Changes in Volatile Flavor Components of Guava Juice with High-Pressure Treatment and Heat Processing and during Storage

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The changes in volatile flavor components of guava juice during pressure processing (25 °C, 600 MPa, 15 min), heat processing (95 °C, 5 min), and storage at 4 and 25 °C were evaluated by purge and trap/gas chromatography/mass spectrometry. Esters were the major volatile fraction in guava juice, and alcohols were the second. Pressure processing could maintain the original flavor distribution of the juice. Heat processing (95 °C, 5 min) caused decreases in the majority of flavor components in the juice when compared with freshly extracted juice. High-pressure treatment at 600 MPa for 15 min can effectively sterilize microbes but partially inactivate enzymes of guava juice; therefore, volatile components in pressure-treated juice gradually changed during storage periods. Pressure-treated guava juice showed increases in methanol, ethanol, and 2-ethylfuran with decreases in the other components during storage period. Nevertheless, the volatile distribution of 600 MPa treated guava juice was similar to that of freshly extracted juice when stored at 4 °C for 30 days.

Keywords: *Guava juice; flavor component; pressurization; heat processing; storage*

INTRODUCTION

The guava (*Psidium guava* L.), which has a unique and banana-like aroma, is an economically important subtropical fruit in many tropical countries for all seasons. Guava is consumed mainly as fresh fruit or processed juice products. Guava juice is one of the most important fruit juices in Taiwan, which cannot be replaced by imported fruit juices such as orange juice and peach juice. Guava puree is processed by juice-processing plants and then frozen until supplied to the food company for manufacture into various juice blends. However, pasteurized guava puree undergoes deterioration during storage at frozen temperatures, resulting in development of off-flavor and decreased sensory quality of guava juice. The results indicated that traditional processing could not prevent the changes of flavor and quality of juice (Yen et al., 1992, 1994).

High-pressure treatment is one such process that can inactivate enzymes and inhibit microorganisms in certain foods or food ingredients. High-pressure processing of food materials can provide an effective nonthermal alternative to conventional thermal processing (Cheftel, 1992). Thus, pressure-processing can maintain flavor and color quality of food (Farkas, 1986; Knorr, 1993). This technique has more advantages than other processing methods. Consequently, high pressurization is suggested to be applied to food processing instead of heat treatment. Many studies identifying the volatile flavor components of guava fruit and its processed products have been done (Macleod and Troconis, 1982; Idstein and Schreier, 1985; Chyau et al., 1989, 1992; Nishimura et al., 1989; Ekundayo and Ajani, 1991; Vernin et al., 1991). Chyau et al. (1989) studied the changes of volatile flavor components of clear guava juice during processing. Yen et al. (1992) studied the changes of volatile flavor components of guava puree during pasteurization and frozen storage. Study concerning the effect of high-pressure treatment on the changes of volatile flavor components in Satsuma mandarin juice has been reported by Takahashi et al. (1993). Reports concerning changes of volatile flavor components of strawberry and peach were also published (Kimura et al., 1994; Sumitani et al., 1994). However, studies concerning the changes of volatile flavor in guava juice during high-pressure treatment and storage have not been reported heretofore.

The objective of our study was to determine the changes of volatile flavor components during high-pressure treatment, heating, and storage at 4 and 25 °C. Untreated guava juice was also compared with juices that underwent heating and high-pressure treatment.

MATERIALS AND METHODS

Materials. Fresh guava (*Psidium guava* L.) fruit was obtained from Kaohsiung county in the south of Taiwan.

Preparation of Guava Juice. Guava puree was prepared at the Chia Meei Food Industrial Corp., Taichung, Taiwan. The manufacturing procedure of guava puree was washing, selecting, crushing, removing seed, and juice extraction successively, according to the method described by Yen et al. (1996). The soluble solids content of prepared guava puree was 10.2 °Brix.

Distilled water was used to dilute the guava puree to 30% (w/w) guava juice. A sterilized solution of citric acid (Merck, Darmstadt, Germany) was added to the juice samples to adjust the pH to 3.8, and sucrose (Sigma) was added to the juice to adjust the °Brix to 12. The fresh juice samples were packed in 500 mL plastic bottles and stored at 4 °C. Partial juice samples were treated immediately by high hydrostatic pressure or heating process.

