

## Various Factors Impacting to Wood Apple Beverage Production

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### ABSTRACT

*The vast array of health benefits that are attributed to wood apples are mainly due to their nutrients, vitamins, and organic compounds, including their tannins, calcium, phosphorous, fiber, protein, and iron. The pulp can be eaten raw, but it is popularly scooped out and frozen, or made into jam. It can also be mixed with coconut milk for a delicious, health beverage, or frozen into ice cream. In this research, we examine the effect of mixture formula and pasteurization to product shelf-life. Our results show the mixture formula 10% fruit juice, 3% honey, and final dry matter 20°Bx to get the best product sensory characteristics. The pasteurization strongly affects to the vitamin C loss. Owing to the low pH (2.9-3.5) and low pasteurization temperature 85°C with the pasteurization unit 8.2 minutes, we receive the good product quality in 4 weeks of preservation.*

**Keywords:** Wood apple, mixture, pasteurization, beverage

### INTRODUCTION

*Feronia limonia* L. (Syn. *Feronia elephantum*, *Limonia acidissima*, wood apple), is a tropical fruit plant of Rutaceae family, traditionally well-known for curing various ailments in ethnomedicine. Wood apple is used in the preparation of chutneys and for making jelly and jam<sup>3</sup>. Wood apple has got high medicinal value. Every part of the fruit posse's medicinal property. Fruits, leaves and stem bark. of wood apple have been studied for anti-tumor<sup>9</sup> and antimicrobial activity<sup>7</sup>. Fruit pulp has anti-inflammatory, antipyretic and analgesic activity<sup>1</sup>. Wood apple has anti-diabetic and antioxidant potential by reducing the level of blood glucose and malondialdehyde<sup>5</sup>. Fruit is much used in India as a liver and cardiac tonic and when unripe, as a means of halting diarrhea and dysentery and for effective treatment for high cough, sore throat and disease of the gums<sup>8</sup>. In addition to this, wood apples also have hypoglycemic activity, antitumor, larvicidal and antimicrobial activity and hepatoprotective activity<sup>10</sup>. Wood apple fruit is considered to be one of the natural sources of anti-oxidants due to its potential radical scavenging activity of various phytochemicals<sup>4</sup>. People consume the raw fruit pulp as such with or without sugars, or as a beverage after blending it with other ingredients. The pulp is also suitable for making food products such as jam, fruit bar, wine, chutneys or sherbet, pulp powder etc<sup>6</sup>. Currently, wood apple based processed products are attracting and becoming popular in the markets because of its rich nutrient profile.

N. Ilaiyaraja *et al.*<sup>2</sup> optimized the extraction of bioactive compounds from *Feronia limonia* (wood apple) fruit using response surface methodology (RSM). The independent variables were viz. concentration of ethanol (X1: 30–70%), incubation temperature (X2: 37–60%) and solvent-to-solid ratio (X3: 20–40%). ANOVA results showed that concentration of ethanol and temperature affected the total polyphenol content (TPC, Y1), DPPH (Y2) and ABTS (Y3) radical scavenging activities significantly ( $p < 0.05$ ) whereas solvent-to-solid ratio was found to be insignificant. A second-order polynomial model satisfactorily fitted the experimental data with the R<sup>2</sup> values of 0.966, 0.946 and 0.955, respectively for the responses Y1, Y2 and Y3 ( $p < 0.0001$ ), implying a good agreement between the predicted and experimental values.

The optimal conditions for the highest yield of TPC ( $7.21 \pm 1.4$  g GAE/ g) with >80% radical scavenging activities were derived at X1 = 62.7%, X1 = 49.7 C and X3 = 39.4 mL/g.

The main purpose of our research is to investigate different factors such as the mixture formula and pasteurization affecting to the wood apple fruit beverage.

## MATERIAL & METHOD

### Material

Wood apple fruits are collected in Mekong River Delta.

Fig. 1: Wood apple fruit



### Research method

#### *Effect of the juice ratio and sugar to product sensory characteristics*

Factor A: juice ratio,%: A1: 5; A2: 10; A3: 15; A4: 20.

Factor B: sugar supplementation, °Bx: B1:14; B2: 16; B3:18; B4: 20.

Total root of equation:  $A*B = 4*4 = 16$ .

Evaluation: Sensory characteristics, pH, acidity of fruit beverage.

#### *Effect of honey ratio to fruit beverage quality*

Factor C: honey, %: C1: 0; C2: 3; C3: 6; C4: 9; C5: 12.

