International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 2 (2018) pp. 1324-1327

Fermentation of Ambarella (*SPONDIAS DULCIS*) Wine

[1]Minh N. P.[*] and [2]Oanh T. T. K.

[1]Faculty of Food Technology - Biotech, Dong A University, Da Nang City, Vietnam.
[2]Soc Trang Community College, Vietnam.
**Corresponding author*

Abstract

Ambarella *(Spondias dulcis*) is an equatorial or tropical tree, one of the newer fruits on the ever expanding list of exotics quickly gaining in popularity. The ripen fruit is also much sweeter than the less mature green fruit. The fruit is quite nice eaten fresh. The fruit is considered to be a good source of vitamin C and it is suggested that is has some value in aiding diabetes, heart ailment and urinary troubles. In order to accelerate the added value of this valuable fruit, we investigated the wine fermentation from ripen ambarella. Substrate concentration, pH, and soluble dry matter content in ambarella juice were an important parameters strongly affecting to wine fermentation. We used bentonite and isinglass as coagulant supporting for the clarification. Our results showed that ambarella juice must be diluted at ratio (1: 0.5, juice:water) ready for the fermentation. The fermentation process could be accomplished at the 10^{th} day at pH = 4.4, ^{o}Brix = 20. Turbidity in the fermented fluid could be reomoved effectively by treating with 1.0 gram of bentonite per 1 litter of fermented fluid in 4 weeks to get a good appearance of wine bottle.

Keywords: Ambarella, fermentation, coagulant, bentonite, isinglass, clarification

INTRODUCTION

Ambarella fruit (*Spondias dulcis*) is a medium-sized tree with olive green hairless leaves. The fruit is an ellipsoid to ovoid drupe. When the fruit ripens, its skin and flesh turn golden-yellow, emitting aroma components. The ripe fruit is also much sweeter than the less mature green fruit. Ambarella fruit (*Spondias dulcis*) has a high water and fiber content that can help the digestive process and relieve dehydration. Ambarella is well known as potential source of natural polyphenols, antimicrobial, cytotoxic and thrombolytic and antioxidant activities (Shawkat Md. Aminul Islam, 2013; Rahman, 2016). Vitamin C content in ambarella fruit of 30 mg. Raw ambarella fruit still contains more vitamin C, potassium and folic acid. Ambarella fruit has a sweet sour taste. The ambarella fruit can be eaten directly in fresh or processed usually for sweets, besides ambarella fruit can also be processed into sparkling beverages (Massiot, 1991), drink (Severine Franquin, 2005), nectar (G.M.S.K. Ranathunga, 2011), combo (A. Daranagama, 2012), syrup (Rina Yenrina, 2017). We didn't see any research mentioned to wine fermentation from ripen ambarella fruit. So we investigated a wine fermentation from this valuable source. We focused on examining the effect of soluble dry matter and pH in ambarella juice before fermentation, effect of bentonite and isinglass as coagulant.

MATERIAL & METHOD

Material

We collected ambarella fruits in Central of Vietnam. They must be cultivated following VietGAP to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Beside ambarella fruits, we also used other materials during the research such as citric acid, ascorbic acid, NaOH, HCl, $KMNO_4$, $K_2Cr_2O_7$, KI, $Na_2S_2O_3$, $NaHSO_3$, starch, sacharose, *Saccaromyces cerevisiase,* bentonite, isinglass. Lab utensils and equipments included grinder, pH meter, spectrophotometer, refractometer, weight balance, electrical oven, fermentation tank.

Research method

Investigate nutritional contents in the raw ambarella fruit

Ripen ambarella fruits must be washed under tap water thoroughly before being mashed and filtered to get juice for fermentation. In the juice, we analyzed soluble dry matter, moisture, acidity, sugar and pH.

Investigate the effect of juice concentration for fermentation

Our experiment focused on different dilution ratios of juice with water (1:0, 1: 0.5, 1:1, 1:1.5) in three replications. Then we added more sugar to 20^{o}Brix, pH=4.0. After that, the fluid was sterilized by NaHSO3 in 150 mg/l by 25 minutes. The yeast addition with 0.05% was applied. The fermentation process was monitored in 12 days. We analyzed the remaining sugar and ethanol to find the end of fermentation. After the primary fermentation, the fermented wine was kept intact in 4 weeks ready for coagulation and filtration. Sensory evaluation was carried out to find out the best sample with the appropriated dilution ratio or juice concentration.

