Development and Utilization of Technology on Indian Mango Fruit Processing

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Abstract - *This project aimed to develop and utilize technology on Indian mango fruit processing. Chemical properties of matured unripe and ripe Indian mangoes were determined in terms of total sugar, reducing sugar, starch, titratable acidity and pH. Fermentation parameters investigated in the study were amount of sugar added (20 and 25%) fermentation medium, acidity of fermentation medium (addition of 1.33 and 1.66 grams of citric acid for ripe and dilution of water for unripe), degree of ripening of Indian mango fruits (ripe and unripe) and ageing period (3 and 4 months). Sixteen treatments were done in triplicates and a composite sample was taken from each treatment for sensory evaluation. Results of the preference test were subjected to statistical analysis. The physicochemical properties of Indian mango wine produced using best fermentation parameters were determined. Appropriate packaging material was selected and packaging design was developed for Indian mango wine. Project cooperators were selected and the technology was transferred through training and production runs. Results of preference test showed that the wine with best sensory properties was prepared using matured unripe Indian mango diluted with water and added with 25% sugar. According to the panel of sensory experts, the taste of Indian mango wine was strong with proper blending of sweetness and sourness, its mouth feel was smooth and good balance, aroma was hot pungent and its color and appearance was clear and light yellow. Its titratable acidity was 0.622%, pH was 5, alcohol content was 11% and brix was 5°.*

Keywords *- fermentation, Indian mango, sensory properties, wine, Philippine Products*

INTRODUCTION

Mango is one of the most popular tropical fruits and considered as one of the finest fruits in the world. It is the Philippines' national fruit and is the third most important fruit crop of the country based on export volume and value. The Philippines produces one million tons a year in high season and about 650,000 to 700,000 tons in low season. Mango has an established export market and the world demand for mangoes, both fresh and processed, is increasing particularly in temperate countries [1].

The fruit contains nearly 81 per cent moisture, 0.4 per cent fat, 0.6 per cent proteins, 0.8 per cent of fibers. It also contains nearly 17 per cent of carbohydrate. The fruit is rich with important minerals contains important minerals like Potassium, magnesium, Sodium, Phosphorus, and Sulphur.

In addition to sumptuous tropical flavor, Mangos deliver a host of nutrients and make healthy eating a delightful sensory experience. Mangoes are an excellent source of vitamins A and C, both important antioxidant nutrients. Vitamin C promotes healthy immune function and collagen formation. Vitamin A is important for vision and bone growth. Mangoes are a good source of dietary fiber, therefore, it is associated with a reduced risk of some types of cancer, protecting against heart disease and cholesterol build up. Mangoes contain over 20 different vitamins and minerals [2].

Three of the popular varieties of mango in the Philippines are Super or Carabao, Pico and Indian mango. About a quarter of the total Carabao and Pico mango production in the Philippines is processed and the mango processing industry continuously grows in the country. Products derived from these two varieties include mango puree, mango juice, dried mangoes, mango concentrates, frozen mangoes, mango glaze,

edible parts, mango wine, mango in brine and mango preserves.

Among these varieties, Indian mango is the most easily propagated in the province. In addition, its production does not require costly inputs such as flower induction and pest management. At present, there is still no consumer product derived from Indian mango that exists in the market. In addition, there is limited literature that shows processing of Indian Mango in the Philippines.

The mango industry has provided livelihood opportunities to its growers and those involved in its marketing channel. As a commodity of commercial value, mango is extensively planted in different regions of the country. As of 2006, total area planted to this crop in Batangas Province was estimated at 9,454 hectares [3].

This study aimed to develop value added products in the form of wine from Indian Mango and transfer the developed technology to selected farmers' cooperatives in Batangas, Philippines. Since, wine from Carabao mango has been recognized in local and foreign markets, the researchers intend to produce wine from Indian Mango. This study will be a great help for the Indian Mango growers and mango industry as a whole for it will provide information necessary to increase the economic value of Indian Mango.

