35 days

Factor B - Level of Yeast

B_1 - 2.5 mg of yeast

B_2 - 5.0 mg of yeast

B_3 - 7.5 mg of yeast

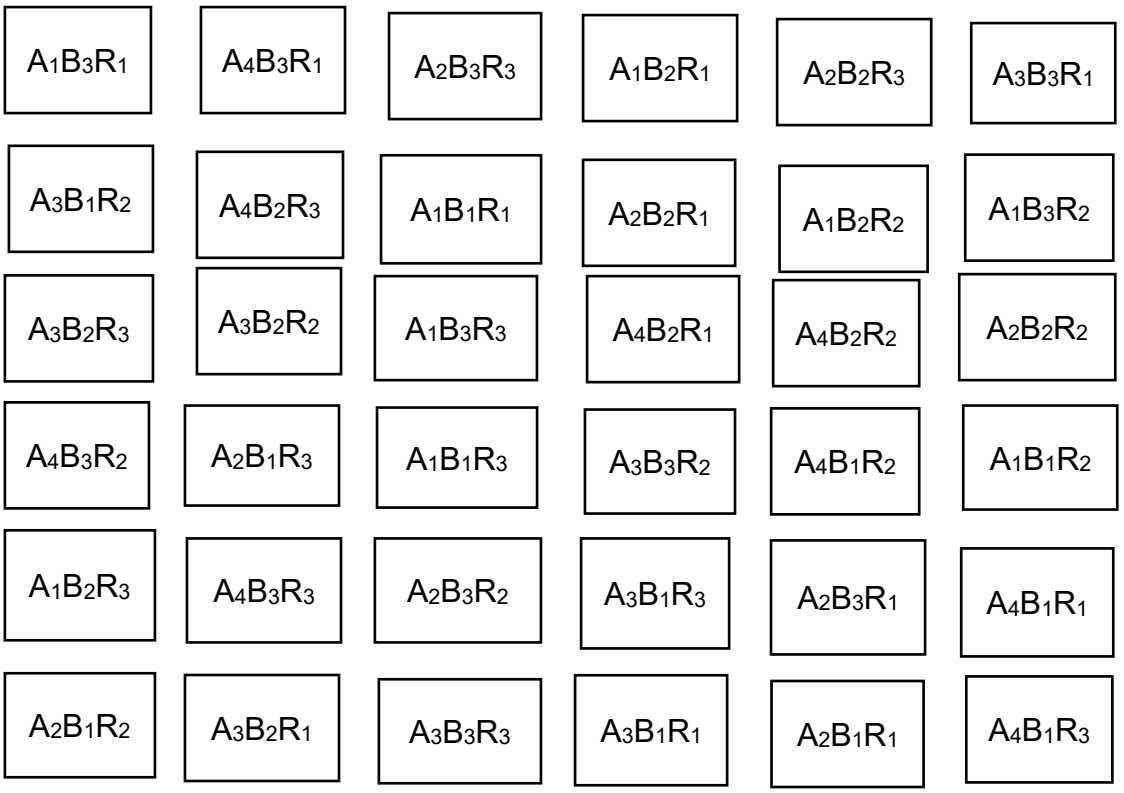


Figure 2: Experimental Layout

Preparation of Materials and Utensils

The materials and utensils used were properly sterilized to prevent contamination. The ripe soursop used in this study were bought from the locality.

Steps in Preparation of Fermented Soursop Vinegar

Preparation of Soursop

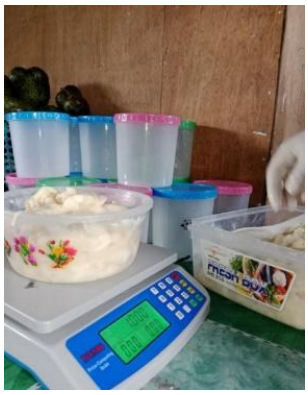
The soursop fruit was peeled the seed were removed and sliced into small pieces or mashed it to release the juice.





Fermentation of Soursop

The sliced soursop meat was placed in jar. Then added 60ml or 1 cup of water, 15ml or sugar and yeast according treatment. The following treatment were applied 2.5 mg,5mg,7.5mg of yeast then stirred to dissolved.





Fermentation Process (Stage 1)

Covered the jar to prevent falling debris and contamination while still allowing the natural yeasts to initiate fermentation. Let the mixture sit at room temperature for 6 days. During this period, the sugars ferment, producing alcohol.



