RICE WINE FROM THREE RICE(*Oryza sativa*) VARIETIES

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SCIENCE RESEARCH 2

by

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DICLAIMER

The results of this study are highly unreliable and could not be possibly used for further studies due the following reasons:

1. The data gathering phase of this study has no evidentiary support in the form of photographs, recorded videos and the like:
2. Further, during the oral defence, the author had been advised to redo some of the experiments. This piece of advice was not heeded until such time that the rice wine were already discarded. Attempts to redo the said experiments were made, however they used a commercially available rice wine.

In the light of these facts, this paper has also NOT been approved by the Research Committee.

Mr. Marc Eli Dellomes,

IV-Graviton, 2008-09

Noted by:

Mr. Joseph Simon V. Madriñan

Research Adviser

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Abstract

The quality of the rice wine in the Philippines has never been consistent. Several varieties of rice are being used to make rice wine and rice wines differ in each locality. The quality of the final product lies on the varieties and organisms used in fermenting the substrate. Therefore, there is a need for consistent and good quality rice variety as the substrate in the fermentation of rice to produce a cosistent and good quality rice wine. The study aims to pinpoint what is the better variety to be used and to tell if other existing varieties are better than the varieties previously being used and to produce rice wine using new varieties of rice.The result of this study will provide information on he chemical properties of the newly used varieties and tell whether the people like it or not. It will also provide basic information on what rice variety will produce a good quality rice wine. In addition, the result will also provide basic information that can be used for further studies in the standardization of the starter culture. A good rice variety that will produce a high yield and good quality wine will benefit both the manufacturers and the consumers of rice wine.

Three rice varieties were cooked and fermented with *Saccharomyces cerevisiae* and were fermented for 2 months. The rice varieties used in making rice wine are namely, Malagkit sungsong, Black Rice-Negro and PSB RC-15. Physico-chemical properties of rice wine were measured in terms of pH, alcohol content and total soluble solids.

The mean pH for Black Rice-Negro was 4.38±0.11547, Malagkit sungsong was 4.24±0.011547, PSB RC-15 was 4.34±0.015275. The mean alcohol content for Black Rice-Negro was 3.46±0.000577, Malagkit sungsong was 13.56±0.006658, PSB RC-15 was 7.56±0.002887.

Turkey's pairwise comparisons shows that the pH of Black Rice-Negro differs significantly with the alcohol content of PSB RC-15 and Malagkit sungsong. Turkey's pairwise comparisons shows that the pH of Black Rice-Negro differs significantly with the pH of PSB RC-15 and Malagkit sungsong.

This will provide information on he chemical properties of the newly used varieties. It will also provide basic information on what rice variety will produce a good quality rice wine. In addition, it will also provide basic information that can be used for further studies in the standardization of the starter culture. A good rice variety that will produce a high yield and good quality wine will benefit both the manufacturers and the consumers of rice wine.

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CHAPTER 1

INTRODUCTION

A. BACKGROUND OF THE STUDY

Rice wine is an alcoholic beverage made from rice. Unlike, wine this is made by fermentation of naturally sweet grapes and other fruit, rice wine results from the fermentation of rice starch converted into sugars. This process is akin to that used to produce beer, however, beer production employs a mashing process to convert starch to sugars whereas rice wine uses the different amyloytic process. Rice wine has a higher alcohol content than wine which in turn has a higher alcohol content than beer. (Wikipedia)

The Philippine Rice Research Institute has been growing four colored varieties of rice grown in Palawan and the Cordillera that is used in making good quality rice wines that may add to the varieties grown by PhilRice.(www.PhilRice.gov)

The Philippines has about 200 varieties of glutinous rice. These rice varieties are commonly cooked and eaten as plain rice. These varieties have potential of making quality wines that may add to the varieties grown by PhilRice. (www.PhilRice.gov)

In the Philippines, rice winee is commonly prepared and consumed in the northern part of Luzon particularly in the Cordillera Region where they call it 'tapuy'. It is served during special occasions like weddings, birthdays, and other ceremonial festivities and also for home consumption. (Lazaro, 2004)