High-Pressure Equipment. Hydrostatic pressurization equipment (Pmax 600 MPa, Mitsubishi Heavy Industries, Ltd.,

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type 471-046, Hiroshima, Japan) was employed in this study. It consisted of a pressure container and a pressure cell. The capacity (volume) was ∼120 mL. The temperature of the pressure cell was maintained by a thermocontrolled water bath (Hakke GH, Germany). Pressure was applied by operating a piston with an oil hydraulic motor of the high-pressure equipment. For pressure up to 600 MPa, the period required was ∼40 s. The period required to return to atmospheric pressure was ∼5 s.

High-Pressure Treatment. After pH and °Brix adjustment, the guava puree samples were filled in a plastic container (volume ∼100 mL) and treated with high pressure immediately. Continuous pressurization under 600 MPa for 15 min was used to treat the puree samples, and the treatment temperature was controlled at 25 °C.

Heat Treatment. The guava juice was heated at 95 °C for 5 min in a plate heat exchanger. Cooling plates were chilled with ice water to reduce the temperature of heated puree to <20 °C. The cooled juice was filled into plastic bottles (500 mL) and brought to 4 °C storage.

Storage Test. The guava juice was pressurized at 600 MPa at 25 °C for 15 min and then rapidly cooled and stored at 4 °C over a period of 60 days. The heated samples were treated as described above. Pressure-processed, heated, and untreated juice samples were kept in plastic bottles and stored at 4 or 25 °C to measure the flavor components during processing and storage.

Purge and Trap/Gas Chromatography/Mass Spectrometry (P&T/GC/MS). A Tekmar purge and trap injector (Tekmar, Inc., Raritan, NJ) was used to purge volatile compounds from juice samples (2 mL each) for subsequent cryogenic trapping into a deactivated fused Tenax open tubular trap. Trapped volatiles were then thermally desorbed and analyzed by GC/MS. P&T conditions were as follows: purge time, 5 min; nitrogen purge flow, 24.6 mL/min; precondensor temperature, −100 °C; cryogenic trap temperature, −120 °C (5 min precool time); trap material, deactivated 2-mm-i.d. × 30 cm Tenax column; sample temperature, 40 °C; deactivated oven temperature, 50 °C; injection temperature, 200 °C; and injection time, 10 min. The GC/MS system consisted of an HP 5890A GC/HP 5970B mass selective detector (MSD) (Hewlett-Packard Co., Palo Alto, CA). Separations were performed on a DB-1 column (60-m length × 0.32-mm i.d. × 0.25-nm df, J&W Scientific Co., Folsom, CA). Injector block temperature was maintained at 200 °C. Nitrogen was the carrier gas at a flow rate of 1.2 mL/min. Oven temperature was programmed from 40 to 80 °C at a rate of 2 °C/min with an initial hold time of 10 min; oven temperature was then further increased to 200 °C at a rate of 5 °C/min with a final hold time of 10 min. MSD conditions were as follows: capillary direct interface temperature, 200 °C; ion source temperature, 200 °C; ionization voltage, 70 eV; mass range 33−300 amu; electron multiplier voltage, 2200 V; and scan rate, 1.6 scans/s.

Compound Identification. Peak identifications were based on GC retention indices (RI) (Schomburg and Dielmann, 1973) and mass spectra of unknowns compared with those of authentic standard compounds under identical conditions. Tentative identifications were based on standard MS library information (HP 59944A MS Chem Station, Hewlett-Packard Co.) or by RI comparison with standard compounds.

Quantitative Analysis. Fresh juice was divided into three 100 mL aliquots. Each aliquot was spiked with 0.1 μL of amyl formate as internal standard (IS) using a series 7101 syringe (Hamilton Co., Reno, NV) and stored at 0 °C until analyzed. Each juice sample was analyzed in triplicate, with all analyses being complete within 10 h of sample preparation. P&T/GC conditions were the same as given previously except for the following: the GC system consisted of a Hitachi G-3000 GC (Tokyo, Japan) equipped with an FID and a 60-m × 0.32-mm-i.d. × 0.25-μm df J&W DB-1 column, and nitrogen carrier gas was used at a flow rate of 1.2 mL/min. The FID temperature was 250 °C, and the amplitude range was set for high sensitivity. Data were recorded and analyzed using a Hitachi D-2500 integrator. The concentration of each component was calculated using calibration curves of analyte/IS area (or peak height) ratio versus concentration of analyte.

