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Several Technical Parameters Affecting to Wood Apple Tea Production Supplemented with Curcumin

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Abstract

Wood apple or bael (*Limonia acidissima*) has got high medicinal value. Every part of the fruit has got its medicinal property. The fruits are consumed as a good source of juice during its harvesting season due to their low cost and thirst quenching ability. Curcumin (*Curcuma longa*) is a constituent of the traditional medicine known as turmeric. The powder of turmeric is expansively used as preservative and coloring agents. An idea to combine these valuable herbs together to produce one instant tea powder was performed. We examine several technical parameters affecting to wood apple tea production supplemented with curcumin so as to preserve its powder shelf-life in 8 weeks. In supplementation of curcumin and wood apple in different ratios (1:2, 1:4, 1:6, 1:8, 1:10), formula of combination (1:4) showed the highest sensory value. Succrose concentration (12 %; 14 %; 16 %^{0}Brix), acidity (0.15 %; 0.20 %, 0.25 %) and salinity (0%, 0.02 % and 0.04 %) were also performed to demonstrate if they affected to tea quality. Optimal values were noted at Brix 14%, acidity 0.20 % and salinity 0.02%. Effect of three kinds of sugar (xilytol/ stevia/ isomalt) to tea quality was investigated by keeping ratio of sugar mixture S (xilytol and stevia) at 1:1, but fluctuating ratio of isomalt and this sugar mixture S at 1:6; 1:7; 1:8; 1:9; 1:10. The highest sensory acceptance was indicated at sugar ratio (isomalt and sugar mixture S, 1:7). In spray drying step, we surveyed different the soluble matter concencentrations (20, 25, 30ºBx) and spray drying temperatures (90, 95, 100, 105ºC) to tea powder quality. At the dry matter 25ºBx and spray drying temperature 95ºC, we got the good tea powder quality. In powder: liquid dilution (extraction), we arranged different diluted ratios (1:2, 1:4, 1:6, 1:8). We noticed the best one at 1:4. In order to ensure the long shelf-life of tea powder, we also demonstrated different packaging materials (PE, PA, alluminum, TetraPak) and preserved durations (0, 3, 6, 9, 12 months). We realized that packing tea powder by TetraPak bag in 12 months was stable.

Keywords: Wood apple, curcumin, tea powder, spray drying, shelf-life, packaging material

INTRODUCTION

The wood apple fruit tree can be grown even on saline, waste and neglected lands normally unsuitable for cultivation of other fruit trees (Awadhesh Kumar, 2017). Wood apple fruit has a smooth, woody shell with a green, gray, or yellow peel. The fibrous yellow pulp is very aromatic. The fruit is eaten fresh or dried. If fresh, the juice is strained or sweetened to make a drink, jelly (Srivastava S, 2014; Nguyen Phuoc Minh, 2015; Awadhesh Kumar, 2017). People consume the raw fruit pulp as such with or without sugars, or as abeverage 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 (Nguyen Thi Hong Tham, 2014). Wood apple based processed products are attracting and becoming popular in the markets because of its rich nutrient profile (Poongodi Vijayakumar, 2013). Fruits, leaves and stem bark of wood apple have been studied for anti-tumor and antimicrobial activity (Rahman, M.M; 2002). 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 (Nithya, N.; 2010).

Tumeric has been used as a spice for a food preservative and a dye for a long period. Curcumin is known for its antioxidant (A. J. Ruby, 1995; Muhamed Haneefa.M, 2014). As a food additive, turmeric can improve the deliciousness, aesthetic appeal, and shelf life of delicate food products (Abdul Rohman, 2012). Curcumin is a highly pleiotropic molecule that was first shown to exhibit antibacterial activity. This polyphenol has been shown to possess anti-inflammatory, hypoglycemic, antioxidant, wound-healing, and antimicrobial activities (Aggarwal BB, 2009; Gupta SC, 2011). Some promising effects have been observed in patients with various pro-inflammatory diseases including cancer, cardiovascular disease, arthritis, uveitis, ulcerative proctitis, Crohn's disease, ulcerative colitis, irritable bowel disease, tropical pancreatitis, peptic ulcer, gastric ulcer, idiopathic orbital inflammatory pseudotumor, oral lichen planus, gastric inflammation (Subash C. Gupta, 2013).

