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Extraction and Evaluation: The Viability of the Three Varieties of Banana (*Musa Paradisiaca*) Exocarps as Potential Sources of Acetic Acid

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ABSTRACT

The banana (*Musa paradisiaca*) exocarps have been a substantial source for maintaining human health and are the fast-growing herbaceous perennials arising from underground rhizomes. The ripe banana is useful in acidity. This study aimed to evaluate how the banana exocarps from ripe ones, can be made into vinegar. Also, to properly analyze the physico-chemical properties (pH and color) and to determine the acetic acid content of the three selected varieties of banana exocarps if it conforms to the set standards. The most accessible in producing acidity is the Latundan (*Musa acuminata musa balbisiana AAB Group*), but all of the samples are accessible in producing acidity. In pH determination the highest in acidity is Lacatan (*Musa acuminata C.*) pH 4, while the Cardaba (*Musa acuminata balbisiana ABB Group*), is pH 3.5, and the lowest is the Latundan pH 3. All of the samples do not have pleasant odor, furthermore the samples well tested and undergo many stages of pasteurization. Thus, the study encourages further development of some spices and food additives and by application of new principles discovered, aside from extending the fermentation time.

INTRODUCTION

The banana plants (*Musa paradisiaca*) are the fast-growing herbaceous perennials arising from underground rhizomes. Banana plants are of great nutritional value contained Vitamin C and a high-grade protein, which includes three essentials amino acids (Villaverde et al., 2013). The ripe banana is useful in acidity. Banana plants are abundant in the Philippines and since we do not make use of the banana exocarps. Since the banana plants contains, a big amount of acid, and then we could make use of the banana exocarps as an alternative source of acetic acid (Antorcha, 2016). The word vinegar is derived from the French words "Vin Aigre, meaning sour wine. The vinegar is classified as acetic acid fermentation (Adams, 1980; Steinkraus, 2002). It is produced via two-stage fermentation. The first stage is the anaerobic conversion of sugars into ethyl alcohol by the action of yeasts followed by the oxidation of the alcohol to acetic acid by the Acetobacter bacteria (Pederson, 1967). It is now one of the most widely used ingredients in the food industry; with worldwide production of 1 million L per year (Hutkins, 2006), and the per Capita consumption is 2 liters (Wood, 1985). Additionally, in the past it has served a wide variety of functions, but today its use is largely confined to food flavoring, production and preservation (Adams, 1980; Pederson, 1967), said that acetic acid can be prepared from any watery substance that contains sugar. Since banana is high in sugar and carbohydrate-containing fruit, it has a high potential for alcohol production (Camarungan, 1940), and subsequently fermented into acetic acid.

According to Adams (1980), he properly cited that banana vinegar production as a small-scale industry especially in developing countries like the Philippines. There are already studies of banana vinegar from different varieties

and some are made from the banana exocarps. According to CO Seteng (1983), said that it can be a source of contamination of some fungi and microorganisms even though it can add to the total fermentable sugar of the fruit. The process is simple, the capital requirement is limited, and banana wastes can be used for the production of acetic acid (Gonelimali, 2018).

There are three selected varieties of banana as source of acetic acid the lacatan (*Musa acuminata C.*), latundan (*Musa acuminata musa balbisiana AAB Group*) and cardaba (*Musa acuminata balbisiana ABB Group*). The lacatan not to be confused with the Cavendish banana Lacatan also called Bungulan. It is a popular dessert banana cultivar in the Philippines. The latundan (also called Tundan, Silk bananas, Pisang raja sereh, Manzana bananas or Apple bananas), are triploid hybrid banana cultivars from the Philippines (Bureau of Agricultural Statistics, 2008). It is one of the most common banana cultivars in Southeast Asia and the Philippines, along with the Lacatan and Saba bananas (Association of Official Analytical Chemists, 1975). The Saba banana is a triploid hybrid (ABB) banana cultivar originating from the Philippines. It is primarily a cooking banana though it can also be eaten raw. It is one of the most important banana varieties in Philippine cuisine. It is also sometimes known as the cardaba banana, though the latter name may be more correctly applied to a very similar cultivar also classified within the Saba subgroup (Do et al., 2014).

