International Food Research Journal 23(Suppl): S101-S106 (December 2016)
Journal homepage: *http://www.ifrj.upm.edu.my*

Effect of blending ratio on quality of fresh pineapple (*Ananas comosus L.*) and mango (*Mangifera indica L.*) juice blends

[1]Kamarul Zaman, A. A., [1*]Shamsudin, R. and [2]Mohd Adzahan, N.

[1]*Department of Process and Food Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia*
[2]*Department of Food Technology, Faculty of Food Science and Technology, Universiti Putra Malaysia. 43400 Serdang, Selangor, Malaysia*

Article history

Received: 12 October 2016
Received in revised form: 17 9 November 2016
Accepted: 11 October 2016

Keywords

Juice blends
Physicochemical properties
Fresh
Mango
Pineapple

Abstract

Quality and alimental contents of single fruit juice can be ameliorated through mixing or blending process with other fruit juices. Pineapple and mango are the most popular tropical fruits in Malaysia with good characteristic taste. Color properties of pineapple and mango juice blends at ratio of 70P:30M; 50P:50M; 30P:70M was evaluated in term of L*, a*, b* hue, Chroma, color difference (ΔE). Blends ratio 70P:30M juice give the best color performance in terms of hue, chroma and ΔE. Physicochemical properties of juice blends ratio of 70P:30M also give more perishable results of pH (4.32) titratable acidity (0.66% malic acid), total soluble solid (13.67), vitamin C (54.25 mg ascorbic acid/100 ml), and turbidity (438 NTU).

Introduction

Pineapple is among the most important tropical fruit apart from banana, passion fruit, and mango. Moris, Gandol (N19), Sarawak, MD2, Josapine and Maspine are varieties of pineapple available in Malaysia (Taufiq *et al*., 2015). Pineapple commonly consumed fresh or processed into other product such as nectar and juice due to its pleasant aroma and flavor (Laorko *et al*., 2013). Pineapple juice generally drinkable in the form of single-strength or concentrated, and blend for development of new flavors for beverages and other new products due to its strong acid flavor (De Carvalho *et al*., 2007; Jan *et al*., 2012; Shamsudin *et al*., 2014). Fresh pineapple juice pH and total soluble solids were in the range of 3.5-4.0 and 12.2-14.2 °Brix respectively (Laorko *et al*., 2013). Studies by Shamsudin *et al*. (2007) found the fresh pineapple juice of Josapine variety total soluble solid, pH, titratable acidity, lightness (L*) were 12.08 °Brix, 3.81, 0.9% citric acid and 40.9 respectively.

Mango known as king of tropical fruits due to its succulence, sweet taste, and exotic flavor (El-Mansy *et al*., 2005) with good source of ascorbic acid, phenolic compound and other dietary antioxidants (Kondapalli *et al*., 2015). Chokanan mango is one of popular cultivar grown in Malaysia (Santhirasegaram *et al*., 2013) alongside Harumanis, Maha, Golek and Apple mango. Chokanan mango yields off-season flowering without chemical initiation (Santhirasegaram *et al*., 2015a) with harvests time in May, June and August enabling it to be processed into products such as juice, nectar and puree (Spreer *et al*., 2009). pH, total soluble solid, titratable acidity, L*, ascorbic acid content of fresh Chokanan mango were 4.62±0.02, 14.67±0.06 °Brix, 0.20±0.02% citric acid, 70.28±0.05 and 8.91±0.51 mg/100ml respectively (Santhirasegaram *et al*., 2015a).

Juices are liquid form of non-alcoholic product with degree of clarity and viscosity produced through pressing of fruits with or without added of sugar or carbon dioxide (Costescu *et al*., 2006). Fruit juice may be extracted directly from fresh fruits or obtained from reconstitution of fruits concentrate (Ratih, 2013). According to Vasada (2002), fruit juice becomes among important trade commodities in most countries. Fruit juice formed using few fruits also known as juice blend. In recent year blends of fruit juices have been extensively marketed due to its unique, palatable flavor (Jan and Masih, 2012). Juice blend is one of the best methods to improve the nutritional quality of the juice. Juice blends can be produced from various fruits in order to combine the basic nutrients present, giving better quality juice nutritionally and organoleptically (Akusu *et*