In order to utilize the functional components and improve the added value of these fruits, we decided to combine two valuable herbs into one instant tea powder. We examine several technical parameters affecting to wood apple tea production supplemented with curcumin so as to preserve its powder shelf-life.

MATERIAL & METHOD

Material

We collected wood apple fruit and curcumin in the South of Vietnam. They must be cultivated following Global GAP to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Beside wood apple and curcumin, we also used other materials during the research such as xilytol, acesulfame-K, isomalt, salt, maltodextrin, potasium metabisulfite, acid citric. Lab utensils and equipments included thermometer, grinder, spray dryer, refractometer, pH meter, colorimeter, weight balance, UV-Vis,

Research method

Investigate the effect of ratio of (curcumin: wood apple) mixture to product quality

We monitored different ratio of curcumin: wood apple (1:2, 1:4, 1:6, 1:8, 1:10). Sensory characteristics (flavor and color), soluble dry matter of the mixing solution were measured.

Investigate the effect of succrose concentration, acidity and salinity to product quality

Our experiment focused on different succrose concentration (12 %; 14 %; 16 %^{0}Brix), acidity (0.15 %; 0.20 %, 0.25 %) and salinity (0%, 0.02 %, 0.04 %). Sensory characteristics (flavor and color), soluble dry matter of the mixing solution were measured.

Investigate the effect of three kinds of sugar (xilytol/ stevia/ isomalt) to product quality

We investigated ratio of sugar mixture S (xilytol and stevia) at 1:1, while changing ratio of isomalt and this sugar mixture S at 1:6; 1:7; 1:8; 1:9; 1:10. Sensory characteristics (flavor and color), soluble dry matter of the mixing solution were measured.

Investigate the effect of soluble matter concentrations and spray drying temperatures product quality

Our experiments implemented on different the soluble matter concencentrations (20, 25, 30ºBx) and spray drying temperatures (90, 95, 100, 105ºC) to tea powder quality. Moisture content, powder recovery, vitamin C, carotenoid, aroma and color of tea powder were measured.

Investigate the effect of powder: liquid dilution to product quality

Our experiments focused on finding which ratio of powder: liquid dilution (1:2, 1:4, 1:6, 1:8) appropriated. Aroma and color of tea beverage were measured.

Investigate the effect of packaging material and preservation time to tea powder shelf-life

We also demonstrated different packaging materials (PE, PA, alluminum, TetraPak) and preserved durations (0, 3, 6, 9, 12 weeks). Moisture, vitamin C, and carotenoid contents of tea powder were measured.

Sampling method

We collected 500 gram of each sample for testing.

Analytical method

We analyzed different parameters: sugar content (Lane – Eynon), acidity and vitamin C (titration), soluble dry matter (refractometer), color (colorimeter), sensory (Hedomic)

Statistical analysis

Data were statistically summarized by Statgraphics.

RESULT & DISCUSSION

Chemical content in raw wood apple and curcumin

Chemical contents in raw wood apple and curcumin were analyzed. Our results were illustrated in table 1 and table 2.

Table 1. Chemical contents in wood apple fruit

Description	Value
Moisture (%)	94.93
Soluble dry matter (ºBrix)	4.45
Total sugar (%, mg/100ml)	2.54
Total acidity (%)	0.37
pH	4.08
Vitamin C (mg%, mg/100g)	19.04
Carotenoid (ppm)	41.88

Table 2. Chemical contents in curcumin

Description	Value
Moisture (%)	79.12
Soluble dry matter (ºBrix)	4.71
Lipid (%)	0.25
Carotenoid (ppm)	720.19

We clearly saw that the soluble dry matter in wood apple was not high enough so we must add much more sugar (maltodextrin) into it to increase dry matter content. Vitamin C and carotenoid were two valuable elements in curcumin, so they should be preserved utmost.