In this study, the researcher came up to study how the banana exocarps from ripe ones, can be made into vinegar. Also, the researchers really want to analyze the physicochemical properties (pH and color) and to determine the acetic acid content of the three selected varieties of banana exocarps if it conforms to the set standards. Aside from that, it also involves the utilization

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of wasted Cavendish for small-scale and bigger scale enterprises and for future references and use.

MATERIALS AND METHODS

Plant material. The three selected varieties of banana (*Musa paradisiaca*) exocarps were collected at Prosperidad, Agusan del Sur, CARAGA Region, Philippines. The

sample of the plant was submitted and conducted at the laboratory area of the Department of Biology, Caraga State University (CSU), Ampayon, Butuan City, Agusan del Norte for the plant sample to be examined for some procedural activities. The study used the procedural and experimental method of research which carried out and gather good result of the study.

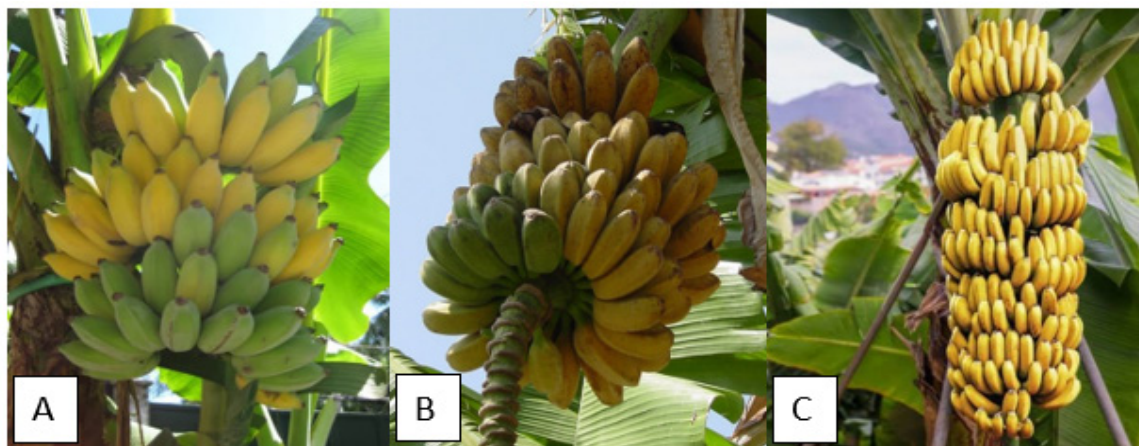


Figure 1: The three varieties of Banana (*Musa paradisiaca*) family. (A) Latundan (*Musa acuminata musa balbisiana AAB Group*), (B) Cardaba (*Musa acuminata balbisiana ABB Group*), and (C) Lacatan (*Musa acuminata C.*)

Study Area

The three (3) selected varieties of banana (*Musa paradisiaca*) exocarps were collected at Prosperidad, Agusan del Sur, CARAGA Region, Philippines. The researcher was gathered the needed data to assess and evaluate how the banana exocarps from ripe ones, can be made into vinegar or as potential source of acetic acid.



Figure 2: The Map of the Study Area.

Preparation of Ingredients and Materials

The researcher really needs to have one (1) kilogram of banana (*Musa paradisiaca*) exocarps in every variety of banana. Also, has one (1) cup of white sugar to be mixed with the liquid. Two (2) cups of purified water and two (2) teaspoons of baker's yeast. The last is two (2) cups of vinegar starter.