Straining of Liquid

After the initial fermentation, strained the mixture and removed the soursop pulp.



Acetic Fermentation (Stage 2)

After straining, poured the liquid back into the jar and add 7.5 ml or 1 tablespoon vinegar and covered it again. Allowed the liquid to ferment for 24 days. Noticed the development of acidity as the alcohol turns into vinegar through the action of acetic acid bacteria.





Tasting and Storing:

Tasted the vinegar 24 days after fermentation. After it reaches the appropriate acidity, filter to get any leftover solids. Put the vinegar in tightly-fitting lidded bottles or jars and keep it somewhere dark and cool. (Smith, J. A., & Davis, L. R. (2023).



Data Gathered

Sensory Evaluation

The sensory evaluation was performed in Bagumbayan, Sultan Kudarat. Thirty (30) selected respondents were asked to taste soursop vinegar and evaluate the various treatments using the 9-point Hedonic Scale of Measurement. The respondents were ten (10) Food Technologist students and, ten (10) Technology and Livelihood Education teachers and students, ten (10) Home Maker. They evaluated and indicated on a scale the degree of appearance, taste, aroma, texture, consistency and general acceptability. The samples will be decoded "A_1 B_1R_1", "A_1 B_1R_2", "$A_1B_1R_3$", and "$A_1B_1R_4$" The results of this sensory evaluation indicated a need for quality improvement. Every respondent was received small token of Appreciation like chocolates and small amount of cash.

The rating scale was used in the study were as follows: developed by **Peryam, D. R., & Pilgrim, F. J. (1957).**

Rating	Description	Interpretation
9	Like Extremely	Feel a strong, positive satisfaction with the taste.
8	Like Very Much	Strong preference or enjoyment not intense as extremely
7	Like Moderately	Have a moderate level of positive sentiments and for improvement
6	Like Slightly	A mild positive taste, find some enjoyable but are not overall eager.
5	Neither Like nor Dislike	Respondents neither feel positively nor negatively about the taste. This can indicate indifference or a lack of strong feelings.
4	Dislike Slightly	Respondents have a mild negative sentiment towards the taste

3	Dislike Moderately	Respondents are dissatisfied and may have significant concerns or issues with the taste
2	Dislike Very Much	Respondents are strong negative reaction and likely frustrated on the taste
1	Dislike Extremely	The respondents have intense negative feeling and express dissatisfaction on the taste

For the sensory evaluation of the treatments, the score sheets were gathered, recorded, tallied, summarized, and prepared for computation. Mean was used to determine its color, aroma, taste, appearance, and general acceptability. The following scale and description were used in the study:

8.41 – 9.00	Like Extremely
7.16 – 8.40	Like Very Much
6.81 – 7.15	Like Moderately
5.01 – 6.80	Like Slightly
4.21 – 5.00	Neither Like Nor Dislike
3.41 – 4.20	Dislike Slightly
2.16 – 3.40	Dislike Moderately
1.81 – 2.15	Dislike Very Much
1.00 – 1.80	Dislike Extremely

a. **Financial Analysis –** the cross income of soursop vinegar was calculated. The cost of all ingredients was deducted from the income.

Net Profit = Sales – Expenses

$$\text{ROI} = \frac{\text{Net Income}}{\text{Expenses}} \times 100$$

Statistical Analysis

Data gathered was statistically analyzed using the Analysis of Variance (ANOVA) in a Completely Randomize Design (CRD). Test on significant difference per treatment was subjected using the Least Significant Difference (LSD) (Montgomery, 2017)

4. Results and Discussion

This chapter shows the analysis and interpretation of the data gathered from the study. In this chapter, tabular data is presented to show case and high light the incredible information discovered in the research study.

Taste

Table 1 shows the sensory evaluation of soursop (*Annona muricata*) vinegar in terms of taste, as influenced by the period of fermentation and varying levels of yeast.

A significant difference was observed on the number of fermentation durations, indicating that fermentation durations considerably influence the acceptability of soursop vinegar. This is consistent with the study of Bautista et al. (2020), who observed that prolonged fermentation affects the production of organic acid, affecting the overall taste reference of fruit-based vinegar. In contrast, the 35-day fermentation (4.91) and the 20-day fermentation (4.5) were both rated as "neither like nor dislike". It indicates a decline in taste choice over prolonged fermentation. The soursop vinegar fermented for 30 -days shows the highest sensory rating of 7.03 like moderately, followed by the 25-day fermentation (5.88,"like slightly"). As seen in some research on fruit vinegars, this relates to excessive acid production, which result in increased sourness and decreased palatability (Kim et al., 2016).