Investigate the effect of pH and sugar content before fermentation

We examined different pH values (4.0, 4.4, 4.8) and sugar concentration (20, 22, 24^{o}Brix). The fluid was sterilized by NaHSO3 in 150 mg/l by 25 minutes. The yeast addition with 0.05% was applied. The fermentation process was monitored in 12 days. After the primary fermentation, the fermented wine was kept intact in 4 weeks ready for coagulation and

filtration. Sensory evaluation was carried out to find out the optimal values of pH and sugar content.

Investigate the effect of coagulating agents for filtration

Ripen ambarella fruits must be washed under tap water thoroughly before being mashed and filtered to get juice for fermentation. Dilution ratios of juice with water (1:0.5), sugar to 20^{o}Brix, pH=4.0 were applied. After that, the fluid was sterilized by $NaHSO_3$ in 150 mg/l by 25 minutes. The yeast addition with 0.05% was applied. The fermentation process was monitored in 12 days. After the primary fermentation, the fermented wine was kept intact in 1, 2, 3, 4 weeks ready for coagulation and filtration on diatomit (0 g/l, 0.5 g/l, 1 g/l, 1.5 g/l) and isinglass (0 g/l, 0.5 g/l, 1 g/l, 1.5 g/l) as wine fining and clarifying agents. Sensory evaluation and tubidity (spectrophotometer) were carried out to find out the optimal concentration of wine fining and clarifying agent.

Physical, chemical and sensory analysis

We collected 100 ml of each sample for testing. We analyzed different parameters: sugar content (Bectran), acidity (pH meter), vitamin C (titration), ethanol (distillation), soluble dry matter (refractometer), turbidity (spectrophotometer). Sensory acceptance was evaluated by consumer satisfaction in score range from 1 to 5 for wine.

Statistical analysis

Data were statistically summarized by Statgraphics.

RESULT & DISCUSSION

Nutritional contents in the raw ambarella fruit

Testing analysis results in raw ambarella fruit were depicted in table 1. We saw that soluble dry matter in ambarella juice was quite high, so it's quite convenient for fermentation.

Table 1. Nutritional contents in the raw ambarella fruit

Description	Value
Moisture (%)	82.75
Soluble dry matte (^{o}Brix)	11.8
pH	4.0
Reducing sugar (%)	10.4
Total acidity (%)	0.42
Vitamin C (%mg)	42.55

It is somewhat more difficult to extract the sugar and other soluble materials from the pulp of ambarella fruits than it is from grapes, and secondly the juices obtained from most of the fruits are lower in sugar content and higher in acids than is true for grapes. Problem is solved by the addition of water to dilute the excess acid and the addition of sugar to correct the sugar deficiency.

The effect of juice concentration for fermentation

Table 2. Sugar and ethanol in the fermented ambarella wine

Dilution ratio (juice:water)	Remaining sugar (g/100ml)	Ethanol (%v/v)
1:0	3.45^{a}	12.15^{a}
1:0.5	3.96^{a}	10.84^{b}
1:1	4.85^{b}	9.55^{c}
1:1.5	6.55^{c}	8.29^{d}

Table 3. Fermentation by time on the effect of juice concentration

Fermentation time (days)	Remaining sugar (g/100ml)	Ethanol (%v/v)
2	19.03^{f}	3.05^{e}
4	16.55^{e}	7.44^{d}
6	8.12^{d}	9.02^{c}
8	4.67^{c}	10.65^{b}
10	1.22^{ab}	13.45^{a}
12	1.14^{ab}	13.66^{a}
14	0.95^{a}	13.78^{a}

Table 4. Sensory evaluation on the ambarella fermentation by different dilution ratio

Dilution ratio	Color	Flavor	Taste	Turbidity
1:0	3.9^{a}	3.5^{a}	2.6^{b}	4.3^{a}
1:0.5	3.1^{b}	3.0^{b}	3.5^{a}	3.5^{b}
1:1	2.8^{c}	2.8^{c}	3.2^{a}	3.2^{bc}
1:1.5	2.1^{d}	2.3^{d}	2.8^{b}	2.9^{c}

Fermentation involves a reaction that converts the sugars in the juice into alcohol and carbon dioxide. Yeasts utilise the sugars during the fermentation period. From table 2, 3 and 4 we clearly noticed that dilution ratio of ambarella juice: water (1:0.5) was optimal for wine fermentation in 10 days so we selected these values for further studies.