This project aimed to develop and utilize technology on the processing of Indian mango fruits. Specifically it intended to determine the chemical properties of unripe and ripe Indian Mango. Produce wine using the following conditions and subject the products to sensory evaluation to determine the best parameters for Indian mango wine production: amount of sugar added to fermentation medium (20%, 25%), acidity of fermentation medium (addition of citric acid, water), maturity of Indian Mango (ripe, unripe) and aging of produced wine (three, four months). Determine the properties of wine produced using the best parameters in terms of: sensory properties, taste, mouth feel, aroma, color and appearance; Chemical and Physical Properties: titratable acidity, pH value and % alcohol content. Select appropriate packaging material and design for the produced wine. Select project co-operators/ technology takers from aspiring farmers' cooperatives. Transfer the developed technology on Indian mango processing to the selected project cooperators.

MATERIALS AND METHODS

Sample Collection and Research Methods

Fully matured unripe and ripe Indian mangos were collected in an orchard in Batangas City. Half of the samples were stored in a paper box until full ripening stage was achieved. The fully matured unripe and ripe Indian mangoes were peeled and the flesh was separated from the seed. The flesh or mesocarp of the Indian mango was blended and was used for analysis for wine production.

Analysis of the Mesocarp of Indian Mango

Prior to wine production, the Indian mango was subjected to the following chemical analyses; *Total Sugar*, *Total Reducing Sugars*, *Starch Content*, *pH value* and *Titratable Acidity*.

Production of Wines under Varying Parameters and Sensory Evaluation of the Produced Wines

Indian mango wines were produced under varied parameters such as amount of sugar added to fermentation medium, acidity of fermentation medium, degree of ripening of Indian mango and ageing period were varied.

Amount of sugar added to the fermentation medium was varied into 20 and 25 percent of sugar by volume while the acidity of fermentation medium was varied by adding 1.33 and 1.60 grams of citric acid for the ripe Indian mango and dilution of water (0 and 11.68 percent) for unripe. The degree of ripening was varied by using unripe and ripe Indian mangoes while ageing period was varied into three and four months.

Considering the said factors, a total of 16 different treatments for wine production were evaluated in the study. Each treatment was done in triplicate.

To determine which of the 16 treatments yielded the wine with best sensory properties, a composite sample from each treatment was subjected to sensory evaluation. A panel of sensory experts evaluated the 16 wine samples based on their preference with respect to taste, mouth feel, aroma, color and appearance. Score of sixteen was given to the sample with best sensory properties while the score of one was given to the sample with poor properties.

Wine Production

All glass wares were first cleaned and sterilized using an autoclave set at 121^0C for 30 minutes to avoid microorganism contamination.

Indian mango fruits were washed and dipped in calcium hypochlorite solution for ten minutes. Then, the fruits were washed again in running water. Fruits were then unpeeled, chopped into small pieces and blended with water (1:1 ratio).

The puree was transferred to a fermentation vessel and its sugar and acidity were adjusted. The mixture was pasteurized by adding 5ml of 10 percent sodium metabisulfite for every one gallon of the mixture. The treated mixture was set aside for 24 hours. Then 1.07g of yeast was added per liter of puree. The must was covered using sterile cotton plug and left for seven days under this condition. After seven days, the cover was changed into anaerobic set-up. After four weeks of anaerobic fermentation, clear wine was siphoned into sterile ageing vessel and 50ppm of sodium metabisulfite was added. The wines were aged for four and six months. After ageing, wine was clarified and bottled.

Analysis of Wine

Alcohol Content

The Gas Chromatographic method was utilized in determining percent alcohol content of produced wine. A gas chromatograph with flame ionization detector, integrator, heated on-column injector, and six feet by two millimeter internal diameter glass column packed with 0.2 percent Carbowax 1500 on 80-100 mesh Carbopack C was utilized.

Selection of appropriate packaging material and development of packaging design

Appropriate packaging material was selected and design was developed for Indian mango wine by the researchers with the assistance of experts from the Department of Science and Technology (DOST).

The developed designs were evaluated by faculty members and consumers. Comments and suggestions were incorporated in the revision of designs.

Selection of Project Co-operators

A Technical Working Group (TWG) was formed to conduct the evaluation of potential project co-operators who submitted their letter of intent to be a part of the project. Nine cooperatives from Rosario, Lobo, San Juan and Lipa City, Batangas, Philippines were evaluated.