Ratio of (curcumin: wood apple) mixture to product quality

Table 3. Ratio of curcumin: wood apple to aroma and color of product quality

Mixture	Sensory score	
(curcumin: wood apple)	Aroma	Color
1:2	2.4[d]	3.9[b]
1:4	4.5[a]	4.6[a]
1:6	3.6[b]	3.3[c]
1:8	3.1[c]	2.4[d]
1:10	2.6[d]	1.3[e]

In supplementation of curcumin and wood apple in different ratios (1:2, 1:4, 1:6, 1:8, 1:10), formula of combination (1:4) showed the highest sensory value. From table 3, we decided to choose ratio 1:4 (curcumin: wood apple) for further studies.

Effect of the succrose concentration, acidity and salinity to product quality

Table 4. Effect of succrose concentration and acidity to product quality

Sucrose (°Brix)	Acidity (%)			Average
	0.15	0.20	0.25	
12.0	1.38	2.74	1.68	1.93[c]
14.0	2.66	4.75	3.47	3.63[a]
16.0	2.55	4.3	2.3	3.05[b]
Average	2.20[c]	3.93[a]	2.48[b]	

From table 4, we realized that sucrose 14°Brix and 0.2% acidity having the highest sensory score. So we selected these values for further studies.

Table 5. Effect of sanility to product quality

Salinity (%)	Sensory score
0	1.2
0.02	2.8
0.04	2.4

From table 5, we chosed salinity 0.02% for further studies.

Effect of three kinds of sugar (xilytol/ stevia/ isomalt) to product quality

By keeping ratio of sugar mixture S (xilytol and stevia) at 1:1, but fluctuating ratio of isomalt and this sugar mixture S at 1:6; 1:7; 1:8; 1:9; 1:10. The highest sensory acceptance was indicated at sugar ratio (isomalt and sugar mixture S, 1:7)

Table 6. Effect of three kinds of sugar to product quality

Isomalt: Mixture S (xilytol and stevia))	Taste score
1:6	3.7[b]
1:7	4.9[a]
1:8	3.5[b]
1:9	1.4[d]
1:10	2.4[c]

Table 7. Chemical content in the mixing stuff (curcumin: wood apple) after supplementation

Description	Value
Soluble dry matter (°Brix)	4.62
pH	3.68
Vitamin C (mg%)	3.77
Total carotenoid (ppm)	10.34

Effect of soluble matter concentrations and spray drying temperatures product quality

In spray drying step, we surveyed different the soluble matter concencentrations (20, 25, 30°Bx) and spray drying temperatures (90, 95, 100, 110°C) to tea powder quality. At the dry matter 25°Bx and spray drying temperature 95°C, we got the good tea powder quality.

Table 8. Moisture content (%) in tea powder after spray drying

Spray drying temperature (°C)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	5.54	5.21	4.89	5.21[d]
95	5.01	4.67	4.54	4.74[c]
100	4.57	4.49	4.38	4.48[b]
105	4.19	4.32	4.22	4.24[a]
Average	4.83[c]	4.67[b]	4.51[a]	

Table 9. Powder recovery (%) after spray drying

Spray drying temperature (oC)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	56.64	63.22	72.75	64.20[c]
95	60.34	67.45	75.14	67.64[b]
100	64.31	70.29	77.22	70.61[a]
105	54.88	62.91	72.45	63.41[c]
Average	59.04[c]	65.97[b]	74.39[a]	

Table 10. Vitamin C (mg%) in dried powder after spray drying

Spray drying temperature (oC)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	14.01	8.24	6.76	9.67[a]
95	18.14	14.01	10.08	14.08[b]
100	26.22	20.34	15.03	20.53[c]
105	38.97	20.17	19.24	26.13[d]
Average	24.34[c]	15.69[b]	12.78[a]	

Table 11. Total carotenoid (ppm) in dried powder after spray drying

Spray drying temperature (°C)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	27.95	25.83	22.91	25.56[b]
95	25.13	22.93	21.87	23.31[a]
100	28.75	24.88	22.95	25.53[c]
105	33.59	28.78	24.75	29.04[d]
Average	28.86[c]	25.61[b]	23.12[a]	

Table 12. Aroma score of beverage after diluting powder with water

Spray drying temperature (°C)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	4.5	3.7	2.4	3.53[a]
95	4.3	3.5	2.2	3.33[b]
100	4.1	2.9	1.9	2.97[c]
105	3.8	1.7	1.5	2.33[d]
Average	4.18[a]	2.95[b]	2.00[c]	