Evaluation: Sensory characteristics, pH, color of fruit beverage.

#### *Effect of pasteurization to product quality and shelf-life*

Factor D: pasteurization temperature, (0 C): D1: 75; D2: 80; D3: 85; D4: 90.

Factor E: pasteurization time, minute: E1: 2; E2: 4; E3: 6

Total root of equation:  $D*E = 4*3 = 12$ .

Evaluation: Sensory characteristics; vitamin C; sugar depression, acidity and microbial density by preservation time.

### Testing

Acidity: titration by NaOH (0.1N) with indicator Phenolphthalein. Sugar: by refractometer. Vitamin C: by Muri method. Microorganism: colony on Agar medium.

### Statistical analysis

All data are processed by Statgraphics.

## RESULT AND DISCUSSION

### Wood apple fruit composition

Table 1. Wood apple fruit composition

Composition	Quantity
Dry matter (°Bx)	10-15
Acidity (by citric acid, %)	3.42
Vitamin C (mg %)	18.88
Saccharose (%)	11.58
Ash (%)	0.378

Wood apple fruit has a strong sour taste that affecting to the product sensory as well as preservation.

Effect of the mixture formula

Table 2. Effect of the mixture formula to product quality

Juice, %	Sugar, °Bx	pH	Acidity, %	Sensory score		
				Flavor	Taste	Color
5	14	3.41	0.24	3.0	2.4	2.9
	16	3.42	0.24	2.6	2.8	3.1
	18	3.40	0.24	2.3	3.0	2.5
	20	3.35	0.23	2.9	2.4	2.9
10	14	3.22	0.28	3.3	2.8	4.1
	16	3.18	0.28	3.9	3.3	4.0
	18	3.20	0.27	4.0	3.7	3.9
	20	3.18	0.28	4.5	4.6	4.2
15	14	2.95	0.36	2.8	2.5	3.8
	16	2.94	0.36	2.7	2.8	3.8
	18	2.96	0.37	3.3	3.7	4.0
	20	2.98	0.36	3.6	3.1	4.4
20	14	3.06	0.59	3.8	2.4	4.1
	16	3.08	0.57	3.3	2.8	4.4
	18	3.07	0.57	3.5	3.2	4.4
	20	3.06	0.56	3.4	3.4	4.2

Table 3. Effect of the mixture formula to product flavor

Juice (%)	Sugar concentration, °Bx				Average of root
	14	16	18	20	
5	3.0	2.6	2.3	2.9	2.7 <sup>c</sup>
10	3.3	3.9	4.0	4.5	3.9 <sup>a</sup>
15	2.8	2.7	3.3	3.6	3.1 <sup>bc</sup>
20	3.8	3.3	3.5	3.4	3.5 <sup>ab</sup>
Average	3.2 <sup>ab</sup>	3.1 <sup>b</sup>	3.2 <sup>ab</sup>	3.6 <sup>a</sup>	

Table 4. Effect of the mixture formula to product taste

Juice (%)	Sugar concentration, °Bx				Average of root
	14	16	18	20	
5	2.4	2.8	3.0	2.4	2.7 <sup>b</sup>
10	2.8	3.3	3.7	4.6	3.6 <sup>a</sup>
15	2.5	2.8	3.7	3.1	3.0 <sup>b</sup>
20	2.4	2.8	3.2	3.4	3.0
Average	2.5 <sup>b</sup>	2.9 <sup>b</sup>	3.4 <sup>a</sup>	3.4 <sup>a</sup>	

Table 5. Effect of the mixture formula to product color

Juice (%)	Sugar concentration, °Bx				Average of root
	14	16	18	20	
5	2.9	3.1	2.5	2.9	2.9 <sup>b</sup>
10	4.1	4.0	3.9	4.2	4.0 <sup>a</sup>
15	3.8	3.8	4.0	4.4	4.1 <sup>a</sup>
20	4.1	4.4	4.4	4.2	4.3 <sup>a</sup>
Average	3.7 <sup>a</sup>	3.8 <sup>a</sup>	3.7 <sup>a</sup>	3.9 <sup>a</sup>	

From above result, with the mixture formula 10%, sugar concentration 20°Bx we will receive the best wood apple fruit beverage.