The Philippines has been exporting rice wine to Japan since 1995. Records of the national Statistics Office show that it had exported 632000 liters in 1995, and 1.15 M liters from January to November. (PhilRice, 2005)

According to the economic analysis of the Philippine Rice Reseach Institute, rice wine production is a profitable venture. The return of investment is estimated to reach as high as 88%. The production takes only a short time and the investment can be recouped in 7-8 months period. (PhilRice, 2005)

However, the quality of rice wine has never been consistent for all batches using different rice varieties. It is because the varieties used differ among localities. (Bandonill, 2005)

Rice wine contains anthocyanin, a good antioxidant. Antioxidants protect cells from toxins that can cause cancer and other cardiovascular diseases. The anthocyanin in rice wine is comparable to that of wines made from grapes.(www.sake.com)

Studies showed that individuals who consume rice wine regularly had a 22.7% reduction in overall cholesterol, while LDL dropped 30.9% and HDL increased by 19%.(www.sake.com)

B. Statement of the Problem

What is the pH, total soluble solids and alcohol content of rice wine from these varieties: Malagkit sungsong, PSB RC-15, and Black Rice-Negro?

C. Objective of the Study

This study aims to:

1. To produce rice wine from the following rice varieties:
    a. Black Rice-Negro
    b. PSB RC-15

c. Malagkit sungsong

2. Describe the quality of the rice wine produced in terms of pH, total soluble solids and alcohol content.

D. Significance of the Study

The quality of the rice wine in the Philippines has never been consistent. Several varieties of rice are being used to make rice wine and rice wines differ in each locality. The quality of the final product lies on the varieties and organisms used in fermenting the substrate. Therefore, there is a need for consistent and good quality rice variety as the substrate in the fermentation of rice to produce a cosistent and good quality rice wine. The study aims to pinpoint what is the better variety to be used and to tell if other existing varieties are better than the varieties previously being used and to produce rice wine using new varieties of rice.

The result of this study will provide information on he chemical properties of the newly used varieties and tell whether the people like it or not. It will also provide basic information on what rice variety will produce a good quality rice wine. In addition, the result will also provide basic information that can be used for further studies in the standardization of the starter culture. A good rice variety that will produce a high yield and good quality wine will benefit both the manufacturers and the consumers of rice wine.

E. Definition of Terms:

Rice- *Oryza sativa.* Annual perennial cereal grass plant of the order Cyperales, cultivated as a source of food for its carbohydrate rich grain. (McGraw-Hill Dictionary of Scientific and Technical Terms)

In this study, rice refers to the main ingredient of rice wine.

Rice wine- an alcoholic beverage made from rice. Unlike wine, which is made by fermentation of naturally sweet grapes, rice wine results from the fermentation of rice starch converted into sugar. (McGraw-Hill Dictionary of Scientific and Technical Terms)

In this study, rice wine refers to the alcoholic beverage that will be made from three rice varieties.

Wine- an alcoholic beverage made by fermentation of the juice of fruits or berries especially grapes. (McGraw-Hill Dictionary of Scientific and Technical Terms)

Glutinous rice- *Oryza sativa* var glutinosa; also called sticky rice, waxy rice, botan rice is a type of short grained Asian rice that is especially sticky when cooked. It is called glutinous in the sense of being glue or sticky. (McGraw-Hill Dictionary of Scientific and Technical Terms)

In this study, glutinous rice wine refers to rice of Black Rice-Negro, PSB RC-15, Malagkit sungsong varieties.

Rice varieties- a taxonomic group of rice or category inferior in a rank to a subspecies. (McGraw-Hill Dictionary of Scientific and Technical Terms)

pH- a term used to describe the hydrogen-ion activity of a system; it is equal to – log a H+.(McGraw-Hill Dictionary of Scientific and Technical Terms)

In this study, pH refers to the acidity of the rice wine determined using a pH meter.