The level of yeast used to ferment soursop vinegar also showed a significant difference. The highest rating of 6.37 interpreted as "like moderately" was observed with 7.5mg of yeast. It was followed by 2.5 mg (5.32) and 5.05 mg (5.05), both of which were rated as "neither like nor dislike." Yeast has a critical role in vinegar fermentation due to directly influence on production of alcohol, which eventually turns into acetic acid (Medina et al., 2021). While decreasing yeast concentrations might have produced less ethanol and less acidity, more yeast might have increased alcohol synthesis and produced a more balanced taste quality.

Additionally, the interaction effect between yeast level and fermentation period was observed. Fermented soursop vinegar for 30 days with 7.5 mg yeast got the highest sensory rating of 8.16 ("like extremely"), soursop vinegar fermented for 25 days with 7.5 mg of yeast and 30 days with 2.5 mg of yeast got the comparable result with 7.69-8.08 respectively. soursop vinegar fermented with 5mg ,2.5 mg and 7.5 mg of yeast with same superscript are comparable to each other ranging from 4.52 - 5.29 interpreted like slightly and neither like nor dislike, whereas vinegar fermented for 20 days with 2.5 mg of yeast and vinegar fermented for 35 days with 7.5mg of yeast got the lowest rating of 3.80 -4.34 interpreted "dislike slightly". This finding implies that extended fermentation resulted in a decline in flavor, the right amount of yeast might mitigate the effect and improve flavor. In line with the result of Xu et al. (2019), that the sensory qualities of vinegar made from fruit are increase when yeast level is improved during fermentation procedures.

Table 1: Taste of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Factor A	Factor B			
	Levels of Yeast			
Number of days Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean**[2/]
A_1 **(20days)** [3/]	3.80^{d}	4.80^{c}	4.70^{c}	4.50^{c}
A_2 **(25 days)**	4.52^{c}	5.06^{c}	8.08^{b}	5.88^{b}
A_3 **(30 days)**	7.69^{b}	5.23^{c}	8.16^{a}	7.03^{a}
A_4 **(35 days)**	5.29^{c}	5.10^{c}	4.34^{d}	4.91^{c}
Mean [1/]	**5.32^{b}**	**5.05^{b}**	**6.37^{a}**	**5.58**

[1/] Means of period of fermentation in a column having common superscript are not significant
[2/] Means of varying levels of yeast in a column having common superscript are not significant
[3/] Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Aroma

Table 2 presents the aroma of soursop (*Annona muricata*) vinegar as influenced by the fermentation period and varying yeast levels.

The aroma of soursop vinegar differed significantly related to the fermenting duration. Thirty-day vinegar fermentation got the highest sensory rating of 7.12 like moderately, followed by 25-day fermentation (6.23), while 20-day (5.49) and 35-day (5.48) fermentation got the same interpretation of "like slightly." It shows that there is an ideal fermentation period where aroma compounds increase before deterioration takes place. The results are in line with the research of Kim et al. (2016), who observed that the growth of volatile chemicals, which aid in the synthesis of scent in fruit-based vinegar, is greatly affects by fermentation time. The sensory evaluation of vinegar may be adversely affected by prolonged fermentation, which can increase acetic acid and other volatile chemicals.

A significant difference was also found in yeast level influenced by the aroma of soursop vinegar. The soursop vinegar with 7.5 mg of yeast had the highest aroma rating of 6.60 like moderately. It was followed by 2.5 mg (5.98, "like slightly") and 5.0 mg (5.66, like slightly). The formation of aroma molecules, particularly esters and higher alcohols, that give vinegar its distinctively fruity and pleasant aroma, is more dependent on yeast (Medina et al., 2021). A desired aroma resulted from the enhancement of these chemicals due to an increased amount of yeast.

There was a significant interaction effect between the fermentation period and yeast level. The vinegar for 30 days of fermentation with 7.5mg of yeast had the highest aroma rating of 8.15 like extremely, followed by soursop vinegar fermented for 20 days with 7.5mg of yeast got the aroma rating of 7.62 interpreted like very much indicating that this combination developed the most aroma, vinegar fermented with 5mg of yeast in all number of days fermentation are comparable to 35 days fermentation with 2.5mg of

yeast and soursop vinegar fermented for 20 days with 7.5mg of yeast raging from 5.47- 5.82 interpreted like slightly, soursop fermented 35 days with 7.5 mg of yeast and soursop vinegar fermented for 20 days with 2.5 mg of yeast got the lowest rating raging with 5.14-5.19 was rated as "neither like nor dislike" This implies that yeast contribute an important role in enhancing of aromas, over fermentation results in an imbalance of volatile chemicals and produce unwanted odors. The prolonging fermentation results in an accumulation of acetic acid and aldehydes decreasing the vinegar's overall sensory quality (Xu et al., 2019).