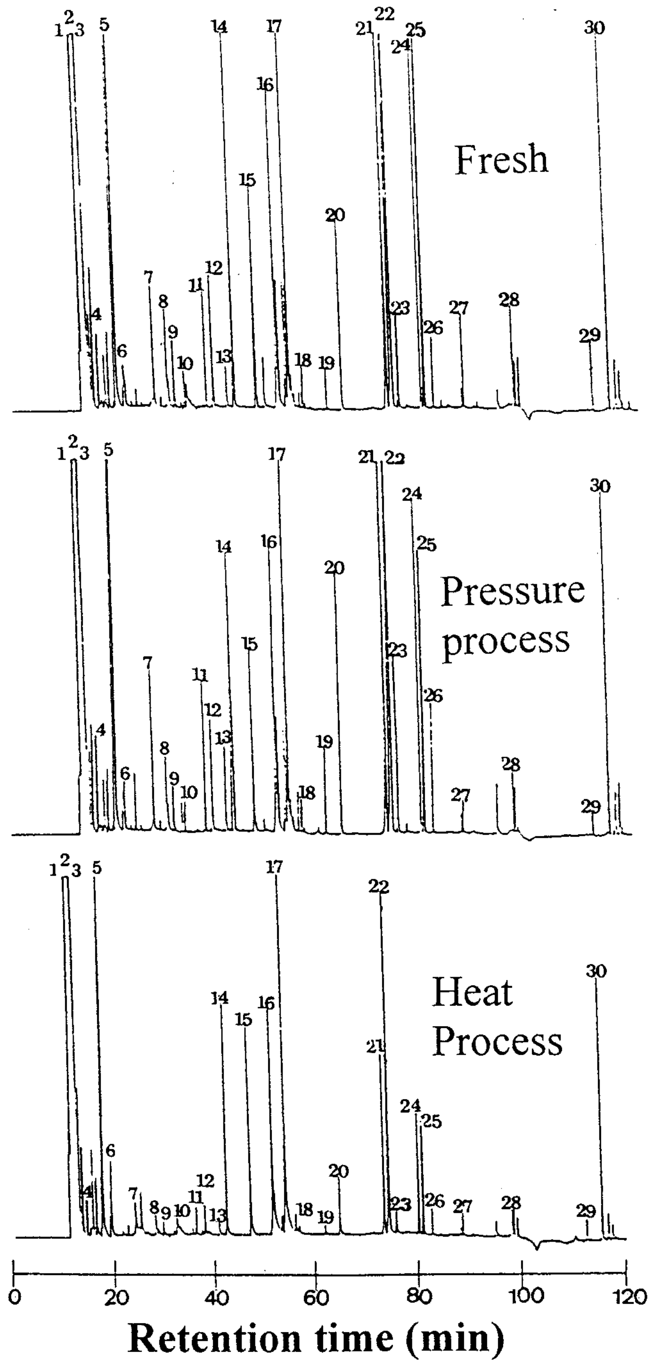

Figure 1. GC profile of volatile compounds in fresh, heated-processed, and pressure-processed guava juice.

RESULTS AND DISCUSSION

The GC profiles of volatile compounds were recorded from fresh, pressure-processed and heat-processed guava juices extracted by the P&T system (Figure 1). Major volatile compounds (30) were identified by MS analysis, including 4 alcohols, 10 esters, 4 aldehydes, 3 ketones, 8 terpene hydrocarbons, and 1 miscellaneous compound (Table 1). The volatile components of juice samples extracted by the P&T system were partiall; however, they could be used as the indicator for the volatile composition of the juice (Chyau et al., 1989; Cadwallader and Xu, 1994).