*Corresponding author.
Email:*rosnahs@upm.edu.my*

al., 2016). De Carvalho *et al*. (2007) also added, vitamins and mineral content of fruit juices can be improved depending on the kind and quality of fruits and vegetables used in the blends. Blending ratio of mixed fruit juice plays important key role in the juice quality either chemically or physically. Chemical composition in fruit juice includes the vitamins, acids, sugars, polysaccharides, pectin, cellulose, polyphenols and minerals contained (Leahu *et al*., 2013). Previous research on pineapple shows pineapple has lower pH value than mango juice which is around 3.5 and 4.5 respectively (Bates *et al*., 2001; Pelegrine *et al*., 2002; Deka *et al*., 2005). Higher ratio of orange juice (70% orange: 30% pineapple) in orange-pineapple juice blends reduced the sugar content and increase the vitamin C content of the juice blends (Akusu *et al*., 2016). Similarly, pineapple-carrot-orange juice blends at blending ratio of 80:10:10 (pineapple: carrot: orange) results with highest vitamin C content (46.90 mg ascorbic acid/ 100ml juice) compare to ratio of 60:10:30 (41.30 mg ascorbic acid/ 100ml juice) and 50:20:30 (45.40 mg ascorbic acid/ 100 ml). Apart from that, total soluble solid (TSS) of blends juices such as orange-carrot juice blends (Hashem *et al*., 2014), roselle-mango juice blends (Mgaya-Kilima *et al*., 2014), and lemon-melon juice blend (Kaya *et al*., 2015) increase from 12.50 to 13.38°Brix, 5.7 to 14.0°Brix and 8.60 to 8.72 respectively. Blending ratio of mixed fruit juices also affect the overall juice acceptance (taste and appearance). Adubofour *et al*. (2016) studies on carrot-MD2 pineapple juice blends results with colour of higher carrot juice ratio (70% carrot) in the blends less appealing to panelist during sensory evaluation. Thus, the aim of this research was to determine the effect of blending ratio on the quality of freshly blends pineapple-mango juices.

Materials and Methods

Materials

Pineapple of Josapine variety and mango of Chokanan variety were obtained from supplier plantation farm in Muar, Johor and Bidor, Perak respectively. Both fruits were peeled, washed and cut into pieces before the single strength juice extract using juice extractor (Power Juice, Smart ShopTM, US). Both single strength juice of pineapple and mango centrifuge at 9000 rpm for 15 minutes using centrifuge (Benchtop Centrifuge, Universal 320/320 R, Hettich Zentrifugen, Germany) to obtain clear juice. Pineapple and mango juice then, mixed according to the following blending ratio (Table 1):

Table 1 Blending ratio of pineapple and mango juices

Ratio	100P:0M	70P:30M	50P:50M	30P:70M	0P:100M
Pineapple	100	70	50	30	0
Mango	0	30	50	70	100

P and M were pineapple and mango respectively

Color measurement

Color measurement performed using Spectrophotometer UltraScan Pro (D65 Hunter Lab, USA) to obtains values of L*, a*, b*. L* measured the darkness (black, 0 to white, 100) while a* measure range color from -a*(greenness) to +a*(redness), b* for blueness (-b*) to yellowness (+b*). Hue angle (h*), chroma and color change (ΔE) determined based on a* and b* value obtained.

$$\text{Hue angle} = \tan^{-1}(b^*/a^*)$$
$$\text{Chroma} = \sqrt{(a^{*2}+b^{*2})}$$
$$\Delta E = \sqrt{(\Delta L^{*2}+\Delta a^{*2}+\Delta b^{*2})}$$

pH and total titratable acidity (TTA)

pH was measured using pH meter (pH 200, HM Digital, Korea). Titratable acidity measured as percentage of malic acid (Scott *et al*., 2001) using AOAC, 1995 method in which 10 ml of juice sample diluted with 40 ml distilled water, titrate with 0.1 mol/L of NaOH until pink precipitate form. The following equation was used to calculate the titratable acidity.

$$\%\text{malic acid} = (\text{ml NaOH used} \times 0.1\text{N NaOH} \times 0.067 \times 100)/\text{grams of sample}$$

Turbidity

The turbidity measurements were performed directly on the juices using turbidimeter (TN-100, Eutech, Singapore). The turbidimeter was calibrated using different formazine standard solution from 0.02 to 800NTU.