Table 2: Aroma of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Factor A **Number of days Fermentation**	**Factor B** **Levels of Yeast**			
	B_1 (2.5mg)	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean** 2/
A_1 **(20days)** 3/	5.19^{e}	5.82^{d}	5.47^{d}	5.49^{c}
A_2 **(25 days)**	5.42^{de}	5.65^{d}	7.62^{b}	6.23^{b}
A_3 **(30 days)**	7.57^{c}	5.63^{d}	8.15^{a}	7.12^{a}
A_4 **(35 days)**	5.74^{d}	5.55^{d}	5.14^{e}	5.48^{c}
Mean 1/	**5.98^{b}**	**5.66^{b}**	**6.60^{a}**	**6.08**

1/ Means of period of fermentation in a column having common superscript are not significant
2/ Means of varying levels of yeast in a column having common superscript are not significant
3/ Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Color

Table 3 shows the color of soursop vinegar as influenced by the period of fermentation and varying levels of yeast.

The color of soursop vinegar was significantly affected by the period of fermentation. Among the different fermentation periods, the 30-day fermentation was rated the highest at 7.09 like moderately followed by 25-day fermentation was rated at 6.39 like moderately. The 35-day fermentation period was rated 5.74, interpreted “like slightly,” comparable to the 20-day fermentation period, which was rated 5.69, interpreted “like slightly.” The soursop vinegar that was fermented for 35 days is lighter in color. This implies that longer fermentation affects color changes as a result of altered microbial activity and pigment degradation (Mokhtar et al., 2020).

There was a significant difference was observed in the level of yeast in soursop vinegar. The soursop vinegar added with 2.5mg yeast was rated 6.22 like slightly which is comparable to 5.0mg yeast rated 5.70 like slightly. The vinegar with 7.5mg yeast was rated 6.76, or “like moderately” shows the highest rating in the range of the yeast levels. It implies that increasing the amount of yeast during the fermentation of vinegar

influences the color and sensory appearance of vinegar (Ghosh et al., 2019).

There was a significant difference in the color of soursop vinegar in the interaction effect of the fermentation period and yeast level. The soursop vinegar fermented in about 30 days of fermentation added with 7.5mg yeast got the highest rating of 8.0 interpreted as "like very much". Followed by soursop fermented 30days with 2.5mg of yeast and soursop fermented for 25 days with 7.5mg of yeast got the rating ranging from 7.50-7.63 interpreted also like very much. Soursop fermented with 5mg and 2.5 mg of yeast got the comparable result in all number of days of fermentation ranging from 5.52-5.92 respectively. On the other hand, soursop vinegar fermented for about 20 days with 2.5mg yeast added had the lowest rating of 5.52 rated "neither like nor dislike." These findings were supported by the study of Yuan et al. (2021) that sensory qualities are greatly affect and influenced by the interaction between microbial activity and the period of fermentation of vinegar.

Table 3: Color of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Factor A	Factor B: Levels of Yeast			
Number of Days Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean** [2/]
A_1 **(20days)** [3/]	5.52^{d}	5.84^{d}	5.71^{c}	5.69^{c}
A_2 **(25 days)**	5.78^{d}	5.88^{d}	7.50^{b}	6.39^{b}
A_3 **(30 days)**	7.63^{b}	5.63^{d}	8.00^{a}	7.09^{a}
A_4 **(35 days)**	5.92d	5.46^{e}	5.83^{d}	5.74^{c}
Mean [1/]	**6.22^{b}**	**5.70^{b}**	**6.76^{a}**	**6.08**

[1/] Means of period of fermentation in a column having common superscript are not significant
[2/] Means of varying levels of yeast in a column having common superscript are not significant
[3/] Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Appearance

Table 4 shows the appearance of soursop vinegar as influenced by the period of fermentation and levels of yeast.