Table 1. Distribution of Identified Volatile Components in Guava Juice[a]

peak[b]	volatile component	Kovats index[c] (DB-1)	MW
	Alcohols		
1	methanol	<500	32
2	ethanol	506	46
3	*tert*-butyl alcohol	514	74
16	1-hexanol	862	102
22	benzyl alcohol	994	108
	Esters		
5	ethyl acetate	609	88
6	methyl 1-propionate	621	102
8	propyl acetate	665	102
10	methyl 1-butyrate	704	102
13	ethyl 1-butyrate	784	116
14	isobutyl acetate	804	116
18	methyl 1-hexanoate	902	130
20	ethyl 1-hexanoate	954	144
21	(*E*)-3-hexenyl acetate	988	142
30	(*Z*)-hexenyl fumarate	1162	198
	Aldehydes		
4	2-methylpropanal	538	72
9	1-pentanal	678	86
12	1-hexanal	768	100
26	3,5,5-trimethylhexenal	1046	142
	Ketones		
11	2-pentanone	751	86
28	acetophenone	1091	120
	Hydrocarbons		
15	1,4-dimethylbenzene	844	106
17	styrene	883	104
19	α-pinene	934	136
23	1,8-cineole	1001	154
24	(*Z*)-ocimene	1028	136
25	(*E*)-ocimene	1037	136
27	γ-terpinene	1063	136
29	1-dodecane	1146	170
	Miscellaneous Compound		
7	2-ethylfuran	656	96

[a] Guava juice (30%) was adjusted to pH 3.8 and 12 °Brix. [b] The peak numbers correspond to the numbers in Figure 1. [c] Retention indices, using paraffin (C_5-C_{25}) as references.

Table 2. Changes in Volatile Components of Fresh Guava Juice[a] during Storage at 4 °C

		concentration (μg/kg)		
			storage time	
peak[b]	volatile component	fresh[c]	30 days	60 days
	Alcohols			
1	methanol	535	1593	2263
2	ethanol	1211	3941	4831
3	*tert*-butyl alcohol	481	933	419
16	1-hexanol	207	161	92
22	benzyl alcohol	910	843	213
	Esters			
5	ethyl acetate	3066	3413	2381
6	methyl 1-propionate	94	299	176
8	propyl acetate	55	47	53
10	methyl 1-butyrate	35	64	34
13	ethyl 1-butyrate	42	81	21
14	isobutyl acetate	1414	679	133
18	methyl 1-hexanoate	27	20	<5
20	ethyl 1-hexanoate	311	243	61
21	(*E*)-3-hexenyl acetate	845	491	112
30	(*Z*)-hexenyl fumarate	446	317	91
	Aldehydes			
4	2-methylpropanal	46	41	69
9	1-pentanal	33	17	<5
12	1-hexanal	67	47	25
26	3,5,5-trimethylhexenal	44	21	15
	Ketones			
11	2-pentanone	52	37	53
28	acetophenone	33	13	<5
	Hydrocarbons			
15	1,4-dimethylbenzene	35	11	9
17	styrene	416	311	127
19	α-pinene	18	12	<5
23	1,8-cineole	194	141	24
24	(*Z*)-ocimene	336	269	45
25	(*E*)-ocimene	312	246	65
27	γ-terpinene	36	10	<5
29	1-dodecane	44	26	7
	Miscellaneous Compound			
7	2-ethylfuran	116	146	484

[a] Freshly extracted guava juice (30%, pH 3.8, 12 °Brix) with no further treatment (heating or pressurization). Values are the average of three replicates. [b] The peak numbers correspond to the numbers in Figure 1. [c] Before storage.

Figure 1 shows that the volatile component during high-pressure treatment was not changed when compared with the fresh fruit juice. It seems that high-pressure treatment maintains the volatile components and compositions of the juice. Ogawa et al. (1989) and Takahashi et al. (1993) indicated that the citrus juice maintained the freshness and the original flavor during high-pressure processing. Kimura et al. (1994) compared the volatile flavor components of strawberry jams during high-pressure processing and pasteurization and reported that high-pressure processing did not change the volatile components; however, concentrations decreased drastically during storage at room temperature. This result corresponded to our study. Most of the volatile components in the guava juice were lost during pasteurization at 95 °C for 5 min (Figure 1). The total volatile flavor contents dropped from 11.5 to 7.3 mg/kg during heating; thus, the flavor was changed. Kimura et al. (1994) reported that during the pasteurization of jam a large amount of volatile components diminished and some unknown components appeared. In our study, no new creations appeared, and it was inferred that the change of the flavor was affected by the change in concentration of each component.

