Utilization of Fruit Waste (Pineapple Peel) for Vinegar Production

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Abstract

Pineapple peel which is usually discarded during the processing or consumption of the fruit was used as a starting material to produce vinegar by two successive fermentations: alcoholic and acetic acid fermentations. In alcoholic fermentation, pineapple peel was allowed to ferment for conversion of sugar to ethanol by using baker yeast (*Saccharomyces cerevisae*). In acetic acid fermentation, the conversion of ethanol to vinegar was carried out by acetic acid bacteria (*Acetobacteraceti*) with continuous aeration. The vinegar was prepared by varying the amount of yeast, amount of sugar, amount of yeast nutrient (ammonium phosphate) and time of fermentation. Characteristics of prepared vinegar such as total solid content, alcohol content, pH and acidity were determined in this work. The conversion of pineapple peels (food waste) to vinegar (useful product) will minimize environmental pollution while producing value added product, preserving vital nutrients of our foods and bringing down the cost of production of processed foods.

Keywords: Pineapple Peel, Vinegar, Fermentation.

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1. INTRODUCTION

Vinegar may be defined as a condiment made from various sugary and starchy materials by alcoholic and subsequent acetic acid fermentation. Vinegar can be produced by different methods and from various raw materials. Wine (white, red, and sherry wine), cider, fruit musts, malted barley, or pure alcohol are used as substrates. Vinegar production ranges from traditional methods employing wood casks and surface culture to submerged fermentation in acetators. Vinegar traditionally has been used as a food preservative. Whether naturally produced during fermentation or intentionally added, vinegar retards microbial growth and contributes sensory properties to a number of foods (Tan, 2005).

Vinegar plays an important role in salad dressings, ketchup, hot sauce and other sauces. This needs industrial fermentation systems capable of producing a large amount of vinegar. Many techniques have been developed to improve industrial production of vinegar. Today, the most common technology for the vinegar industry is based on the submerged culture with diverse technical modifications which try to improve the general fermentation conditions (aeration, stirring, heating, etc.,) (Tan, 2005).

Vinegar making depends on two fermentation processes. The first is transformation of sugar into alcohol and carbonic acid gas by yeast. The second is the conversion of the alcohol into acetic acid (vinegar). Any substance containing 10% or more sugar, or a substance easily change to sugar, or any fermented liquid containing 4% or more alcohol can be made into vinegar. Waste fruit, inferior honey and other sugar containing materials not suitable for sale or use, can often be made into satisfactory vinegar. The waste cores and peels from canneries, and fruit driers can be turned to profit, in this way (Sandar Aye, 2014).

Pineapple peels as agricultural wastes represent around 35% of the whole fruit mass. If these wastes are discharged to the environment untreated, they could cause a serious problem. So, it is necessary to have recycled waste raw material into useful

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product of higher value added products or even as a raw material for other industries or for use as food or feed after biological treatment (SweSwe Aung, 2013).

This research is aimed to produce low cost vinegar (useful product) from pineapple peels (waste) which is usually discarded during the processing of fruit. The conversion of fruit wastes into vinegar will help to enhance food security as well as to reduce environmental pollution.

2. MATERIALS AND METHODS

2.1 Raw Materials

For the preparation of vinegar, pineapple peels were collected from pineapple vendors. The yeast, *Saccharomyces cerevisiae*and ammonium phosphate were purchased from Kemiko Chemical Sale Centre, Yangon. The sugar used for this research work was purchased from local market.

2.2 Preparation of Pineapple Peel Vinegar

Pineapple peels were thoroughly washed with water to remove impurities, and cut into thin strips. Prepared pineapple peels (180 g), sugar (20 g) and distilled water (800 ml) were put into the sterilized bottle. This is then followed by the addition of yeast (2.5 g) and yeast nutrient (ammonium phosphate) (4g). The fermenter was then corked and sealed with adhesive tape. The fermentation was allowed to take place at room temperature for two days. After two days, alcohol was first formed by yeast. Then the residue was filtered and the filtrate was covered with cheesecloth to allow *Acetobacter* to come in by chanced approach method. This was then allowed to ferment for two weeks. At the end of the fermentation process, the prepared vinegar was filtered, pasteurized and bottled.

2.2.1 Determination of Acidity by Varying the Amount of Sugar in the Preparation of Pineapple Peel Vinegar

The same procedure as described in section (2.2) was carried out by varying the amount of sugar, i.e., (10, 20, 30, 40, 50 and 60 g) respectively, while keeping the following contents, the amount of pineapple peel (180 g), the volume of distilled water

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(800 ml), the amount of yeast (2.5 g) and the amount of yeast nutrient (ammonium phosphate) (4g). The results obtained are shown in Table (2.1).

2.2.2 Determination of Acidity by Varying the Amount of Yeast in the Preparation of Pineapple Peel Vinegar

The same procedure as described in section (2.2) was carried out by varying the amount of yeast, (i.e., 2, 2.5, 3, 3.5, 4 and 4.5 g) respectively, while keeping the following contents, the amount of pineapple peel (180 g), the volume of distilled water (800 ml), the amount of sugar (20 g) and the amount of yeast nutrient (ammonium phophate) (4 g). The results obtained are shown in Table (2.2).