A significant difference was observed in the appearance of soursop vinegar based on the fermentation period. The 30 days of fermentation of soursop vinegar shows the highest rating of 7.16 rated as "like moderately". It was followed by the 25 days fermentation period with a rating of 6.47, interpreted as "like moderately." The 35 days fermentation period was rated as "like slightly" with a rating of 5.94 which is comparable to the 20 days fermentation duration with a rating of 5.93. These findings imply the fermentation duration enhances the appearance of the soursop vinegar. Furthermore, it prolonged fermentation that results in color and translucent changes that influence consumer preference and likeness. However, according to

Mokhtar et al. (2020), the purity and stability of vinegar are extremely affected by the fermentation duration.

There was a significant difference in the appearance of soursop vinegar. The vinegar produced with 7.5mg of yeast shows the highest rating of 6.78, like moderately. In comparison, the 2.5 mg yeast got a rating of 6.26, and the 5.0mg yeast got a rating of 6.09, both interpreted as "like slightly." These findings show that a higher amount of yeast contributes to the improved of visual appearance, most likely due to increasing microbial activity, which facilitates uniform fermentation.

In terms of the appearance of soursop vinegar, there was a significant difference in the interaction between the period of fermentation and yeast level. The soursop vinegar fermented for about 30 days added with 7.5 mg of yeast got the highest rating of 7.82 interpreted like very much, comparable to 25 days fermentation with 7.5mg of yeast with a rating of 7.57 respectively. While the soursop vinegar fermented for 20, 25 ,30 days with 2.5mg of yeast and all number of days fermentation added with 5mg of yeast having same superscript got the rating raging from 5.77- 6.15 interpreted like slightly, which implies that this interaction produces more appealing than other vinegar, suggesting that shorter fermentation with a lower amount of yeast could produce less appealing visual traits. It implies that these results are compatible with previous studies showing that the duration of fermentation and the amount of yeast are important factors in identifying the quality of fermented products, color intensity, and general visual acceptability (Yuan et al., 2021).

Table 4: Appearance of Soursop Vinegar as Influenced by Period of Fermentation and Varying levels of Yeast.

	Factor B			
Factor A	**Levels of Yeast**			
Number of Days Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean**[2/]
A_1 **(20days)** [3/]	5.77^{b}	6.12^{b}	5.91^{d}	5.93^{c}
A_2 **(25 days)**	5.81^{b}	6.02^{b}	7.57^{a}	6.47^{b}
A_3 **(30 days)**	7.51^{a}	6.15^{b}	7.82^{a}	7.16^{a}
A_4 **(35 days)**	5.97^{b}	6.05^{b}	5.81^{b}	5.94^{c}
Mean [1/]	**6.26^{b}**	**6.09^{b}**	**6.78^{a}**	**6.38**

[1/] Means of period of fermentation in a column having common superscript are not significant

[2/] Means of varying levels of yeast in a column having common superscript are not significant

[3/] Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Texture

The texture of soursop vinegar as influenced by the fermentation period and levels of yeast is presented in Table 5.

There was a significant difference was observed in the texture of soursop vinegar during the fermentation period. The highest rating was observed in the 30-day fermentation period with a rating of 7.14, which is interpreted as "like moderately". However, it was followed by the fermentation of about 25 days

which rated 6.30, which is also interpreted as "like moderately." On the other hand, soursop vinegar fermented in 35 days and 20 days fermentation period got the lowest ratings of 5.52 and 5.57, respectively which interpreted "like slightly". The result was supported by previous studies that prolonging fermentation can cause biochemical reactions and microbial activity that change the consistency of vinegar and affect the quality of the vinegar (Mokhtar et al., 2020).

A significant difference was observed in the texture of soursop vinegar influenced with the levels of yeast. The highest rating was observed in the soursop vinegar with 7.5mg of yeast rated 6.71 interpreted as "like moderately". On the other hand, the vinegar added with 2.5mg of yeast got a rating of 5.94 interpreted as "like slightly" comparable to 5.0mg yeast rated with 5.76 like slightly. However, the small amount of yeast is not suitable for microbial activities to enhance the texture and quality of vinegar. These results show that more yeast promotes ideal fermentation and enhanced vinegar quality and consistency according to Ghosh et al. (2019).