Esters were the major volatile fraction in guava juice, and alcohols were the second (Table 2). Among these components, ethyl acetate presented the largest amount (peak 5). It can be observed in Figure 1 and Table 2 that the major esters were ethyl acetate (peak 5), isobutyl acetate (peak 14), ethyl 1-hexanote (peak 20), and (*E*)-3-hexenyl acetate (peak 21). Ethyl 1-hexanoate was considered the important flavor component in guava juice (Macleod and Troconis, 1982). Chyau et al. (1989) reported that the flavor in the juice processed with pectinase was not different from the fresh juice except there were minor difference in the contents, which corresponded to our study. Nishimura et al. (1989) indicated that the major volatile components in canned guava juice were C_6 compounds. The volatile components extracted in our study with the P&T apparatus were composed mainly of such low molecular weight compounds. Chyau et al. (1992) discovered that the major components in matured guava fruit were 1,8-cineole and hexanal; however, in the fully ripe guava fruit, the flavor components were composed mainly of ethyl 1-hexanoate and (*E*)-3-hexenyl acetate. Our study also identified those compounds. Nevertheless, Macleod and Trocnis (1982) claimed that no individual component could represent the unique flavor of guava, which was the performance of various flavor components.

The alcohol contents of the untreated guava juice increased along with the storage period at 4 °C (Table

Table 3. Effects of Pressure Processing and Storage on the Changes in Volatile Components of Guava Juice[a]

		concentration (μg/kg)					
				storage temp, time			
peak[b]	volatile component	fresh[c]	pressurized[d]	4 °C, 30 days	4 °C, 60 days	25 °C, 30 days	25 °C, 60 days
				Alcohols			
1	methanol	535	520	525	820	1115	1863
2	ethanol	1211	1189	1299	2637	3374	4223
3	*tert*-butyl alcohol	481	431	416	344	341	182
16	1-hexanol	207	208	182	170	154	86
22	benzyl alcohol	910	915	810	416	735	115
				Esters			
5	ethyl acetate	3066	3210	3026	3315	3228	1145
6	methyl 1-propionate	94	92	183	144	242	187
8	propyl acetate	55	50	60	45	46	21
10	methyl 1-butyrate	35	26	66	76	56	77
13	ethyl 1-butyrate	42	61	62	79	29	<5
14	isobutyl acetate	1414	1013	984	417	227	45
18	methyl 1-hexanoate	27	31	35	<5	<5	<5
20	ethyl 1-hexanoate	311	328	312	143	<5	<5
21	(*E*)-3-hexenyl acetate	845	744	725	531	348	110
30	(*Z*)-hexenyl fumarate	446	412	388	244	154	127
				Aldehydes			
4	2-methylpropanal	46	62	53	41	44	16
9	1-pentanal	33	23	25	11	19	<5
12	1-hexanal	67	62	62	43	33	20
26	3,5,5-trimethylhexenal	44	48	49	45	25	<5
				Ketones			
11	2-pentanone	52	24	28	11	24	53
28	acetophenone	33	24	25	17	<5	<5
				Hydrocarbons			
15	1,4-dimethylbenzene	35	17	11	12	12	9
17	styrene	416	400	356	236	158	127
19	α-pinene	18	14	19	<5	<5	<5
23	1,8-cineole	194	212	166	121	42	24
24	(*Z*)-ocimene	336	339	228	219	179	45
25	(*E*)-ocimene	312	321	305	143	215	85
27	γ-terpinene	36	16	15	<5	<5	<5
29	1-dodecane	44	34	31	<5	27	7
				Miscellaneous Compound			
7	2-ethylfuran	116	131	102	149	228	474

[a] Guava juice (30%) was adjusted to pH 3.8 and 12 °Brix. Values are the average of three replicates. [b] The peak numbers correspond to the numbers in Figure 1. [c] Freshly extracted juice with no further treatment (heating or pressurization). [d] Guava juice treated at 25 °C and 600 MPa for 15 min before storage.