2.2.3 Determination of Acidity by Varying the Amount of Yeast Nutrient (Ammonium Phosphate) in the Preparation of Pineapple Peel Vinegar

The same procedure as described in section (2.2) was carried out by varying the amount of yeast nutrient (ammonium phosphate), (i.e., 3, 4, 5, 6 and 7 g) respectively, while keeping the following contents, the amount of pineapple peel (180 g), the volume of distilled water (800 ml), the amount of sugar (20 g) and the amount of yeast (2.5g). The results obtained are shown in Table (2.3).

2.2.4 Determination of Acidity at Various Fermentation Periods in the Preparation of Pineapple Peel Vinegar

The same procedure as described in section (2.2) was carried out by varying the fermentation periods, i.e., (2, 4, 6, 8, 10and 12 weeks) respectively, while keeping the following contents, the amount of pineapple peel (180 g), the volume of distilled water (800 ml), the amount of sugar (20 g) and the amount of yeast (2.5 g) and the amount of yeast nutrient (ammonium phosphate) (4 g). The results obtained are shown in Table (2.4).

2.3 Analysis of Vinegar

The properties of prepared vinegar from pineapple peel such as acidity, pH, alcohol content and total solids content were determined as shown below.

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2.3.1 Determination of Acidity

Prepared vinegar (10 ml) was placed in a 250 ml of clean, dry conical flask. Then, it was titrated with 0.1 N, standard sodium hydroxide solution by using phenolphthalein indicator. The titrated volume was noted as soon as it turned into light purple (end point), and the acidity of sample was determined as follows.

$$\text{Acidity (w/v\%)} = \frac{\text{Titrex Factor}}{\text{Volume of sample}} \text{x } 100\%$$

Titre = Titrant value of 0.1 N, NaOH

Factor = 0.006005 (for acetic acid)

The results obtained are shown in Tables (2.1) to (2.5).

2.3.2 Determination of pH

The pH of prepared vinegar was determined by using digital pH meter (Pen Type pH meter 009 (I), Range: 0.0-14.0). The glass electrode was first standardized by using buffer solution of pH 7 and the electrode was adjusted to that value. Then, the pH value of vinegar was measured and, the results obtained are shown in Table (2.1) to (2.5).

2.3.3 Determination of Alcohol Content

The alcohol content of prepared vinegar was determined by an alcoholmeter at room temperature. The results obtained are shown in Tables (2.1) to (2.5).

2.3.4 Determination of Total Solids Content

Prepared vinegar (10 ml) was placed in a previously weighed, clean, dry stainless steel dish and heated to dryness. Then, it was placed in an oven at 105ºC for 3 hours. After that, it was cooled in a desiccator for 15 minutes and weighed again. This procedure was repeated until a constant weight was obtained. The percentage of total solids content of vinegar was calculated as follows.

$$\text{Total Solids Content (w/w\%)} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \text{ x } 100\%$$

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The results obtained are shown in Tables (2.1) to (2.5).

3. RESULTS AND DISCUSSION

Food waste in industrialized countries can be reduced by raising awareness among food industries, retailers and consumers. There is a need to find good and beneficial use for safe food that is presently thrown away. Recycling of fruit and vegetable wastes is one of the most important means of utilizing it in a number of innovative ways yielding new products and essential products required in human. A number of beverages such as cider, beer, brandy, and vinegar could also be obtained from the fermentation of fruit wastes. This research is to find out the possibility of using pineapple peelings for the preparation of vinegar by two-stage fermentation process.

In this work, preparation of vinegar was carried out by varying the amount of sugar (i.e., 10, 20, 30, 40, 50 and 60 g), the amount of yeast (i.e., 2, 2.5, 3, 3.5, 4 and 4.5 g), the amount of yeast nutrient (ammonium phosphate) (i.e., 3, 4, 5, 6 and 7 g) and fermentation period (i.e., 2, 4, 6, 8, 10 and 12 weeks) while keeping the amount of pineapple peel (180g) and distilled water (800 ml).

The effect of sugar contents on acidity of pineapple peel vinegar is shown in Table (2.1). According to the results of Table (2.1), it was clearly seen that the vinegar prepared by using 50 g of sugar has the highest acidity compared to the other prepared vinegar. When the amount of sugar was lower than 50 g, the acidity was decreased because of the insufficient amount of sugar for fermentation. The value of acidity was also decreased when the amount of sugar was higher than 50 g. This may be probably due to the excess amount of sugar that may inhibit the growth of yeast for fermentation.

Table (2.2) showed the effect of yeast contents on acidity in the preparation of pineapple peel vinegar. It was observed that, the maximum acidity of vinegar was obtained by using 3 g of yeast. The acidity of prepared vinegar found to be decreased when the amount of yeast was higher than 3 g. When the amount of yeast was lower than

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3 g, the acidity was also decreased because of the insufficient amount of yeast for fermentation.