Effect of pH and sugar content for wine fermentation

Fermentation proceeds under anaerobic conditions and may be boosted with di-ammonium phosphate (DAP) to supplement nitrogen required for yeast growth in non-traditional approach of winemaking (Shrikant Baslingappa Swami, 2016). Spoilage bacteria do not grow well below pH 3.6. Wine yeasts and some lactic acid bacteria can still metabolize in a pH range of 3.3–3.6. The low pH can prolong the fermentation process due to slow growth of microorganisms involved (Pradip D. Satav, 2016). Pradip D. Satav and Archana S. Pethe (2016) also demonstated pH as an important factor for the fermentation of fruit juice into a good quality wine. Low pH inhibits the growth of unwanted microflora and thus can improve the quality of final product.

Table 5. Effect of pH and sugar content for wine fermentation

Description	Demonstrated value	Remaining sugar (g/100ml)	Ethanol (%v/v)
pH	4.0	5.95^{b}	10.22^{c}
	4.4	5.90^{b}	12.35^{a}
	4.8	5.14^{a}	11.42^{b}
^{o}Brix	20	3.35^{a}	12.30^{a}
	22	6.06^{b}	11.39^{b}
	24	8.18^{c}	10.95^{c}

Table 6. Fermentation by time on the effect of pH and sugar content

Fermentation time (days)	**Remaining sugar (g/100ml)**	**Ethanol (%v/v)**
2	19.42^{f}	3.11^{e}
4	17.06^{e}	7.29^{d}
6	8.95^{d}	9.15^{c}
8	5.12^{c}	10.34^{b}
10	1.18ab	13.28^{a}
12	1.11^{ab}	13.33^{a}
14	0.95+	13.41^{a}

Table 7. Sensory evaluation on the ambarella fermentation by different pH and sugar content

Dilution ratio	Color	Flavor	Taste	Turbidity
pH: Sugar (4.0:20)	3.01^{c}	3.03^{c}	3.14^{c}	2.94^{c}
pH: Sugar (4.0:22)	3.19^{bc}	3.15^{bc}	3.40^{bc}	3.01^{bc}
pH: Sugar (4.0:24)	3.24^{b}	3.22^{b}	3.45^{b}	3.11^{b}
pH: Sugar (4.4:20)	3.58^{a}	3.61^{a}	3.74^{a}	3.85^{a}
pH: Sugar (4.4:22)	3.25^{b}	3.40^{b}	3.39^{b}	3.30^{b}
pH: Sugar (4.4:24)	2.94^{c}	2.85^{c}	2.97^{c}	2.75^{c}
pH: Sugar (4.8:20)	2.50^{d}	2.53^{d}	2.56^{d}	2.49^{d}
pH: Sugar (4.8:22)	2.94^{cd}	2.85^{cd}	2.90^{cd}	2.81^{cd}
pH: Sugar (4.8:24)	3.15^{b}	3.16^{b}	3.22^{b}	3.11^{b}

Fermentable sugars consist mainly of hexoses and are normally found at varying concentrations. One important reason is that a higher amount of ethanol is produced during alcoholic fermentation which will lead to higher toxicity towards the end of fermentation.

From table 5, 6 and 7, we saw the optimal parameter for wine fermentation with the pH 4.4 and 20^{o}Brix so we selected these values for further experiments.