Total soluble solids- the total content of soluble solids in a solution. (McGraw-Hill Dictionary of Scientific and Technical Terms)

In this study, TSS refers to the amount of solids present in the rice wine determined using a refractometer.

Alcohol content- the amount of alcohol expressed as a percentage included in a beverage. (McGraw-Hill Dictionary of Scientific and Technical Terms)

In this study, alcohol content refers to the amount of alcohol in terms of percentage present in the rice wine determined by a hydrometer.

CHAPTER II

REVIEW OF RELATED LITERATURE

A. Rice Wine

Rice wine is an alcoholic beverage made from rice. Unlike wine, which is made by fermentation of naturally sweet grapes and other fruit, rice "wine" results from the fermentation of rice starch converted to sugars. This process is akin to that used to produce beer; however, beer production employs a mashing process to convert starch to sugars whereas rice wine uses the different amylolytic process. Alcoholic beverages distilled from rice were exclusive to East and Southeast Asian countries, with knowledge of the distillation process reaching India and parts of South Asia later through trade.Rice brew typically has a higher alcohol content (18-25%) than wine (10-20%), which in turn has a higher alcohol content than beer (3-8%). (www.wikipedia.com)

B. Alcohol Fermentation

Ethanol fermentation is the biological process by which sugars such as glucose, fructose, and sucrose are converted into cellular energy and thereby producing ethanol and carbon dioxide as metabolic waste products. Yeasts carry out ethanol fermentation on sugars in the absence of oxygen. Because the process does not require oxygen, ethanol fermentation is classified as anaerobic. Ethanol fermentation is responsible for the rising of bread dough, the production of ethanol in alcoholic beverages, and for much of the production of ethanol for use as fuel. (www.wikipedia.com)

The chemical equation below summarizes the fermentation of glucose. One glucose molecule is converted into two ethanol molecules and two carbon dioxide molecules:

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$

The process begins with a molecule of glucose being broken down by the process of glycolysis into pyruvate:[1]

$$C_6H_{12}O_6 \rightarrow 2\ CH_3COCOO^- + 2H^+$$

This reaction is accompanied by the size difference of two molecules of NAD^+ to NADH and a net of two ADP molecules converted to two ATP plus the two water molecules.

Pyruvate is then converted to acetaldehyde and carbon dioxide. The acetaldehyde is subsequently reduced to ethanol by the NADH from the previous glycolysis, which is returned to NAD^+:[1]

$$CH_3COCOO^- + H^+ \rightarrow CH_3CHO + CO_2$$
$$CH_3CHO + NADH \rightarrow C_2H_5OH + NAD^+$$

Many species of Yeast (K. lactis, K lipolytica) will oxidize pyruvate completely to carbon dioxide and water (respiration) if oxygen is present in the environment and will ferment only in an anaerobic environment. However, the commonly used bakers Yeast S. cerevisiae as well the yeast S. pombe, both prefer fermentation to respiration even in the presence of oxygen and will yield ethanol even under aerobic conditions given the right sources of nutrition.(www.wikipedia.com)

C. Rice Wine Preparation

Rice wine preparation varies among localities. There are three general methods being used in the preparation of rice wine. One method roasts the rice being utilized. The other method uses half cooked rice. However, others prefer well cooked rice. The wine coming out of the fermenting rice can either be collected then added to the fermenting mixture, or the mixture can be transferred directly to the glazed jar for fermentation.