Table 1 shows the criteria used to evaluate the nine aspirants. Top three cooperatives were chosen as project co-operators. In addition, the cooperative that got the highest rating was chosen as pilot processing center.

Table 1. Selection criteria

	Criteria	%
1.	The cooperative is located in an Agrarian Reform Community.	5
2.	The cooperative has at least 100 members.	5
3.	Raw materials within the cooperative are abundant.	20
4.	The cooperative has adequate facilities such as space for working area, tools and equipment.	25
5.	The cooperative is stable in terms of operation and finance.	20
6.	The organizational maturity is at least level IV.	25

RESULTS AND DISCUSSION

Table 2. Chemical Properties of Unripe and Ripe Indian Mango

Properties	Unripe	Ripe
Total Sugar (%)	19.11 ± 2.63	36.16 ± 24.98
Total Reducing Sugar (%)	13.48 ± 0.94	11.93± 0.38
Starch (%)	0.05 ± 0	0.04 ± 0
pH	3.0	4.0
Titratable Acidity (%)	1.1538	0.3497

The chemical properties of unripe and ripe Indian mango are presented in Table 2. Results showed that the total sugar content of the ripe Indian mango was higher than that of the unripe Indian mango while the total reducing sugar of unripe was higher than that of the ripe Indian mango. Total sugar content was the measure of sucrose, fructose and glucose content of the fruit while total reducing sugar was the measure of glucose and fructose and other monosaccharide in the fruit. The results indicate that during ripening process, most of the monosaccharide components of the fruits were converted to sucrose.

Fermentation required both disaccharide and monosaccharide. Since both materials contained high sugar, they can be considered as good substrate for wine production.

Result also showed that the unripe Indian mango wine was more acidic than the ripe ones. Low pH value is preferred for wine since it improves the stability of wine. Winemakers usually adjust the pH

value of must to 3.0. Result indicates that there's no need to add citric acid to unripe Indian mango instead addition of water may be of help to lessen its acidity.

The Produced Wines and the Result of Sensory Evaluation

Sixteen Indian mango wines were produced from sixteen treatments. Composite samples from the sixteen wines were subjected to sensory evaluation. Each sample was given a code. The Code 4R-25.133 refers to wine sample aged for four months, derived from ripe fruit with 25 percent sugar and 1.33 gram of citric acid while 3R-20.160 refers to wine sample aged for three months, derived from ripe fruit with 20 percent sugar and 1.60 gram of citric acid. On the other hand, 4U-25+ refers to wine sample aged for four months, derived from unripe fruit with 25 percent sugar and diluted with 11.68 percent distilled water while 3U-20.0 refers to wine sample aged for three months, derived from unripe fruit with 20 percent sugar and no addition of distilled water.

Results of the preference test were subjected to statistical analysis. Scores given by the panel of sensory experts were ranked. Figure 1 shows the result of preference test.

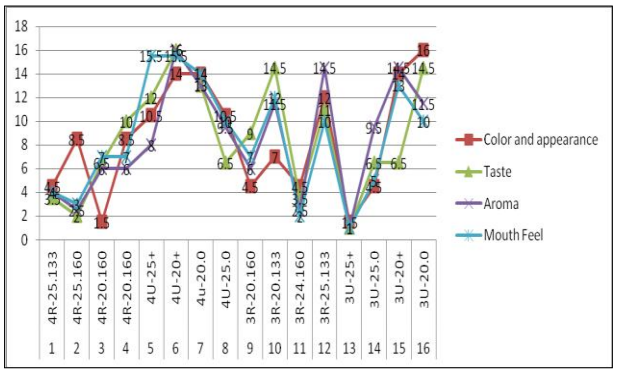

Fig.1. Rank of the sixteen wine samples based on the result of preference test

As shown in figure 1, wine samples that ranked first in the preference test in terms of color and appearance, were samples 3 and 13 coded as 4R-20.160 and 3U-25+, respectively. The wine coded with 4R-20.160 was produced using ripe Indian mango, added with 25 percent sugar and 1.66 gram citric acid and aged for 4 months. On the other hand, 3U-25+ was produced using unripe Indian mango, added with 25 percent sugar diluted with 11.68 percent distilled water and aged for 3 months.