Effect of honey ratio to wood apple fruit beverage quality

Table 6. Effect of honey ratio to wood apple fruit beverage color

Honey ratio, (%)	Color	
	a	b
0	1.24 <sup>b</sup>	3.94 <sup>b</sup>
3	2.57 <sup>a</sup>	4.94 <sup>a</sup>
6	1.16 <sup>bc</sup>	3.00 <sup>c</sup>
9	0.72 <sup>cd</sup>	2.97 <sup>c</sup>
12	0.63 <sup>c</sup>	3.13 <sup>c</sup>

Table 7. Effect of honey ratio to wood apple fruit beverage quality

Honey, %	pH	Acidity, %	Sensory characteristics		
			Flavor	Taste	Color
0	3.15	0.29	3.2 <sup>b</sup>	3.2 <sup>b</sup>	3.9 <sup>a</sup>
3	3.10	0.29	4.0 <sup>a</sup>	4.4 <sup>a</sup>	4.3 <sup>a</sup>
6	3.02	0.31	3.2 <sup>b</sup>	3.1 <sup>b</sup>	3.9 <sup>a</sup>
9	2.92	0.30	3.5 <sup>ab</sup>	2.8 <sup>bc</sup>	4.0 <sup>a</sup>
12	2.86	0.31	3.3 <sup>b</sup>	2.6 <sup>c</sup>	3.2 <sup>b</sup>

From above results, we choose honey 3% for further research.