Using glutinous rice of any variety, which is cooked and cooled, makes the preparation of rice wine then starter powder is sprinkled on it and mixed well. The inoculated cooked rice is transferred to a jar and then allowed to ferment for several weeks. The wine exuded from the hydrolyzed rice is removed with a dipper.(How to produce rice wine, PhilRice)

D. Water

Water is one of the most important materials in rice wine production. It dissolves enzymes and many substances in the prepared mold starter and fermenting mash. It is 130% of the weight of the used rice. Water is not added to the making of rice wine but it is present in the rice itself. Water is also added to the rice during cooking, (www.sake.com)

E. Rice

Rice is the principal raw material of rice wine. It affects the nature of yield and quality of rice wine. Size of grain is considered for best yield. Large grains are the most recommended. Amylose percentage of long grained rice is generally higher to that of short and medium grain. The amount of amylase in the rice affects the amount of alcohol produced. However, one can find small grains suitable for wine brewing. (www.sake.com)

Starch is the storage polysaccharide of plants, is a polymer consisting of entirely of glucose. The monomers are joined by 1-4 linkages, like the monomers of maltose and the angle of these bonds results in the polymers helical shape. The simple form of starch is a branched polymer. (Campbell, Neil; Biology pp.68)

E.1 Malagkit sungsong

Malagkit sungsong is whit, short grained glutinous rice variety native in Central Luzon. It is used commonly in local delicacies because of its availability in the market. It has an average yield of 6 tons per hectare, maturity time 119 days, and plant height is 129 cm. (PhilRice, 2005)

E.2 PSB RC-15

PSB RC-15 is white, long-grained glutinous rice variety from Central Luzon. It can be eaten as plain or as rice cakes because of its good taste and softness. It has an average yield of 4 tons per hectare, maturity time is 121 days, and plant height is 100 cm. (PhilRice, 2005)

E.3

Black Rice-Negro is a black, hybrid, long grained glutinous rice variety native in Negros Occidental. Because of its high-class quality, it is today's most expensive glutinous rice, it costs P50 per kilo. It has an average yield of 3 tons per hectare, maturity time of 109 days, and plant height of 110 cm. (PhilRice, 2005)

F. Starter Culture

The preparation of the starter culture is accompanied with many beliefs. In the Philippines only old women with grandchildren are allowed to prepare the starter culture and even the rice wine. (Agoncillo, 2001)

The preparation odf the starter culture is a process of solid substrate fermentation for enzyme production. There are lots of hydrolyzing enzymes, produced by the microorganisms in the starter culture. Theses are the amylase, responsible for the degradation of starch to dextrin; amyloglucosidase, for the saccharification of dextrin to glucose, maltose and other fermentable sugars; protease and lipase for the decomposition of proteins and fats contained in the raw materials of the starter culture. (www.sake.com)

The yeast, Saccharomyces cerevisiae is the most important domesticated fungus. The tiny yeast cells, available as many strains of baker's yeast, are very active metabolically. Saccharomyces is a facultative anaerobe that ferments sugars to alcohol when forced to live without oxygen. (Campbell, Neil; Biology pp.599)

G. pH level

pH is a measure of the acidity or alkalinity of the solution. Aqueous solutions at 25 degrees with a pH less than seven are considered acidic, while those with a pH greater than seven are considered basic. pH is formally dependent upon the activity of hydronium ions. Because pH is dependent on ionic activity, a property which cannot be measured fully, it is difficult to determine an accurate value for pH in a solution.(Wikipedia)

PhilRice has rice wine with a pH of 4.26. This wine has acidity of other rice wines. Rice wine's acidity does not actually change with different wines coming from different localities. (Lazaro, 2004)

Rice wines are slightly acidic, with pH ranging from 4-5. Acidity affects the rice wines taste by affecting its sourness and after taste. pH is also indicative of the amount of organic acids present in rice wine. (www.sake.com)

H. Alcohol Content

Alcohol content (is a standard measure of how much alcohol (ethanol) is contained in an alcoholic beverage (expressed as a percentage of total volume).