Total soluble solid (TSS)

Digital refractometer (AR-2008, Krus Germany) was used to measure the total soluble solid of juice in unit °Brix.

Vitamin C

The content of vitamin C of juice was determined through titration method with indicator dye of 2,6-dichloroindophenol (AOAC Method 967.21). Vitamin C expressed as mg ascorbic acid/ml of juice using the following mathematical model:

$$\text{mg ascorbic acid/ml juice} = (X-B) \times (F/E) \times (V/Y)$$

where:
X= average ml of sample titration
B= average ml for blank titration
F= titer dye (mg ascorbic acid equivalent to 1.0 ml indophenol standard solution)
E= ml assayed (2ml)
V= volume initial assay solution
Y= volume sample aliquot titrate

Results and Discussion

Color measurement

Color is crucial characteristic in food as consumer preference of acceptability. The color parameters of pineapple-mango juice blends shows in Table 2 in term of lightness (L*), a*, b*, angle hue, chroma and total color difference (ΔE). Predicated on the results, mango juice affect the color properties of L* but pineapple juice contributes more to color parameter of a* and b*. Initially, single pineapple and mango juice have L* of 26.60±0.01 and 29.47±0.03 respectively. L* value increases as mango ratio in juice blends increases from 70P:30M >50P:50M >30P:70M (27.16±0.02 >27.23±0.02 >28.27±0.01) but no significant different were observe among the different juice ratios (p>0.05). L* value of pineapple-mango juice blends follows the darker mango color, similar in roselle-mango juice blends which L* value of blends juice with higher ratio of roselle become darker as the roselle juice have higher L* of 42.4±0.8 compare to mango juice, 14.5±0.02 (Mgaya-Kilima *et al*., 2014). The results shows, as a* value higher the b* value lower causing the color closer to greenness and less yellow. 70P:30M have higher values of a* (-0.42±0) but lower b*(1.26±0.12) value compare to 30P:70M juice (a*, -0.65±0.14 and b*, 1.44±0.06). Juice blends at ratio 50P:50M shows the lowest a* (-0.40±0.11) and b*(1.15±0.08) values. The changes in color parameter of L, a* and b* may due to the particle size changes in the juice (Valero *et al*., 2007) as both pineapple and mango juices were subjected to mechanical process during extraction process. Different in color of homemade orange juice and industrial were highly contributed by extraction process that modified the pulp structure (Stinco *et al*., 2012).

Hue angle and chroma measured the color appearance properties, giving more information about the spatial color distribution (Goncalves *et al*., 2007). The results show (Table 1) the hue angle increase with increase in pineapple juice ratio from 30P:70M>50P:50M>70P:30M. Esteve and Frigola (2007) state that juice become redder and less yellow when the hue decremented. Thus, increment of pineapple volume results with more yellow color. In terms of chroma, juice of 70M: 30P (1.58±0.01) blending ratio have higher chroma value compare to juice blends at ratio 70P:30M (1.33±0.14) and 50P:50M (1.22±0.11). Whereas, there were no significant changes in ΔE of pineapple-mango juice blends at different blending ratio as fortified by Leahu *et al*. (2013), color did not change significantly in relation to the ratio of mixed juices.

Table 2 Color parameter of pineapple mango juice blends at different ratio

Juice ratio	L	a*	b*	Hue angle (h*)	Chroma	ΔE
100P:0M	26.60±0.01[a]	-0.56±0.08[a]	2.27±0.06[c]	76.13±1.74[a]	2.34±0.08[a]	26.70±0.00[a]
70P:30M	27.16±0.02[a]	-0.42±0.11[a]	1.26±0.12[a,b]	71.67±2.82[a,b]	1.33±0.14[b,c]	27.21±0.95[a]
50P:50M	27.23±0.02[a]	-0.40±0.11[a]	1.15±0.08[a]	70.66±3.45[a,b,c]	1.22±0.11[b]	27.26±0.0.02[a]
30P:70M	28.27±0.01[a]	-0.65±0.14[a]	1.44±0.06[b]	65.56±5.37[a,b,c]	1.58±0.01[c]	28.31±0.02[a]
0P:100M	29.47±0.03[a]	-1.10±0.06	2.17±0.09[c]	63.09±0.51[c]	2.43±0.11[a]	29.56±0.01[a]

Negative sign (-) showing the colour closer to green.