Table 13. Taste score of beverage after diluting powder with water

Spray drying temperature (°C)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	4.1	3.9	2.2	3.40[a]
95	3.8	3.5	1.9	3.07[b]
100	3.9	3.5	1.6	3.00[b]
105	3.5	3.2	1.3	2.67[c]
Average	3.83[a]	3.53[b]	1.75[c]	

Table 14. Color score of of beverage after diluting powder with water

Spray drying temperature (°C)	Soluble matter concentrations of liquid before spray drying (°Brix)			Average
	20	25	30	
90	4.6	3.7	3.1	3.80[a]
95	4.3	3.6	2.7	3.53[ab]
100	4.4	3.5	2.5	3.47[b]
105	4.2	3.3	2.1	3.20[c]
Average	4.38[a]	3.53[b]	2.60[c]	

Effect of powder: liquid dilution to beverage quality

In powder: liquid dilution (extraction), we arranged different diluted ratios (1:2, 1:4, 1:6, 1:8). We noticed the best one at 1:4.

Table 15. Sensory evaluation (aroma, taste and color) of beverage after diluting powder with different water ratio

Dilution ratio	Sensory score		
Powder: water	Aroma	Taste	Color
1:2	3.6[b]	3.8[b]	4.6[a]
1:4	4.5[a]	4.9[a]	4.7[a]
1:6	2.7[c]	3.2[b]	3.3[b]
1:8	1.4[d]	1.7[c]	1.6[c]

Effect of packaging material and preservation time to tea powder shelf-life

In order to ensure the long shelf-life of tea powder, we also demonstrated different packaging materials (PE, PA, alluminum, TetraPak) and preserved durations (0, 3, 6, 9, 12 months). We realized that packing tea powder by TetraPak bag in 12 months was stable.

Table 16. Moisture content in tea powder after packaging by different materials and times

Packaging material	Preservation (months)					Average
	0	3	6	9	12	
PE	4.66	6.17	7.15	8.62	9.48	7.22[d]
PA	4.66	5.22	5.79	6.61	7.37	5.93[c]
Alluminum	4.66	5.01	5.20	5.42	5.64	5.19[b]
TetraPak	4.66	4.76	4.88	4.95	5.11	4.87[a]
Average	4.66[a]	5.29[b]	5.76[c]	6.4[d]	6.90[e]	

Table 17. Vitamin C (%mg) in tea powder after packaging by different materials and times

Packaging material	Preservation (months)					Average
	0	3	6	9	12	
PE	13.35	11.48	8.67	4.02	2.05	7.91[d]
PA	13.35	12.55	11.95	8.85	6.68	10.68[c]
Alluminum	13.35	12.87	12.05	11.14	10.88	12.06[b]
TetraPak	13.35	13.01	12.76	12.60	12.45	12.83[a]
Average	13.35[a]	12.48[a]	11.36[b]	9.15[c]	8.02[d]	

Table 18. Total carotenoid (ppm) in tea powder after packaging by different materials and times

Packaging material	Preservation (months)					Average
	0	3	6	9	12	
PE	112.25	95.05	87.04	74.29	65.57	86.84[d]
PA	112.25	104.15	101.12	98.95	90.27	101.35[c]
Alluminum	112.25	107.18	106.22	104.45	102.79	106.58[b]
TetraPak	112.25	111.07	110.95	109.79	108.55	110.52[a]
Average	112.25[a]	104.936[b]	101.33[c]	96.87[d]	91.80[e]	

Table 19. Major components in tea powder after 8 weeks of preservation

Components	Value
Moisture (%)	5.11
Lipid (%)	0.85
Vitamin C (%mg)	12.24
Total carotenoid	108.40

CONCLUSION

The wood apple pulp is a rich source of beta-carotene, which also contains significant amount of vitamins B such as riboflavin and thiamine and it had small quantities of ascorbic acid content. The turmeric rhizome contains a variety of pigments among which curcumin is a major pigment. Processing potential of wood apple fruits and curcumin into tea powder needs to be explored for commercialization of fruit.

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