Rice wines being sold by PhilRice are 14% alcohol, but normally rice wines finish Fermentation with 16%-20% alcohol. They reduce the alcohol into 14% by adding water to the rice wine. The sakeof Japan has pH of 10% only, rice wines alcohol differ in different according to the peoples taste. (Lazaro, 2004)

Rice wine affects the alcoholic taste of the wine; too low alcohol may mean that the wine did not undergo proper fermentation. The amount of alcohol in the rice wine is also indication of the efficiency of yeasts converting into alcohol. (Lazaro, 2004)

I. Total Soluble Solids

Total Soluble Solids (often abbreviated TtS) is an expression for the combined content of all inorganic and organic substances contained in a liquid which are present in a molecular, ionized or micro-granular (colloidal sol) suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a sieve size of two micrometres. Total dissolved solids are normally only discussed for freshwater systems, since salinity comprises some of the ions constituting the definition of TDS. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is generally considered not as a primary pollutant (e.g. it is not deemed to be associated with health effects),

but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants.

Primary sources for TDS in receiving waters are agricultural runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. The most common chemical constituents are calcium, phosphates, nitrates, sodium, potassium and chloride, which are found in nutrient runoff, general stormwater runoff and runoff from snowy climates where road de-icing salts are applied. The chemicals may be cations, anions, molecules or agglomerations on the order of 1000 or fewer molecules, so long as a soluble micro-granule is formed. More exotic and harmful elements of TTS are pesticides arising from surface runoff. Certain naturally occurring total dissolved solids arise from the weathering and dissolution of rocks and soils. The United States has established a secondary water quality standard of 500 mg/l to provide for palatability of drinking water.

Total dissolved solids are differentiated from total suspended solids (TSS), in that the latter cannot pass through a sieve of two micrometres and yet are indefinitely suspended in solution. The term "settleable solids" refers to material of any size that will not remain suspended or dissolved in a holding tank not subject to motion, and exclude both TDS and TSS. Settleable solids may include larger particulate matter or insoluble molecules. (www.wikipedia.com)

CHAPTER III

The following procedure were adapted from PhilRice TDS

Mortar and pestle	Burner
Plastic funnel	Water bath
Graduated pitcher	Digital weighing scale
Thermometer	

The following was provided by the researcher:

Mixing bowl	Spoon
Plastic basin	Hose
Cookie jars	Cookie jars
Filter paper	Tray
Laddle	Bottles
9 fermentation jars	Cork
Cheesecloth	Rice cooker

The following was brought from the indicate source:

3 kg Black rice-Negro	PhilRice-Negros
3 kg Malagkit sungsong	PhilRice-Central
3 kg PSB RC-15	PhilRice-Central

B. Study Site and Study Period

The rice wine production and testing were conducted at the Philippine Science High School Research Laboratory during April and May 2008.

C. Preparation of Materials

Three fermentation jars for each rice variety were used. Nine 2-liter bottles were also used in pasteurization. The nine 2-liter bottles were washed with soap and water and were sterilized in an autoclave at 121 degrees Celsius and 15 psi for 20 minutes. A 20 cups rice cooker were used in cooking. A 15x20 inch tray were prepared in the inoculation process. A water bath were needed in pasteurization of th rice wine.

D. Cooking

One kg of glutinous rice varieties, Malagkit sungsong, Black rice-Negro, and PSB RC-15 were weighed in a weighing scale. The rice were put in a 4 L capacity of basin and were washed thoroughly with 2 L of potable water three times each. The washed rice were drained and put in a rice cooker with 1.5 L of water. The rice were cooked in a 20 cups rice cooker.

E. Incubation

The cooked glutinous rice were spread in a 15x20 in tray at least 1.5 in thickness and let it cool. The cooked glutinous rice were inoculated with powdered bubod at a rate of 1 gram per 100 grams raw rice. The tray were covered with a piece of cheescloth and incubate at room temperature for 2 days.

F. Fermentation

The incubated rice mixture were transferred to a fermentation jar with a capacity of 4 liters with a water seal and it were allowed to ferment for two months until bubbling stops. After fermentation, the juice were pressed out through the cheesecloth and the residue was discarded.

G. Pasteurization

The freshly pasteurized rice wine were pasteurized in a 2-liter bottle. The bottle was submerged at least half of the bottle at a water bath filled with water at a temperature 65-70 degrees Celsius for 30 minutes.

H. Aging

The pasteurized rice wine were allowed to stand for one to two months in a dark cool place to prevent discoloration.