In terms of the interaction effect between the period of fermentation and the levels of yeast in terms of the texture of soursop vinegar, shows a significant difference among treatments tested. The vinegar fermented for 30 days with the amount of yeast of 7.5mg got the highest rating of 7.92 "like very much". Followed by 2.5 mg of yeast comparable to 7.5 mg of yeast with 25 days of fermentation with the rating of 7.44 and 7.49 respectively. Vinegar fermented with 5mg of yeast with same superscript are comparable to 2.5mg of yeast and 7.5 mg with 20 days of fermentation with the rating ranging from 5.17-6.06 interpreted like slightly. Suggesting that a shorter fermentation period combined with insufficient yeast may result in a negative quality. However, these findings are in line with some research that indicates the sensory qualities of fermented products, particularly the texture are greatly influenced by the period of fermentation and concentration of yeast (Yuan et al., 2021).

Table 5: Texture of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Factor A	**Factor B** Levels of Yeast			
Number of Days of Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean**[2/]
A_1 **(20days)** [3/]	5.17^{c}	5.62^{d}	5.93^{c}	5.57^{c}
A_2 **(25 days)**	5.67^{d}	5.74^{c}	7.49^{b}	6.30^{b}
A_3 **(30 days)**	7.44^{b}	6.06^{c}	7.92^{a}	7.22^{a}
A_4 **(35 days)**	5.47^{d}	5.60^{d}	5.49^{d}	5.52^{c}
Mean [1/]	**5.94^{b}**	**5.76^{b}**	**6.71^{a}**	**6.13**

[1/] Means of period of fermentation in a column having common superscript are not significant
[2/] Means of varying levels of yeast in a column having common superscript are not significant
[3/] Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Consistency

The consistency of soursop vinegar influenced by the period of fermentation and varying levels of yeast is shown in Table 6.

A significant difference was observed in the consistency of soursop vinegar during the period of fermentation. The highest rating of 7.14 like moderately was observed after 30 days of fermentation. It was followed with a rating of 6.06 like slightly and was observed for 25 days of fermentation, while the lowest rating in consistency was observed in 20 days of fermentation with a rating 5.17 comparable to 35 days of fermentation with the rating of 5.60 interpreted like slightly, indicating that a longer fermentation beyond 30 days may not affect the consistency of vinegar. However, it may have a negative result on overall acceptability. This result is dissimilarity to the study of Gao et al. (2019), who found that longer fermentation can affect viscosity and consistency through microbial activity and enzymatic degradation.

The different yeast levels significantly affected the consistency of soursop vinegar. The soursop vinegar with 7.5mg of yeast shows the highest rating of 6.66 interpreted as "moderately". This suggests that this amount had a favorable effect on the texture of the soursop vinegar. A rating of 5.74 like slightly was obtained for vinegar containing 2.5mg of yeast, while the lowest rating was observed in 5.0mg yeast with a rate 5.57 like slightly. These findings imply that the ideal yeast amount is necessary, meanwhile, maximum and minimum yeast levels could degrade the texture according to Smith et al. (2021).

The soursop vinegar consistency was significantly affected by the interaction between the period of fermentation and the amount of yeast. The soursop vinegar fermented for 30 days with 7.5mg of yeast got a rating of 8.03 "like very much". Soursop fermented for 25 days and 30 days with 2.5 mg of yeast had interaction effect and comparable to each other with the rating of 7.39 and 7.61 interpreted like moderately. On the other hand, vinegar fermented with 5mg of yeast got a comparable result to the other treatment with same superscript with a rating raging from 5.33-5.57 respectively. In contrast, vinegar fermented for about 20 days and added with 2.5mg of yeast got the lowest rating of 4.63 interpreted as “dislike slightly”. It is important to enhance both the period of fermentation and the amount of yeast during fermentation in order to produce vinegar with exceptional consistency and customer acceptance according to Zhao et al. (2020).

Table 6: Consistency of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Factor A	**Factor B**			
	Levels of Yeast			
Number of Days Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean** 2/
A_1 **(20days)** 3/	4.63^{e}	5.33^{d}	5.54^{d}	5.17^{c}
A_2 **(25 days)**	5.18^{de}	5.38^{d}	7.61^{b}	6.06^{b}
A_3 **(30 days)**	7.39^{b}	6.00^{c}	8.03^{a}	7.14^{a}
A_4 **(35 days)**	5.76^{cd}	5.57^{d}	5.47^{d}	5.60^{c}
Mean 1/	**5.74^{b}**	**5.57^{b}**	**6.66^{a}**	**5.99**

1/ Means of period of fermentation in a column having common superscript are not significant
2/ Means of varying levels of yeast in a column having common superscript are not significant
3/ Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

General Acceptability

The general acceptability of soursop vinegar as influenced by the period of fermentation and varying levels of yeast is presented in Table 7.