Effect of the pasteurization

Fig. 2: Beverage core temperature at 75°C heating

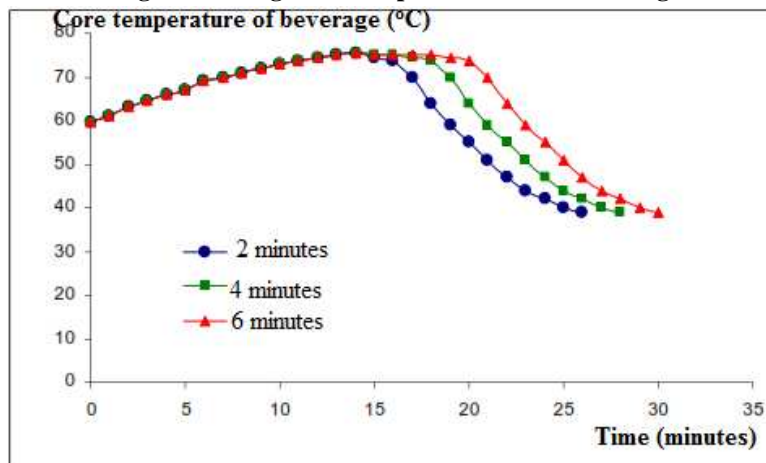


Fig. 3: Beverage core temperature at 80°C heating

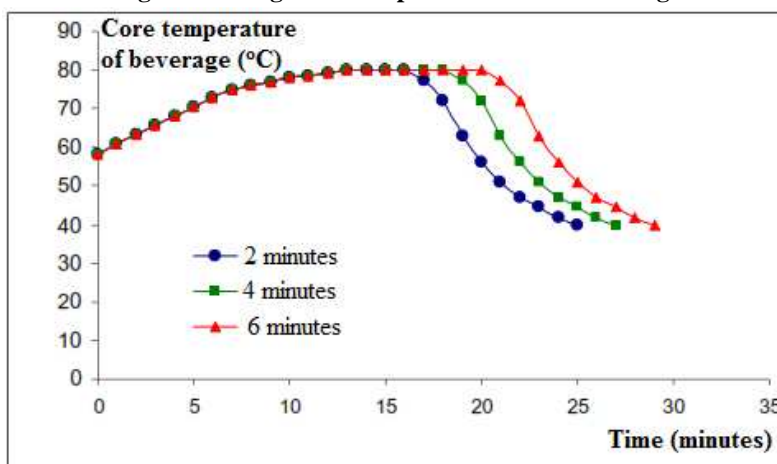


Fig. 4: Beverage core temperature at 85°C heating

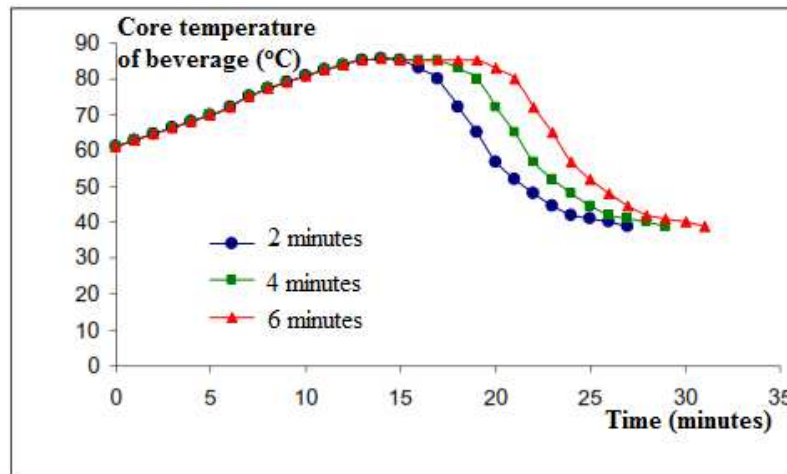


Fig. 5: Beverage core temperature at 90°C heating

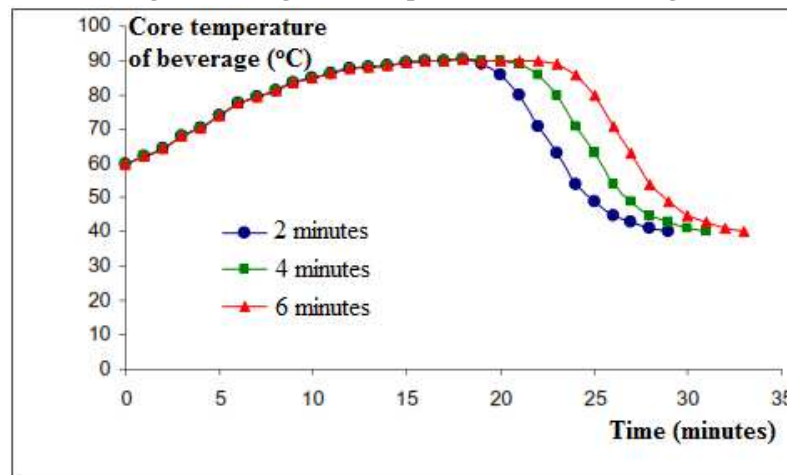


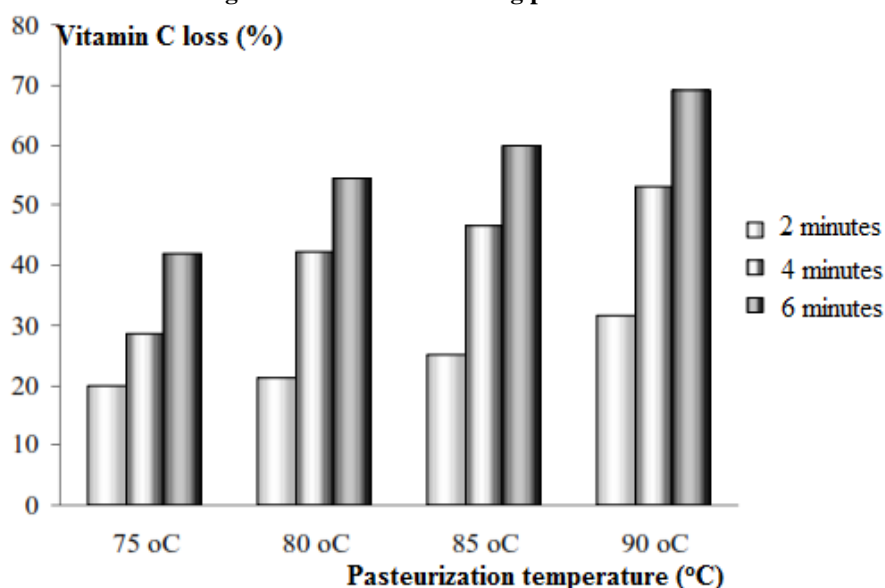
Table 8. Pasteurization unit of the pasteurization, minutes

Pasteurization temperature (°C)	Maintaining temperature, minutes			
	0	2	4	6
75	0.4	0.6	0.8	0.9
80	1.4	2.0	2.5	3.1
85	4.1	6.2	8.2	10.2
90	21.7	28.9	36.1	43.2

Table 9. Effect of pasteurization to wood apple fruit beverage sensory characteristics

Pasteurization temperature (°C)	Maintaining temperature, minutes			Average of root
	2	4	6	
75	6.8	7.8	7.0	7.8 <sup>a</sup>
80	8.0	7.5	6.7	7.4 <sup>ab</sup>
85	7.7	7.8	6.1	7.2 <sup>b</sup>
90	6.3	6.9	6.6	6.6 <sup>c</sup>
Average	7.7 <sup>a</sup>	7.5 <sup>a</sup>	6.6 <sup>b</sup>	

Fig. 6: Vitamin C loss during pasteurization



High temperature in short time during pasteurization, vitamin C loss will be less