100P:0M, 70P:30M, 50P:50M, 30P:70M and 0P:100M were 100% pineapple, 70% pineapple: 30% mango, 50%pineapple: 50%mango, 30% pineapple: 70%mango and 100% mango respectively.

Column share the same superscript were not significantly different with each other (p>0.05)

Table 3 Physicochemical properties of pineapple-mango juice blends at different blending ratio

Juice ratio	100P:0M	70P:30M	50P:50M	30P:70M	0P:100M
pH	3.96±0.010	4.32±0.006	4.62±0.010	4.68±0.011	4.86±0.006
TA (g/L)	0.7±0.031[a]	0.66±0.026[a]	0.52±0.040[b]	0.46±0.055[b]	0.29±0.035
Turbidity (NTU)	435.34±0.025[a]	438.00±1.00a	752.00±1.00	774.00±1.00	798.00±1.00
TSS (Brix)	12.93±0.058	13.67±0.201[a]	13.9±0.100[a]	14.23±0.251[a]	15.20±0.200
Vitamin C (mg ascorbic acid/100ml)	75.25±0.132	54.25±0.061	38.5±0.080	45.25±0.184	50.75±0.109

100P:0M, 70P:30M, 50P:50M, 30P:70M and 0P:100M were 100% pineapple, 70% pineapple: 30% mango, 50%pineapple: 50%mango, 30% pineapple: 70%mango and 100% mango respectively.

Row share the same superscript were not significantly different with each other (p>0.05).

Physicochemical properties

Table 3 shows the physicochemical properties of pH, titratable acidity, turbidity, total soluble solids, and vitamin C content of pineapple-mango juice blends. pH of single pineapple juice (3.96±0.010) was lower than mango juice (4.86±0.006) as supported by antecedent study by Shamsudin *et al*. (2007), Chia *et al*. (2012) and Mansor *et al*. (2014) on pineapple juice and Santhirasegaram *et al*. (2013), Santhirasegaram *et al*. (2015a) and Santhirasegaram *et al*. (2015b) on mango juice. Higher ratio of pineapple juice in the blending ratio decrease the pH of pineapple-mango juice blends from 4.68±0.011 for 30P:70M to 4.62±0.010 for 50P:50M and to 4.32±0.006 for 70P:30M ratio. Similarly, blends of pineapple: carrot: orange of ratio 80:10:10 initially have pH of 4.21 reduce to 3.98 as volume of orange increase to blending ratio of 50:20:30. Sindumathi and Premalathe (2013) and Nidhi *et al*. (2008) also shows similar trends of pH change in papaya-pineapple blends and bael-guava blends respectively.

Titratable acidity (TA) of blends ratio 70P:30M, 50P:50M and 30P:70M were 0.66±0.026, 0.52±0.040, and 0.46±0.055 (%malic acid /g) respectively. TA of single mango juice (0.29±0.035% malic acid /g) increase as volume ratio of pineapple increase in the blends (Table 2). Similar to the study undertaken by Byanna and Doreyappa Gowda (2011) and Jan *et al*. (2012), the results showed that as pH values of juice blends decrease, TA increase. Results obtained also in agreement of pH and TA correlation with previous study by Chia *et al*. (2012). Incrementing of TA might due to conversion of acid into salts and sugar from juice particle as reported by Hashem *et al*. (2014).