I. Bottling

The clear wine were siphoned in a 2-liter bottle. If the wine is not yet clear, one teaspoon of activated charcoal were added for every liter of wine and the wine were filtered using filter paper. Wine were stored in a dry cool place.

J. Physico-chemical Analyses of Rice Wine

J.1 Alcohol Content

The sample of wine to be measured were put in a graduated cylinder. The cylinder was filled with 4/5 of wine. The cylinder were placed on a plain surface. The hydrometer were gently lowered into the cylinder and it must not touch the bottom of the cylinder. The hydrometer must float freely and must not touch the sides of the graduated cylinde. The reading on the lower miniscus that matches on the number on the hydrometer was taken. The hydrometer ere taken out, cleaned and placed away. The sample of wine were added back to the rest of the batch. The cylinder were cleaned and placed away.

J.2 Calibration of pH meter

The electrode were rinsed with deionized water and were blotted dry using a piece of tissue. The electrode were placed in a pH 7 buffer, the display will be allowed to stabilize, and, then, the display will be set to read 7. The electrode were removed from the buffer.

J.3 pH

Forty ml of rice wine were placed in a 50 ml container and will be determined using a digital pH meter. The sample wine were dipped in the pH meter probe and the values that were obtained were expressed in pH will appear in the display of the pH meter.

J.4 Total Soluble Solids

The total soluble solids of rice wine were analyzed using a refractometer. One or two drops of wine were placed in the prism of the refractometer and the values that obtained were expressed in Brix.

Chapter IV

Results and Discussions

I. Results

A.1 pH, alcohol content and total soluble solids

Table 1 show the means of pH, alcohol content and total soluble solids of rice wine made from 3 rice varieties. Black rice-Negro wine produced a greater average pH with 4.38 pH compared to the other two. Malagkit sungsong wine produced greater average alcohol content with 13.56% than the other two rice wines. Malagkit sungsong wine produced a greater average in total soluble solids compared to the other two rice wines.

Table 1. The mean pH, alcohol content and total soluble solids of rice wines made from 3 rice varieties

	pH (mean)	Alcohol content (%) (mean)
Black Rice-Negro	4.38±0.11547	3.46±0.000577
Malagkit sungsong	4.24±0.011547	13.56±0.006658

PSB RC-15	4.34±0.015275	7.56±0.002887

A.2 Statistical analysis

pH

Table 2 shows the one-way ANOVA of the pH of rice wines made from Malagkit sungsong, Black Rice-Negro and PSB RC-15. The analysis showed that there is a significant difference in the pH of the rice wines.

Table 2. One-way ANOVA of pH

	Sum of squares	df	Mean square	F	P(same
Between groups	0.0308222	2	0.0154111	92.47	.000(significant)
Within groups	0.001	6	0.000166667		
total	0.0318222	8			

Alcohol content

Table 3 shows the one-way ANOVA of the alcohol content of rice wines made from Malagkit sungsong, Black Rice-Negro and PSB RC-15. The analysis showed that there is significant difference in the alcohol content of the rice wines.

Table 3. one-way ANOVA of alcohol content

	Sum of squares	df	Mean square	F	P(same)
Between groups	154.82	2	77.41	438.2	.000(significant)
Within groups	1.06	6	0.176667		
total	155.88	8			

A.3 Post-HOC of pH, and Alcohol Content

Alcohol Content

Table 5 shows the post-HOC of alcohol content by Turkey's pairwise comparisons that the pH of Black Rice-Negro differs significantly with the alcohol content of PSB RC-15 and Malagkit sungsong.

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Table 4. Post-HOC of Alcohol Content

Black Rice-Negro	PSB RC-15	Malagkit Sungsong
	0.000257	0.0002269
		0.0002272

pH

Table 6 shows the shows the post-HOC of pH by Turkey's pairwise comparisons that the pH of Black Rice-Negro differs significantly with the pH of PSB RC-15 and Malagkit sungsong.