2). During 60 days of storage, the alcohol contents increased from 3.3 to 7.8 mg/kg, and the other volatile components decreased. Methanol (peak 1), ethanol (peak 2), and *tert*-butyl alcohol (peak 3) increased during storage for 30 days. The increases in methanol and ethanol of the juice might be due to the action of microbes and enzymes in the juice. In this situation, the action of pectinase (PE) to pectin and the fermentation with yeast produced the methanol and ethanol, respectively. The reaction between ethanol and acetate produced ethyl acetate, which caused the increase of the amount of ethyl acetate at 30 days of storage. 2-Ethylfuran (peak 7) also increased during storage; this compound might be the browning intermediate of the sugar decomposition. Besides these components, the other volatile components decreased during the storage period. The major components, esters, decreased from 6.3 to 3.1 mg/kg during the storage for 60 days. Likewise, the total hydrocarbons also decreased from 1.4 to 0.3 mg/kg. The contents of aldehydes and ketones were not rich, and they were not effective in changing the guava juice flavor. Hence, for the untreated juices, the concentrations of methanol and ethanol increased, but most of the volatile components decreased gradually, which could be the result of the actions of residual microbes or enzymes in the juice.

The volatile components of the juice during high-pressure processing and storage at 4 and 25 °C are reported in Table 3. It was observed that the total volatile contents decreased from 10.9 to 10.5 mg/kg during the storage at 4 °C for 30 days. The total alcohols or esters as well as the contents of individual components were relatively close after the storage at 4 °C for 30 days. Hence, it was found that the quality of the juice stored at 4 °C for 30 days maintained the flavor stability. This phenomenon was due to partial inhibition of enzymes in pressure-processed juice. After the storage at 4 °C for 60 days, the changes in volatile components were characterized by the increase in alcohols. Among the components, the contents of methanols (peak 1) and ethanols (peak 2) increased; this was attributed to the functioning of enzymes. The complete sterilization of microbes during high-pressure processing, the activities of enzymes, was not completely inhibited (Yen et al., 1996). The rupture of microorganisms caused the releasing of enzymes, which also affected the stabilization of juices. Yen et al. (1992) studied the changes of volatile flavor components during the processing of guava puree and frozen storage and indicated that residual enzymes in the puree caused the incessant changes. Thus, it is clear that the changes in flavor components of pressurized juice are not due to the postprocessing contamina-

Table 4. Effects of Heat Processing and Storage on the Changes in Volatile Components of Guava Juice[a]

		concentration (μg/kg)					
				storage temp, time			
peak[b]	volatile component	fresh[c]	heated[d]	4 °C, 30 days	4 °C, 60 days	25 °C, 30 days	25 °C, 60 days
				Alcohols			
1	methanol	535	317	325	346	383	498
2	ethanol	1211	1117	987	683	517	317
3	*tert*-butyl alcohol	481	454	480	354	370	254
16	1-hexanol	207	189	166	185	119	62
22	benzyl alcohol	910	631	628	351	575	318
				Esters			
5	ethyl acetate	3066	2151	2569	1951	2388	1751
6	methyl 1-propionate	94	84	175	459	204	121
8	propyl acetate	55	16	28	47	35	38
10	methyl 1-butyrate	35	26	24	33	44	<5
13	ethyl 1-butyrate	42	28	27	28	34	25
14	isobutyl acetate	1414	884	892	744	735	415
18	methyl 1-hexanoate	27	95	85	75	82	44
20	ethyl 1-hexanoate	311	84	102	93	115	63
21	(*E*)-3-hexenyl acetate	845	321	303	316	275	141
30	(Z)-hexenyl fumarate	446	122	115	119	102	95
				Aldehydes			
4	2-methylpropanal	46	37	35	11	36	17
9	1-pentanal	33	16	15	<5	<5	<5
12	1-hexanal	67	21	25	15	23	7
26	3,5,5-trimethylhexenal	44	11	14	12	9	<5
				Ketones			
11	2-pentanone	52	11	<5	<5	<5	<5
28	acetophenone	33	10	75	11	15	7
				Hydrocarbons			
15	1,4-dimethylbenzene	35	<5	16	<5	15	11
17	styrene	416	325	299	312	205	65
19	α-pinene	18	<5	<5	<5	<5	<5
23	1,8-cineole	194	37	34	27	25	11
24	(*Z*)-ocimene	336	113	108	97	131	46
25	(*E*)-ocimene	312	96	87	93	75	55
27	γ-terpinene	36	11	8	12	12	7
				Miscellaneous Compound			
7	2-ethylfuran	116	48	45	66	142	185