The turbidity was directly effect by increase in mango juice ratio ($p<0.05$) result with cloudy appearance. Cloudy fruit juices contain colloidal suspension, flavor substances, and natural antioxidant such as carotenoids and polyphenol (Montenegro *et al*., 1995). Blending ratio of 30P:70M (774.00±1.00) more turbid compare to ratio of 70P:30M (438.00±1.00) and 50P:50M (752.00±1.00) may due to the greater breakdown of pectin in mango juice than in pineapple juice during processing (Quek *et al*., 2012). Turbidity mainly occurs due to polysaccharides such as starch, pectin, cellulose, and hemicellulose (Nagar *et al*., 2012). Extraction of pineapple and mango juice involved with mechanical process contribute to turbidity as mechanically blended roselle calyces results with higher turbidity compare to water extraction (Wong *et al*., 2013). This supported the earlier results of color parameter of L* in which higher volume ratio of mango turns the color to be darker. Blending ratio of 70P:30M results with more acceptable preference than the other blending ratio.

Total soluble solid (TSS) of fresh mango juice (15.20±0.200°Brix) was higher than pineapple juice (12.93±0.058°Brix) while juice ratio of 70P:30M, 50P:50M and 30P:70M, TSS were 13.67±0.201, 13.9±0.100, and 14.23±0.251 °Brix respectively. TSS contents in fruit juice were cognate directly to sugar and acids as low pH of juice are comparatively affluent in organics acids results in low TSS content (Tasnim *et al*., 2010). Since, pineapple was sour in taste, blending of pineapple and mango able to amend the taste of the blend juice. Increase in TSS after blending with higher ratio of mango juice might results from conversion of simple sugar from hydrolysis of polysaccharides like pectin, cellulose and starch (Jan and Masih, 2012; Sindhumathi and Premalatha, 2013).

Initial content of vitamin C in pineapple and mango juice were 75.25±0.132and 50.75±0.109mg ascorbic/100ml. Higher vitamin C value were found in juice blends with higher pineapple ratio (70P:30M, 54.25±0.061 mg ascorbic/100ml) compare to higher mango ratio (30P:70M, 45.25±0.184 mg ascorbic/100ml). Similarly, orange-kiwi juice blends with higher orange volume ratio (70 orange: 30 kiwi, 96.8 mg ascorbic acid/100ml) higher in vitamin C compare to blends of 30 orange: 70 kiwi (52.8 mg ascorbic acid/100ml) (Leahu *et al*., 2013). Decreased in vitamin C value in 50P:50M juice ratio might be due to presence of other antioxidants in both pineapple and mango juice. Vitamin C lack in stability and easily affected by light, oxygen, and temperature (Chia *et al*., 2012; Mansor *et al*., 2014). Juice blends of 70P:30M improved the vitamin C content of 100% mango juice.

Conclusion

The results obtained shows that it possible to improve the juice quality attributes by blending of pineapple and mango juice. Appearance quality namely color parameter and turbidity of pineapple and mango juice blends were amended as the blending ratio of pineapple increase in the blends. Different blending ratios of pineapple and mango juice were also contributed to different physicochemical quality of pH, titratable acidity, TSS of pineapple-mango juice blends. Predicated on this study blending ratio of 70P: 30M resulted with best quality of juice compare to others blending ratios with higher vitamin C content.

Acknowledgement

This research was supported by Postgraduate Grant (IPS) University Putra Malaysia [VOT9473900].

References

Adubofour, J., Amoah, I. and Ayiyi, R. D. 2016. Effect of blanching on physicochemical properties of chantenay carrots juice and assessing the quality of formulated carrot-MD2 pineapple juice blends. American Journal of Food Science and Technology 4(3): 81-88.

Akusu, O. M., Kiin-Kabari, D. B. and Ebere, C. O. 2016. Quality characteristic of orange/pineapple fruit juice blends. American Journal of Food Science and Technology 4(2): 43-47.

Bates, R. P. and Crandall, P. G. 2001. Principle and practices of small and medium-scale fruit juice processing. Rome: Food and Agriculture Organization of the United Nations.

Byanna, C. N. and Doreyappa Gowda, I. N. 2011. Standardization of sweet orange and pomegranate blended RTS beverage preparation and its storage. Crop Research Journals 4(1 and 2): 108-115.

Canitez, N. 2002. Pasteurization of apple cider with UV irradiation. Orono: University of Maine, MSc thesis.

Chia, S. L., Rosnah, S., Noranizan, M. A. and Wan Ramli, W. D.2012. The effect of storage on the quality attributes of ultraviolet irradiated and thermally pasteurised pineapple juices. International Food Research Journal 19(3): 1001-1010.