Table 5. Post-HOC of pH

Black Rice-Negro	PSB RC-15	Malagkit Sungsong
	0.0002269	0.0002328
		0.001891

B. Discussion

Rice wine making procedure was adapted to that of used of the Philippine Rice Research Institute. The yeast used was ordered from the Cordillera Region from the native Igorots. The breaded yeast is called 'bubod'.

The parameters composed of alcohol content, pH and total soluble solids were discovered to produce a significant difference between the rice varieties, Malagkit sungsong, Black Rice-Negro and PSB RC-15.

The pH is a measure how acidic a juice is. The rice wines produced had pH of about 4 which is ideal for rice wines. The acidity of the wine gives its tangy flavor. This is caused by the enzymatic activity of the yeasts during fermentation.

The alcohol content of the rice wine should ideally be 14% alcohol. Only Malagkit sungsong rice wine only met this standard. The other two varieties fell short to that value. The cause maybe is the death of the yeasts before finishing fermentation possibly caused by invading yeasts.

The total soluble solids give the rice wine its unique flavor according to manufacturers of the said product. The absence of these total soluble solids may make the wine not sweet. All the rice wines produced gave supple amount of total soluble solids and probably the wines may have tasted good. Total soluble solids can be a mixture of sugars, organic particles, dirt and other minerals.

However, because of error in the data gathering in total soluble solids, instead of total soluble solids the reading measured is in salinity. This is because the refractometer used were for salinity and not for total soluble solids.

Chapter 5

Summary, Conclusion and Recommendations

The study determined the difference in making rice wine from Malagkit sungsong, PSB RC-15 and Black Rice-Negro varieties.

Specifically, it aimed to:

1. Measure the alcohol content, pH and total soluble solids of rice wine made from Malagkit sungsong, PSB RC-15 and Black Rice-Negro varieties.

2. Determine the significant difference in the alcohol content, pH and total soluble solids of rice wine made from Malagkit sungsong, PSB RC-15 and Black Rice-Negro varieties.

3. Produce rice wine from Malagkit sungsong, PSB RC-15 and Black Rice-Negro varieties.

It was hypothesized that there is a significant difference in the parameter values between the wines made from Malagkit sungsong, PSB RC-15 and Black Rice-Negro varieties.

Summary

The findings of the study are summarized as:

- The researcher was able to make wine by fermenting rice treated with S. Cerevisiae made from Malagkit sungsong, PSB RC-15 and Black Rice-Negro varieties.
- The parameter values of the Malagkit sungsong, PSB RC-15 and Black Rice-Negro wines were found out to have significant differences in their parameter values except for total soluble solids.
- Rice wine made from Malagkit sungsong variety is found to have higher alcohol content and total soluble solids than the other two rice varieties.

Conclusions

The researcher were able to produce rice wine from three rice varieties, namely, Malagkit sungsong, PSB RC-15 and Black Rice-Negro. The alcohol content was greater in Malagkit sungsong wine with a mean alcohol content of 13.56% compared to the other varieties. Black Rice-Negro had a mean of only 3.5% and PSB RC-15 had an mean of 7.56%. The rice wine made from Black Rice-Negro had a mean pH of 4.38, from Malagkit sungsong a mean pH of 4.24, from PSB RC-15 a mean pH of 4.34.

APPENDICES

Appendix

A. Raw Data

Alcohol content of three different rice wines

Rice variety	I	II	III
Black rice	3.5%	3.5%	3.4%
PSB RC-15	7.4%	7.9%	7.4%
Malagkit sungsong	13.9%	14%	12.8%

pH of three different rice wines

Rice variety	I	II	III
Malagkit sungsong	4.38	4.38	4.40
PSB RC-15	4.25	4.23	4.26
Black Rice	4.33	4.35	4.35

Total soluble solids of three different rice wines

Rice variety	I	II	III
Malagkit sungsong	22.9	23.2	23.2
PSB RC-15	20.1	20.1	20.2
Black rice-negro	21.3	21.1	20.8