The general acceptability of soursop vinegar was significantly difference in the period of fermentation. The soursop vinegar fermented for about 30 days got the highest rating of 7.27 like moderately followed by the 25-day, rate of 6.12 like slightly. On the other hand, the soursop vinegar fermented for about 35 days got a lower acceptability rating of 5.57, which was comparable to the 20-day fermentation (5.39), both of which were interpreted as like slightly. According to Zhao et al., (2020) fermentation duration is important for improving the sensory qualities. In addition, longer fermentation may cause an extremely acidic taste that reduces customer preference.

On the other hand, there was a significant difference in the overall acceptability of soursop vinegar in terms of the amount of yeast. The highest rating was observed in vinegar containing 7.5mg of yeast with a rating of 6.64 like moderately, while the lowest rating was observed in vinegar with 2.5mg yeast and rated 5.98 like slightly comparable to the vinegar with 5.0mg yeast rated 5.98 which interpreted neutral neither like nor dislike. Lopez and Perez (2018) stated that the taste and aroma depends on the level of yeast. Increasing the amount of yeast resulted to increase the ethanol conversion, better sensory qualities and a balanced acidity (Gómez et al., 2019).

In terms of general acceptability, there was a significant difference on the interaction effect on the period of fermentation and level of yeast. The soursop vinegar fermented for 30 days with 7.5 mg of yeast got the highest rating of 8.05 like very much. Followed by soursop fermented for 25 days with 7.5mg of yeast got the rating of 7.52 interpreted like very much. Soursop fermented with 5mg of yeast and 2mg of yeast in 35 days of fermentation showed a comparable interaction effect with a rating of 5.58-5.71 interpreted like slightly. On the other hand, vinegar fermented for 20 days with 2.5mg of yeast got the lowest rating of 5.01 neither like nor dislike. It implies that both shorter fermentation and a lower amount of yeast harm the development of vinegar. Wang et al. (2021) stated that the organic acids and volatile compounds enhance flavor. However, suboptimal conditions in making vinegar may result in an unbalanced taste.

Table 7: General Acceptability of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

	Factor B			
Factor A	**Levels of Yeast**			
Number of Days Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean**2/
A_1 **(20days)** 3/	5.01^{e}	5.59^{cd}	5.58^{cd}	5.39^{c}
A_2 **(25 days)**	5.40^{de}	5.46^{d}	7.52^{b}	6.13^{b}
A_3 **(30 days)**	7.78^{ab}	5.98^{c}	8.05^{a}	7.24^{a}

A_4 **(35 days)**	5.71^{c}	5.59^{c}	5.40^{de}	5.57^{c}
Mean 1/	**5.98^{b}**	**5.66^{b}**	**6.64^{a}**	**6.09**

1/ Means of period of fermentation in a column having common superscript are not significant
2/ Means of varying levels of yeast in a column having common superscript are not significant
3/ Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Acidity

The acidity of soursop vinegar as influenced by the fermentation period and varying yeast levels is presented in Table 8.

There was a significant difference was observed in the acidity levels in terms of fermentation period. The soursop vinegar fermented about 25 and 30 days got an acidity rate of 3.67. On the other hand, the vinegar fermented in 20 and 35 days shows slightly higher acidity of the level of 4.0.

In addition, the amount of yeast also significantly influenced the acidity. The 7.5mg yeast level got 3.5 in acidity. However, 2.5mg and 5.0mg levels of yeast got an acidity of 4.0. Johnston and Gaas (2006) stated that yeast concentration can affect the acetic acid production during the fermentation of vinegar.

Furthermore, the interaction between the fermentation period and yeast levels showed significant differences. However, the result of acidity was ranged from 3.0 to 4.0. This finding indicates that the period of acidity and the amount of yeast is important for making soursop vinegar. The different mixtures may contribute to various microbial activity will affect the conversion of ethanol to acetic acid according to Bevilacqua et al. (2019).

Table 8: Acidity of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Factor A	**Factor B**			
	Levels of Yeast			
Number of Days Fermentation	**B_1 (2.5mg)**	**B_2 (5.0mg)**	**B_3 (7.5mg)**	**Mean**2/
A_1 **(20days)** 3/	4	4	4	4.00
A_2 **(25 days)**	4	4	3	3.67
A_3 **(30 days)**	4	4	3	3.67
A_4 **(35 days)**	4	4	4	4.00
Mean 1/	**4^{a}**	**4^{a}**	**3.5^{b}**	**3.78**

1/ Means of period of fermentation in a column having common superscript are not significant
2/ Means of varying levels of yeast in a column having common superscript are not significant

3/ Interaction effect of period of fermentation and varying levels of yeast in a column having common superscript are not significant

Financial Analysis

Table 9: Financial Analysis of Soursop Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast.