Costescu, C., Parvu, D. and Rivis, A. 2006. The determination of some physicochemical characteristic for orange, grapefruit and tomato juices. Journal of Agro Alimentary Processes and Technologies 12(2): 429-432.

De Carvalho, J. M., Maia, G.A. and De Figueredo, R. W. 2007. Development of a blended non-alcoholic beverage composed of coconut water and cashew apple juice containing caffeine. Journal Food Quality 30: 664-681.

Deka, B. C., Vijay, S. and Anata, S. 2005. Changes in quality of mango-pineapple spiced beverage during storage. Indian Journal of Horticulture 62(1): 71-75.

El-Mansy, H. A., Sharoba, A. M., Bahlol, H. E. L. M. and El-Desouky, A. I. 2005. Rheological properties of mango and papaya nectar blends. Annals of Agricultural Sciences, Moshtohor 43: 665-686

Esteve, M. J., Frigola, A., Rodrigo, C. and Rodrigo, D. 2005. Effect of storage period under variable conditions on the chemical and physical composition and colour of Spanish refrigerated orange juices. Food and Chemical Toxicology 43: 1413-1422.

Goncalves, B., Silva, A. P., Moutinho-Pereira, J., Bacelar. E., Rosa, E. and Meyer, A. S. 2007. Effect of ripeness and postharvest storage on the evolution of colour and the anthocyanins in cherries (Prunus avium L.). Food Chemistry 103: 976-984.

Hamerski, F., da Silva, V. R., Corazzo, M. L., Ndiaye, P. M. and de Aquino A.D. 2012. International Journal of Food Science and Technology 47: 422-428

Hashem, H., A., Sharaf, A. M., Amira, S. A. and Ibrahim, G. E. 2014. Food Science and Quality Management 33: 21-36.

Kaya, Z., Yildiz, S. and Ünlütür, S. 2015. Effect of UV-C irradiation and heat treatment on the shelf life of lemon-melon juice blend: multivariable statistical approach. Innovative Food Science and Emerging Technologies 29: 230-239.

Klim, M. and Nagy, S.1988. An improved method to determine non enzymatic browning in citrus juice. Journal of Agricultural and Food Chemistry 6(36): 1271-1274.

Kondapalli, N., Varakumar, S., Variyar, P. S., Sharma, A. and Reddy, O. V. S. 2015. Enhamcing antioxidant activity, microbial and sensory quality of mango (*Mangifera indica L.*) juice by ɣ-irradiation and its in vitro radioprotective potential. Journal of Food Science and Technology 52: 4054-4065.

Jan, A. and Masih, E. D. 2012. Development and quality evaluation of pineapple juice blend with carrot and orange juice. International Journal of Scientific and Research Publication 2(8): 1-8.

Laorko, A., Tongchitpakdee, S. and Youravong, W. 2013. Storage quality of pineapple juice non-thermally pasteurized and clarified by microfiltration. Journal of Food Engineering 116: 554-561.

Leahu, A., Damian, C., Oroian, M. and Ropciuc, S. 2013. Physico-chemical parameters of fruit juices evolution during storage. University of Agricultural Sciences and Veterinary Medicine Lasi 59: 213-218.

Mansor, A., Shamsudin, R. and Mohd Adzahan, N. 2014. Effect of ultraviolet (UV-C) radiation as non-thermal treatment on physico-chemical and microbiological properties of pineapple (Ananas cosmosus) variety MD2 juice. Food Innovation Asia Conference 16. Bangkok, Thailand: Food Research and Innovation for Sustainable Global Prosperity.

Mygaya-Kilima, B., Remberg, S. F., Chove, B. E. and Wicklund, T. 2014. Physicochemical and antioxidant properties of roselle-mango juice blends; effects of packaging material, storage, temperature and time. Food Science and Nutrition 3: 100-109.

Montenegro, I., Maia, G. A. and Figueiredo R. W. 1995. Physical-chemical changes during extraction and clarification of guava juice. Food Chemistry 54: 383-386.

Nidhi, Gehlot, R., Singh, R. and Rana, M. K. 2008. Change in chemical composition of ready-to-serve bael-guava blended beverage during storage. Journal of Food Science and Technology 45: 378-380.