[a] Guava juice (30%) was adjusted to pH 3.8 and 12 °Brix. Values are the average of three replicates. [b] The peak numbers correspond to the numbers in Figure 1. [c] Freshly extracted juice with no further treatment (heating or pressurization). [d] Guava juice treated at 95 °C for 5min before storage.

tion; they are possibly due to the enzymatic reactions. Compared with the untreated juice, pressure-processed juice showed better stability (Table 2). Significant changes were observed in the pressure-processed juice during the storage at 25 °C for 30 days when compared with at 4 °C. Methanol, ethanol, ethyl acetate, methyl 1-propionate, and 2-ethylfuran increased while the other components decreased in the pressured-processed juice stored at 25 °C for 30 days. The total volatile drastically decreased from 10.9 to 7.3 mg/kg during storage at 25 °C for 60 days. At this storage condition, all flavor components gradually decreased except methanol, ethanol, and 2-ethylfuran increased.

Table 4 shows the changes of volatile components of heated guava juice during processing and storage at 4 and 25 °C. There were no novel flavor components appearing in the guava juice, so the changes in flavor can be attributed to the individual flavor components. Nevertheless, the organic acids produced by enzymes and microorganisms were not extracted with the P&T apparatus. The volatile contents of the heated guava juices increased slightly from 7.3 to 7.6 mg/kg after 30 days of storage at 4 °C, whereas the contents decreased to 7.6 mg/kg during storage for 60 days. Compared with untreated and pressure-processed juices (Tables 2 and 3), the volatile components of heated juice were more stable. The stability was attributed to the complete microbial sterilization and enzyme inhibition, which corresponded to the stable contents of methanol and ethanol. During the storage at 25 °C, the total volatile contents decreased from 7.3 to 6.7 mg/kg and to 4.6 mg/kg after 30 and 60 days, respectively. The decreases were not subjected to the effects of microorganisms or enzymes. In contrast, the decrease was caused by the slow hydrolysis in the acidic conditions of guava juice. Additionally, the package vessel for the heated sample was not completely sealed, which also led to the loss of volatile components during storage.

The analysis adopted in our study was inclined to identify molecules of low molecular weight with retention indices around 1200. Badings (1985) indicated that P&T could be applied to identify the flavor components and make the flavor profile, which corresponded to the profile perceived by human beings. Our study applied the on-line analysis, which did not cause a loss of flavor during extraction and separation, and no artifacts appeared. Hence, the on-line analysis was very suitable for detection of the changes of volatile materials during processing. According to these results, the volatile components of pressure-processed guava juice were similar to those of the fresh guava juice; hence, high-pressure processing could maintain the original flavor distribution of the juice. This result was also confirmed by a sensory evaluation test (data not shown). High-pressure processing could not completely inhibit the enzymes, so the volatile components gradually changed, especially in the juices stored at 25 °C. In the present study, it was observed that the volatile flavor components of pressure-processed guava juices stored at 4 °C for 30 days maintained conditions close to those of fresh juices. The loss of volatile flavor components was significant after heating at 95 °C for 5 min. Heating at 95 °C for 5 min inhibited most of the enzymes and microbes in the juices, which kept the volatile flavor stable; however, the flavor distribution was not like that of the original condition.

CONCLUSION

No artifacts were observed in the guava juices during high-pressure treatment or heating. High pressure (25 °C, 600 MPa, 15 min) maintained the original flavor. However, during storage, the changes of volatile flavor components were significant, which could be attributed to the partial inhibition of enzymes, especially at 25 °C. Heating at 95 °C for 5 min caused the loss of most flavor components. Nevertheless, because of the complete sterilization of microorganisms and the good inhibition of enzymes, the flavor did not change much during storage. Guava juices treated with high pressure (600 MPa, 15 min) and then subjected to storage at 4 °C for 30 days maintained a volatile component profile similar to that of the fresh juice.

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