Effect of coagulating agents for clarification

Table 8. Effect of coagulating agents for clarification

Clarifying agent	Concentration (g/l)	Optical density
Bentonite	0	0.442^{b}
	0.5	0.285^{a}
	1.0	0.276^{a}
	1.5	0.274^{a}
Isinglass	0	0.422^{a}
	0.5	0.418^{a}
	1.0	0.415^{a}
	1.5	0.413^{a}

Clarification may be achieved by racking, filtration and/or centrifugation. In table 8, we saw the possitive effect of bentonite at 0.5 g/l in wine fining and clarifying. This result was similar to the research of K.F. Pocock et al. (2011) to demonstrate the effect of bentonite fining at different stages of white winemaking on protein stability. Bentonite fining to remove protein is the most widely used treatment to prevent

protein haze in white wines. Adding bentonite during fermentation or fining finished wines was the most efficient option in terms of amounts of bentonite required. Fermenting with bentonite present also may increase fermentation rates.

CONCLUSION

Ambarella fruit both in fresh as well as in processed form not only improve the quality of our diet but also provide essential ingredients like vitamins, minerals, carbohydrates. Utilization of ambarella fruit as the wine is expected to increase the economic value of the ambarella fruit. Therefore, manufacturing of wine from ambarella as a ready to serve value added product to Vietnamese beverage industry will be a good solution for the enormous wastage of local ambarella fruit.

REFERENCE

[1] A. Daranagama, S. Ediriweera & K. Abeywickrama. Pretreatments and cold storage on the quality of minimally processed ambarella (*Spondias dulcis* L.) and the mixed load of ambarella and pineapple (*Ananas comosus* (L.) Merr). *J. Sci. Univ. Kelaniya* 7: 21-41 (2012).

[2] Adewole, S.O.; Caxton-Martins, E.A. Morphological changes and hypoglycemic effects of *Annona muricata* Linn. (*Annonaceae*) leaf aqueous extract on pancreatic B-cells of streptozotocin-treated diabetic rats. *African Journal of Biomedical Resources* 9: 173-187 (2006).

[3] G.M.S.K. Ranathunga, A.P. Henagamage. Development of a Fruit Nectar from Ambarella (Spondias dulcis): A Value Added Product from an Underutilized Fruit Crop in Sri Lanka. *Proceedings of the Research Symposium of Uva Wellassa University*, December 15-16, 2011.

[4] K.F. Pocock, F.N. Salazar and E.J. Waters. The effect of bentonite fining at different stages of white winemaking on protein stability. *Australian Journal of Grape and Wine Research* 17, 280–284 (2011).

[5] Massiot, P., Baron, A., Farhasmane, L. and Parfait, A. Evolution des polysaccharides pariÈtaux de la prune de CythËre (*Spondias cytherea*) au cours de líextraction et de la clarification du jus. *Sci. Alim.* 11: 477-489 (1991).

[6] Pradip D. Satav and Archana S. Pethe. Effect of pH on physicochemical parameters of wine produced from banana. *International Journal of Current Microbiology and Applied Sciences* 5(2): 608-613 (2016).

[7] Rina Yenrina , Tuty Anggraini , Refi Febrina and Heriyenni. The effect of dragon fruit (*Hylocereus polyrhizus*) peel juice addition toward quality of ambarella fruit (*Spondias dulcis*, forst) syrup. *Int. J. Adv. Res.* 5(9): 1231-1237 (2017).

[8] Rahman, M.M., Khan, F.E., Das, R. and Hossain, M.A. Antioxidant activity and total phenolic content of some indigenous fruits of Bangladesh. *International Food Research Journal* 23(6): 2399-2404 (2016).

[9] Severine Franquin, Odile Marcelin and Jean-Marc Brillouet. Optimising quality of a mature-green golden apple (*Spondias cytherea*) drink using amyloglucosidase treatment. *Information and Technology for Sustainable Fruit and Vegetable Production* 5: 12-16 (2005).

[10] Shawkat Md. Aminul Islam, Kh Tanvir Ahmed, Mohammad Kawsar Manik, Md. Arif Wahid, and Chowdhury Shafayat Ibne Kamal. A comparative study of the antioxidant, antimicrobial, cytotoxic and thrombolytic potential of the fruits and leaves of *Spondias dulcis. Asian Pac J Trop Biomed.* 3(9): 682–691 (2013).

[11] Shrikant Baslingappa Swami, N.J. Thakor and A.D. Divate. Fruit wine production: A review. *Journal of Food Research and Technology* 2(3): 93-100 (2016).