In terms of taste, aroma and mouth feel, wine sample that ranked first was sample 13 coded as 3U-25+. Second in rank in terms of taste was sample 2 coded as 4R-25.160. Sample 11 coded as 3R-25.160 ranked second in terms of aroma and mouth feel. Sample 2 was produced using ripe Indian mango, added with 25 percent sugar and 1.60 grams of citric acid and aged for 4 months while sample 11 was produced using ripe Indian mango, added with 25 percent sugar and 1.60 grams of citric acid and aged for 3 months.

Thus, results indicate that the best parameters for Indian mango production were using unripe Indian mango, added with 25 percent sugar, Indian mango puree diluted with 11.68 percent distilled water and aged for 3 months.

Properties of Indian Mango Wine Produced Using the Best Parameters

The properties of Indian mango wine produced using the best parameters are presented in Table 3.

Table 3. Properties of the Indian Mango Wine Produced using the Best Parameters

Properties of Wine	Results
taste	strong
mouth feel	smooth and good balance
aroma	hot, pungent
color and appearance	Clear/ light yellow
titratable acidity (%)	0.622
pH	5
alcohol content (%)	11.0
brix◦	5

The titratable acidity of the produced wine was 0.622 percent. According to Keller [8], the range of wine's acidity is 0.5 to 0.85 percent. For most people, a wine with 1.0 percent acidity is too tart to drink while wine with 0.4 percent is too flat. In addition, a wine that is closer to the 0.4 percent acidity is more susceptible to spoilage. Most red wines have around 0.6 percent acidity while white wines have acidity range of 0.7-0.8 percent. Result indicates that the titratable acidity of the produced Indian mango wine was comparable to that of red wine. On the other hand, the titratable acidity of Indian mango wine is lower than that of banana wine which is 0.85 percent [4].

The pH of the produced wine was 5. The pH of wine directly affects the flavor, aroma, color, clarity and stability of wine. Most white wines have pH range of 3.2 -3.4 and red wines have the range of 3.3-3.5 to be more acceptable to the palate. Based on the results, the pH of Indian mango wine was higher than the pH of the commercially available wines. On the other hand, pH of the produced wine is somewhat near to the pH of banana wine which is 4.45 [4].

The alcohol content of Indian mango wine was 11 percent was comparable to the alcohol content of white dry wine with 11 percent alcohol content [5]. Furthermore, the alcohol content of the produced wine is higher than that of the produced from banana wine which has only 5 perent [4] and from the most popular variety of mango from India which has only 7 percent - 8.5 percent [6]. However, comparing the alcohol content obtained from Don Roberto's Carabao mango wine which is 12.5 percent [7], the obtained alcohol content of the produced Indian mango wine is lower. Nevertheless, the ethanol content of the produced Indian mango wine is comparable to that of other commercially available wines.

Packaging Materials and Design for the Developed Indian Mango Wine

The initial packaging of wine (Figure 2) was subjected to evaluation of faculty members and selected personnel of Department of Agrarian Reform. Most of the respondents suggested changing the bottle and cap. The researchers changed it with amber bottle and metal cap (Figure 3). The said packaging was also evaluated by faculty members and selected personnel of cooperatives and Department of Agrarian Reform. Result of evaluation is shown in Table 4.

Table 4. Acceptability of packaging design and materials for Indian mango wine

Packaging Component	Weighted Mean	Verbal Interpretation
bottle	4.6	Very acceptable
cap	4.7	Very acceptable
design	4.6	Very acceptable
color	4.4	acceptable
logo	4.4	acceptable

Results indicate that the packaging material and design (Figure 3) for Indian mango were acceptable to the respondents.