Procedures and Treatments

The researcher must collect the three varieties of banana (*Musa paradisiaca*) exocarps and trimming off the stem until only the exocarps remained. Wash the banana

exocarps and slice a 1 kilogram of banana exocarps with a knife into smaller sections in all selected varieties of banana. And subsequently, put it in casserole, then add three (3) cups of water, then boil it for 20 minutes. Extract the juice of the banana exocarps, decant and filter through clean and fine cloth. Furthermore, add two (2) cups of purified water then put a one (1) cup of sugars and pasteurize for 10-15 minutes at 60 degrees Celsius to 65 degrees Celsius. Transfer it into a sterilized container, half-filled. Moreover, let it cool and observe, and then add a half teaspoon baker's yeast for every 8 cups mixture. Then, allow fermenting for 7-8 days. Pour it into another container to separate sediments. In addition, add 1 cup of vinegar starter for every four cups liquid. Cover it with clean cloth. Allow to ferment at a normal room temperature for 2-3 weeks or until a sour odor of vinegar is attained. Then decant to separate the sediments.

pH Determination

The pH values of Latundan (*Musa acuminata musa balbisiana AAB Group*), Cardaba (*Musa acuminata balbisiana ABB Group*), and Lacatan (*Musa acuminata C.*) exocarps acetic acid were measures at 1-9C using a pH meter.

Color Determination. The three (3) varieties of banana (*Musa paradisiaca*) exocarps has an individual colors through color determination it can easily find and determine the colors of the three (3) selected banana exocarps.

RESULTS AND DISCUSSION

In pH determination the value of Lacatan exocarp acetic acid were measured at 1-9C using a pH meter. In calibrating the pH value of Lacatan it has a result of pH 3.0, the pH value of Latundan pH 4.0, while the pH

value of Cardaba pH 3.5. The average of three trials was explicitly done. In determining the color values of the three samples, the researcher found out that the color of Lacatan (*Musa acuminata C.*) is yellow orange, the color of Latundan (*Musa acuminata musa balbisiana AAB Group*) is pale yellow brown, and the color of cardaba (*Musa acuminata balbisiana ABB Group*) is light red (Table 1). In this, the color of the three selected samples of banana exocarps is somewhat good and a little bit the same to the sugarcane vinegar. The acetic acid is a global product. China, United States of America, the rest of Asia and Western Europe are largest acetic acid consumer. The annual worldwide demand of acetic acid is around 6.5 million tonnes of which, approximately 1.5 million tonnes are produced by a fermentation process (Frazier et al., 1988). According to Ploetz et al., 2007, from the entire global acetic acid capacity (virgin acid), 65% is in the Asia where China is the major capacity, 19% in the United States of America and the rest is from other regions. These two regions make up to 84% of whole world capacity. Moreover, China is the largest consumer with 30% of total demand. The rest of Asia accounted for 27% of global demand including Malaysia, with 1 to 3% acetic acid consumption in the world, which is nearly 0.12 million tons acetic acid per annum, followed by 20% in the United States of America and 14% in Western Europe. These regions totaled over 91% of worldwide acetic acid consumption (Malveda and Funada, 2010). The experiment based on the said procedures using the

Table 1: The pH and color values of the three selected varieties of banana (*Musa paradisiaca*) exocarps.

Samples	pH	Color Values
Lacatan	3	Yellow Orange
Latundan	4	Pale Yellow Brown
Cardaba	3.5	Light Red

given materials above, after three weeks, a sour odor in every variety of banana exocarps was attained. In figure 1, the high pH values are the Latundan it has 4.0, thereupon it could have pH below 4 limits bacteria but not to yeast and fungi. Theoretically, as alcohol content increases during alcoholic fermentation. This is due to the conversion of sucrose to alcohol (Figure 2). There are already studies of banana vinegar from different varieties and some are made from banana peel. According to Co Seteng (1983), banana peel can be used for vinegar production, but Adams (1980) said that it can be a source of contamination of some fungi and microorganisms even though it can add to the total fermentable sugar of the fruit.