Nagar, S., Mittal, A. and Gupta, V. K. 2012. Enzymatic clarification of fruit juices (apple, pineapple and tomato) using purified Bacillus pumilus SV-85S xylanase. Biotechnology and Bioprocess Engineering 17: 1165-1175.

Pelegrine, D. H., Silva, F. C. and Gasparetto, C. A. 2002. Rheological behavior of pineapple and mango pulps. Food Science and Technology 35(8): 645-648.

Quek, M. C., Chin, N. L. and Yusof, Y. A. 2012. Optimization and comparative study on extraction methods of soursop juice. Journal of Food, Agricultural and Environment 10(3 and 4): 245-251.

Ratih, D. H. 2013. Microbiological quality and safety of fruit juices. Food Review International 1: 54-57.

Santhiraseragam, V., Razali, Z. and Somasundram, C. 2013. Effects of thermal treatment and sonication on quality attributes of Chokanan mango (Magnifera indica L.) juice. Ultrasonic Sonochemistry 20: 1276-1282.

Santhiraseragam, V., Razali, Z., George, D. S. and Somasundram, C. 2015a. Effects of thermal and non-thermal processing on phenolic compounds, antioxidant activity and sensory attributes of Chokanan mango (Magnifera indica L.) juice. Food Bioprocess Technology 8: 2256-2267.

Santhiraseragam, V., Razali, Z., George, D. S., and Somasundram, C. 2015b. Comparison of UV-C treatment and thermal pasteurization on quality of Chokanan mango (Magniferaindica L.) juice. Food and Bioproducts Processing 94: 313-321.

Scott, N. V., Clavero, S. R. and Troller, J. A. 2001. Compendium of methods for microbiological examination of food. In Downes, F. P and Ito, K. Measurement of water activity, acidity and Brix, p. 649-657. Washington D. C: American Public Health Association.

Shamsudin, R., Wan Daud, W. R., Takriff, M. S. and Hassan, O. 2007. Physicochemical properties of the Josapine variety of pineapple fruit. International Journal of Food Engineering 3(5): 1-12

Shamsudin, R., Noranizan, M.A., Yap, P.Y. and Atikah, M. 2014. Effect of Repetitive Ultraviolet Irradiation on the Physico-Chemical Properties and Microbial Stability of Pineapple Juice. Innovative Food Science and Emerging Technologies 23: 114-120

Siler, A. and Morris, J. R. 1993. Quality effects of carbonation and ethyl maltol on venus and concord grape juices and their grape-apple blends. American Journal of Enology and Viticulture 44(3): 320-326.

Sindumathi, G. and Premalatha, M. R. 2013. Development and storage studies of naturally flavored papaya-pineapple blended ready-to-serve (RTS) beverages. International Journal of Science and Research (IJSR): 856-860.

Stinco, C. M., Fernández-Vázquez, R., Escudero-Gilete, M. L., Heredia, F. J., Meléndez-Martínez, A. J. and Vicario, I. M. 2012. Effect of orange juice's processing on the color, particle size, and bioaccessibility of carotenoids. Journal of Food Agricultural and Food Chemistry 60: 1447-1455.

Taufiq, A. M., Yusof, Y. A., Chin, N. L., Othman, S. H., Serikbaeva, A. and Aziz, M. G. 2015. Physicochemical properties of tamarind and pineapple fruit pulps and powders. International Food Research Journal 22(2): 707-712.

Wong, P. K., Yusof, S., Ghazali, H. M. and Che Man, Y. B. 2003. Optimization of hot water extraction of roselle juice using response surface methodology: A comparative study with other extraction methods. Journal of Science and Food Agricultural 12(83): 1273-1278.

Valero, M., Recrosio, N., Saura, D., Munoz, N., Marti, N. and Lizama, V. 2007. Effect of ultrasonic treatment in orange juice processing. Journal of Food Engineering 80: 509-516.

Vasada, P. C. and Heperken, D. 2002. Non-thermal alternative processing technologies for the control of spoilage bacteria in fruit juice and fruit based drink. Food Safety Magazine 1(8): 10-13, 46-47.