Fig. 2. Initial Packaging of Indian Mango Wine

Fig. 3. Final Packaging of Indian Mango

Table 5. The Selected Project Co-operators

Cooperative	Address	Remarks
Pinagsibaan Farmers' Development Cooperative	Pinagsibaan, Rosario, Batangas	Pilot processing Center
Seaside B Multi-purpose Cooperative	Balibago, Lobo, Batangas	Processing Enterprise
San Isidro-Nazi Multi-purpose Cooperative	San Isidro, Lobo, Batangas	Processing Enterprise

After due evaluations, three cooperatives were selected as takers of Indian mango wine technology. The selected project co-operators are shown in Table 5.

Each cooperative was informed of the result of evaluation. An orientation meeting was conducted to discuss their benefits and responsibilities as project co-operators and the content of Memorandum of Agreement (MOA). MOA signing was done last June 2, 2009.

Transfer of the Developed Technology to the Selected Project Cooperators

Two sets of trainings on Indian mango wine were conducted. After the training, series of

production runs were conducted in the processing areas of the three cooperatives. Through trainings and production runs, the three cooperatives were able to produce Indian mango wine with acceptable qualities.

The pilot fruit processing center was established through: 1) renovation of its existing building in pursuant to Food and Drugs (FAD) requirements for fruit processing building; 2) acquisition and transfer of equipment necessary for the production of the Indian mango wine and 3) conduct of production runs for the production of Indian mango wine.

The said assistance given by the researchers enabled the selected cooperative to process the BOF Indian mango wine.

Since 2010, PIFADECO had produced and sold BOF Indian mango wine in national, regional and local trade fairs and exhibits. PIFADECO was also featured in one ABS-CBN Program in recognition of the cooperative's processing of Indian mango into wine.

According to the General Manager of PIFADECO, their adoption of the said technology gave significant effects to their community. Fruits which were neglected in their barangay are now used in processing consumer products with good market value. She also added that the adoption of the Indian mango wine technology of their cooperatives gave employment to unemployed youth in their barangay. This project contributed to the growth of revenues of the Cooperative.

The BOF Indian Mango Wine of Seaside B was featured as an ingredient in cooking special dish in one episode of Kapuso Mo Jessica Soho (a national TV program in GMA network). According to the respective managers of the two project co-operators, the production and marketing of BOF products increased their cooperatives' revenue.

CONCLUSION AND RECOMMENDATION

Based on the results, the following conclusions were drawn. Both ripe and unripe Indian mangoes contain readily fermentable sugars, thus both materials are good raw materials for wine production. However, only unripe Indian mango has pH and acidity level preferred for wine production. The best parameters for Indian mango wine production are the following: addition of 25 percent sugar, dilution of 11.68 percent water to Indian mango puree, utilization of unripe Indian mango and ageing the wine for three months. The produced Indian mango wine has acceptable sensory properties and its alcohol content is comparable with commercially available wine. The selected packaging material is appropriate and the developed packaging design is acceptable to consumers. The researchers had selected worthy project co-operators based on the developed criteria for the selection of project co-operators. Utilization of Indian mango wine technology by the selected cooperatives has increased their revenue and generated new jobs specifically for youth and women in the farms.

REFERENCES

[1] The Mango Industry, URL: http://www.niccep.dti.gov.ph, date retrieved July 3, 2013

[2] ShriSatyanjai, Y. & ShriRakesh Saxena, D. (2012). Post-Harvest Profile of Mango. Nagpur, India

[3] Bureau of Agricultural Statistics BAS, URL:http://www.da.gov.ph, date retrieved July 3, 2013

[4] Akubor, P. I., Obio, S.O., Nwadomere, K.A., Obiomah. E. (2003). Production and Quality Evaluation of Banana Wine, Plant Foods for Human Nutrition, pp. 1-6.

[5] Wine alcohol content, URL: www.alcoholcontent.com, date retrieved: July 5, 2013

[6] Reddy, L.V.A., Reddy, O.V.S. (2005). Production and Characterization of Wine from mango fruit (Mangiferaindica l.). *World Journal of Microbiology & Biotechnology*, pp. 1345-1350

[7] Castaneda. R.R., (2003). Three Fermented Wines in Same Formula-Don Roberto's Sweet (yellow) Mango Wine, (dry) Green Mango Wine and Brewed Coffee Wine. WO 2003010279 A1.