Table 2 shows that all of the samples have not pleasant odor because all of them is acidulated well due to long process. Although no pleasant odor to smell but the researcher really does their part to do the correct process. Furthermore, the samples well tested and undergo many stages of pasteurization. The researcher ascertained that all of the samples are accessible in producing acidity. In

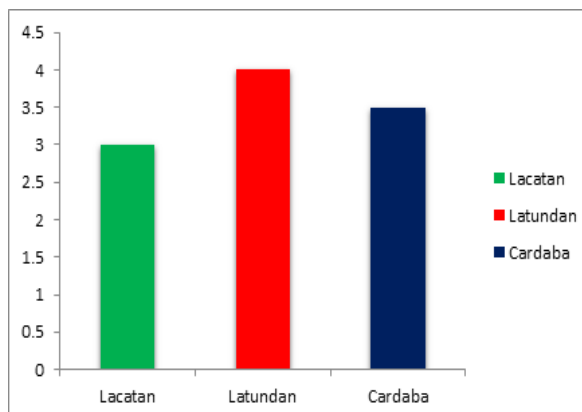


Figure 3: The discrepancy of pH values of an acetic acid of the three selected varieties of banana (*Musa paradisiaca*) exocarps.

Table 2: The pleasant odor of the three selected varieties of banana (*Musa paradisiaca*) exocarps.

Samples	Smell
Lacatan	Unpleasant odor/Acidulated
Latundan	Unpleasant odor/Sourish
Cardaba	Unpleasant odor/Acidulated

addition, all of the given samples have different acidity, but the Lacatan has the lowest percentage of Acetic acid only 29%. While the Cardaba obtained with the result of 33%. Lastly, the most accessible in producing acidity is the Latundan garnering with 38% (Figure 3).

The three selected varieties of banana (*Musa paradisiaca*)

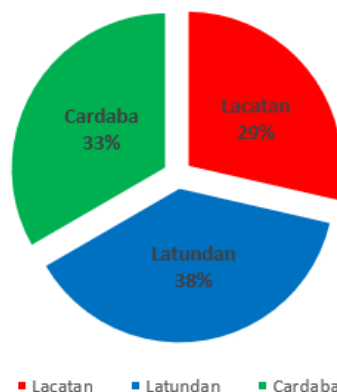


Figure 4: The accessibility in producing acidity of the three varieties of banana (*Musa paradisiaca*) exocarps.

exocarps is mashing and diluting it with water helps to release the soluble sugars from the fruit. Addition of sugars adds to the fermentable sugars to obtain the required alcohol content. It takes 7 to 10 days to convert all of the fermentable sugars to alcohol (Hutkins, 2006) by the action of yeast (*Saccharomyces cerevisiae*) (Adams, 1980). Let alone method for acetic acid fermentation takes a month or longer to reach its optimum physicochemical characteristics (Hutkins, 2006).

CONCLUSIONS

The researchers concludes that the banana exocarps out of the three (3) varieties of banana could be used as an

alternative source of acetic acid. The malic acid is the main acid in the banana exocarp, with substantial quantities of oxalic acid as well (oxalic acid is why sour grass tastes sour). Malic acid content increases substantially upon ripening, whereas the oxalic acid is metabolized (probably via the TCA cycle) and decreases. This one reason why the bitter taste disappears during ripening, however, another may be that tannins in the fruit polymerize. The physicochemical properties and acetic acid content of the vinegar don't conform to the set standards. The main reason is due to short period of fermentation and lack of materials. It is important to observe the period of fermentation because it is time dependent aside from the factors like temperature, starting materials, etc. (Wood, 1985). As a result, this study recommends that the acetic acid/vinegar must be subjected to the sensory analysis, descriptive and consumer acceptance, for further evaluation. Moreover, this study encourages further development of this study by addition of some spices and food additives and by application of new principles discovered, aside from extending the fermentation time.

RECOMMENDATION

The researchers should add more observations in the experiment, to see how the acetic acid from the first experiment differ from the other experiments. Lastly, the study suggested that the local tribes or ordinary people could explicitly continue utilizing this banana plant as a source of treatment or any substantial products. Furthermore, this research might be utilized as a guideline for future study, particularly in the context of plant science that produces substantial products and for medicinal treatments in the community.

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