Table 10. Sugar concentration in wood apple beverage by preservation, °Bx

Pasteurization temperature (°C)	Maintaining time (minutes)	Shelf-life (week)				
		0	1	2	3	4
75	2	20.2	20.1	20.1	19.4	18.8
	4	20.1	20.1	20.1	20.0	19.6
	6	20.2	20.1	20.2	20.2	20.2
80	2	20.2	20.2	20.0	20.0	20.4
	4	20.2	20.2	20.0	20.1	20.1
	6	20.2	20.0	20.1	20.1	20.2
85	2	20.2	20.2	20.2	20.4	20.1
	4	20.2	20.4	20.2	20.4	20.1
	6	20.2	20.2	20.2	20.4	20.0
90	2	20.4	20.4	20.4	20.4	20.4
	4	20.6	20.4	20.4	20.4	20.6
	6	20.6	20.6	20.4	20.6	20.4

Table 11. Acidity in wood apple beverage by preservation

Pasteurization temperature (°C)	Maintaining time (minutes)	Shelf-life (week)				
		0	1	2	3	4
75	2	0.23	0.22	0.23	0.24	0.38
	4	0.22	0.22	0.22	0.24	0.36
	6	0.22	0.23	0.23	0.23	0.24
80	2	0.22	0.20	0.24	0.25	0.24
	4	0.22	0.21	0.24	0.24	0.24
	6	0.21	0.25	0.25	0.24	0.24
85	2	0.26	0.26	0.27	0.27	0.28
	4	0.26	0.24	0.27	0.26	0.27
	6	0.26	0.26	0.27	0.27	0.28
90	2	0.31	0.30	0.30	0.32	0.32
	4	0.31	0.34	0.33	0.31	0.32
	6	0.32	0.31	0.30	0.32	0.30

Table 12. Microorganism in wood apple beverage by preservation

Pasteurization temperature (°C)	Maintaining time (minutes)	Shelf-life (week)				
		0	1	2	3	4
75	2	$4.0 \times 10^1$	$4.5 \times 10^1$	$5.6 \times 10^1$	$8.6 \times 10^1$	$1.79 \times 10^2$
	4	$3.8 \times 10^1$	$4.2 \times 10^1$	$5.3 \times 10^1$	$6.1 \times 10^1$	$1.37 \times 10^2$
	6	$3.7 \times 10^1$	$3.4 \times 10^1$	$3.1 \times 10^1$	$4.7 \times 10^1$	$7.8 \times 10^1$
80	2	$2.6 \times 10^1$	$3.7 \times 10^1$	$4.0 \times 10^1$	$3.8 \times 10^1$	$8.4 \times 10^1$
	4	$2.4 \times 10^1$	$2.5 \times 10^1$	$2.9 \times 10^1$	$3.1 \times 10^1$	$3.3 \times 10^1$
	6	$2.0 \times 10^1$	$2.2 \times 10^1$	$2.6 \times 10^1$	$2.4 \times 10^1$	$2.9 \times 10^1$
85	2	$1.6 \times 10^1$	$2.0 \times 10^1$	$2.2 \times 10^1$	$2.1 \times 10^1$	$2.5 \times 10^1$
	4	$5.0 \times 10^0$	$4.0 \times 10^0$	$2.0 \times 10^0$	$7.0 \times 10^0$	$3.0 \times 10^0$
	6	$2.0 \times 10^0$	$4.0 \times 10^0$	$2.2 \times 10^0$	$26.0 \times 10^0$	$5.0 \times 10^0$
90	2	$7.0 \times 10^0$	$1.2 \times 10^1$	$9.0 \times 10^0$	$1.1 \times 10^1$	$1.0 \times 10^1$
	4	$<1.0 \times 10^0$	$6.0 \times 10^0$	$4.0 \times 10^0$	$5.0 \times 10^0$	$3.0 \times 10^0$
	6	$<1.0 \times 10^0$	$<1.0 \times 10^0$	$<1.0 \times 10^0$	$<1.0 \times 10^0$	$<1.0 \times 10^0$

At 85°C in pasteurization with 4 minutes of keeping, the microorganism is eliminated and stable in 4 weeks of preservation. So we choose this regime for application.

### CONCLUSION

Wood apple fruits can be consumed as ripe fruits or in juice-form. The wood apple fruit is sweet and can also be used for making a tasty drink known as wood apple milk. The ripe fruit is consumed as custard with sugar or honey in certain cultures.

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