The effect of yeast nutrient (ammonium phosphate) contents on acidity of prepared vinegar is shown in Table (2.3). The results from Table (2.3) show that the highest acidity was obtained by using 5 g of yeast nutrient. If the amount of ammonium phosphate was lower than 5 g, the acidity was decreased. When the amount of ammonium phosphate was more than 5 g, the acidity was also decreased. This may be due to the insufficient or the excess amount of ammonium phosphate that inhibits the growth of yeast.

According to Table (2.4), it was apparent that the highest acidity was obtained at fermentation periods of eight weeks. It can be seen that, the acidity was decreased when the fermentation period was longer than eight weeks. That may be caused by the further oxidation of acetic acid.

The characteristics of prepared vinegar, viz., acidity, pH, alcohol content and total solids content were determined and the results are shown in Table (2.1) to (2.5). From these results, it can be concluded that the characteristics of prepared vinegar are comparable with literature values.

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Table (2.1) Effect of Sugar Content on Acidity in the Preparation of Pineapple Peel Vinegar

Weight of pineapple peel = 180 g Volume of distilled water = 800 ml

Weight of yeast = 2.5 g Weight of yeast nutrient = 4 g

No.	Weight of Sugar (g)	Fermentation period (week)	Acidity (w/v%)	pH	Alcohol (v/v%)	Total Solids Content (w/w%)
1	10	6	3.8071	3.3	Nil	1
2	20	6	4.2535	3.2	Nil	1
3	30	6	4.4317	3	Nil	1
4	40	6	4.4636	3.1	Nil	2
5	50*	6	4.6118	2.9	Nil	1
6	60	6	4.3837	3	Nil	2

*Optimum condition

Table (2.2) Effect of Yeast Content on Acidity in the Preparation of Pineapple Peel Vinegar

Weight of pineapple peel = 180 g Volume of distilled water = 800 ml

Weight of yeast = 2.5 g Weight of yeast nutrient = 4 g

No.	Weight of Yeast (g)	Fermentation Period (week)	Acidity (w/v%)	pH	Alcohol (v/v%)	Total Solids Content (w/w%)
1	2	6	4.2687	3.1	Nil	1
2	2.5	6	4.5480	3.0	Nil	2
3	3*	6	5.1283	2.8	Nil	1
4	3.5	6	4.8085	2.9	Nil	1
5	4	6	4.3683	3.0	Nil	2
6	4.5	6	3.9513	3.2	Nil	2

*Optimum condition

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Table (2.3) Effect of Yeast Nutrient (Ammonium Phosphate) Content on Acidity in the Preparation of Pineapple Peel Vinegar

Weight of pineapple peel = 180 g Volume of distilled water = 800 ml

Weight of yeast = 2.5 g Weight of yeast nutrient = 4 g

No.	Weight of Yeast Nutrient (g)	Fermentation Period (week)	Acidity (w/v%)	pH	Alcohol (v/v%)	Total Solids Content (w/w%)
1	3	6	4.0996	3.2	Nil	0
2	4	6	4.4256	3.1	Nil	2
3	5*	6	5.0562	2.8	Nil	1
4	6	6	4.3878	3	Nil	1
5	7	6	4.1555	3.2	Nil	2

*Optimum condition

Table (2.4) Effect of Fermentation Period on Acidity in the Preparation of Pineapple Peel Vinegar

Weight of pineapple peel = 180 g Volume of distilled water = 800 ml

Weight of sugar = 50 g Weight of yeast = 2.5 g

Weight of yeast nutrient =4 g

No.	Fermentation Period (week)	Acidity (w/v%)	pH	Alcohol (v/v%)	Total Solids Content (w/w%)
1	2	1.7669	3.6	6	2
2	4	3.5469	3.1	1	1
3	6	4.7851	2.8	Nil	1
4	8*	5.1636	2.5	Nil	1
5	10	4.4317	3.1	Nil	1
6	12	4.3396	3.1	Nil	1

*Optimum condition

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Table (2.5) Comparison of the Characteristics of the Prepared Vinegar and Literature Values

No.	Characteristics of Vinegar	Prepared Pineapple Peel Vinegar	Literature Value
1	Acidity (w/v%)	5.1636	4-8%*
2	pH	2.5	2.4-3.4*
3	Alcohol Content (v/v%)	Nil	Nil*
4	Total Solids Content (w/w%)	1	-

*http://en.wikipedia.org/wiki/vinegar

4.CONCLUSION

The results of this research work have revealed that pineapple peels can be developed into vinegar through simple fermentation, and vinegar making is a highly profitable venture. The prepared vinegar from this work is suitable to be used in cooking and in the preparation of pickles, sauces and marinades. This study also revealed that while cleaning the environment by reducing discharge of food wastes into the environment, an added value could be achieved through the conversion of food wastes into useful products.

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