Treatment	Soursop Vinegar produced 250ml	Price/Bottle (Php)	Sales (Php)	Total Expenses (Php)	Net Income (Php)	ROI %
B_1 (2.5mg)	12 bottles	55	660.00	639.66	20.34	3.18
B_2 (5.0mg)	12 bottles	55	660.00	647.66	12.34	1.90
B_3 (7.5mg)	12 bottles	55	660.00	654.66	5.34	0.81

Table 9 presents the financial analysis of soursop vinegar production as influenced by the fermentation period and varying yeast levels.

The results indicate that the soursop vinegar with 2.5mg of yeast got the highest return on investment (ROI) at 3.18%, followed by the 5.0mg yeast level, which yielded an ROI of 1.90%. The lowest ROI was observed at the 7.0mg yeast level, with a return of 0.81%.

These findings suggest that the optimal yeast level for maximizing profitability in soursop vinegar production is 2.5mg. This implies that for every peso invested in soursop vinegar production at this yeast level, a return of 3.18 cents is obtained. The decline in ROI at higher yeast concentrations could be attributed to increased production costs without a proportional increase in product yield or quality (Gómez-López, 2018). Studies have shown that excessive yeast levels can lead to inefficient fermentation processes, potentially resulting in product inconsistencies and increased operational expenses (Nanda et al., 2020).

Moreover, financial viability in vinegar production is influenced not only by fermentation efficiency but also by consumer acceptability, product stability, and market demand (Bevilacqua et al., 2019). Optimizing the balance between fermentation conditions and cost-effective production strategies is crucial for improving profitability and ensuring the commercial success of soursop vinegar.

5. Summary, Conclusion, and Recommendations

This chapter deals with the summary, conclusion, and recommendations of the study on the Acceptability and commercial Viability of (*Annona muricata L.*) Vinegar as influence by Period of Fermentation and Varying Levels of Yeast using the statistical data based on the result and finding of the study.

Summary

The research study entitled "Acceptability and Viability of Soursop (*Annona muricata*) Vinegar as Influenced by Period of Fermentation and Varying Levels of Yeast" was conducted to determine the acceptability and commercial viability of soursop vinegar as influenced by period of fermentation and varying levels of yeast. It was conducted at Purok Macapagal Poblacion, Bagumbayan, Sultan Kudarat, from February to March 2025, with a duration of 40 days. The study was laid out in a 4 x 3 factorial experiment in a Completely Randomized Design (CRD). A period of fermentation of soursop was considered as Factor A, and levels of Yeast are considered as Factor B. The period of fermentation was 20 days (A_1), 25 days (A_2), 30 days (A_3), and 35 days (A_4), while the level of yeast is 10mg (B_1), 15mg (B_2) and 20mg (B_3).

The results of the study were summarized as follows:

1. A significant difference was observed in all parameters tested.
2. Soursop vinegar fermented for 30 days shows better results than other periods of fermentation. However, the results after 35 days show negative results that affect the judging evaluation.
3. The amount of 7.5mg yeast added to the soursop vinegar got the highest rating in all the sensory qualities.
4. Soursop fermented for 30 days with 7.5mg yeast showed the treatment in all sensory qualities.
5. Return on investment ranged from 0.81-3.18%. However, the highest ROI was obtained from soursop fermented for 20 days with 7.5mg of yeast.

Conclusion

In conclusion, soursop fermented for 30 days was preferred by the judges, longer that was not preferred. Regarding the amount of yeast, 7.5mg was the most favored. Additionally, there was a significant interaction effect between the period of fermentation and the amount of yeast.

Recommendations

Based on the findings of the study the following recommendations are highly suggested:

1. Amount of 7.5 mg of Yeast was recommended in fermentation of Soursop vinegar due to its excellent taste, aroma, color, appearance, consistency, and general acceptability.
2. In terms of financial analysis, it is recommended that 2.5mg of yeast shall be used due to its high return. However, the manufacturer shall have the option to use 2.5mg of yeast or 7.5mg depending on the customer's preferences in terms of taste aroma, color, appearance, consistency, and general acceptability.
3. Similar Study shall be conducted to verify the result with emphasis on the manipulating yeast and sugar as additional or any manipulation which stabilized acidity and aroma of the product.

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