International Food Research Journal 19 (3): 1211-1215 (2012)

Properties of canned mengkudu (*Morinda citrifolia L.*) extract during storage

Noor Hafizah, Y., *Maskat, M.Y., Wan Aida, W.M. and Maaruf, A.G.

Food Science Program, School of Chemical Science and Food Technology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

Abstract: Storage study of mengkudu (*Morinda citrifolia L.*) extract was carried out to determine the effects of canning and storage period on pH, total polyphenol content, antioxidant activity, intensity of off-odour and aroma acceptance. Uncanned (control) and canned extract were stored for 0, 8, 16 and 24 weeks under room temperature. Results showed canning resulted in a significant ($p<0.05$) reduction in pH, total polyphenol content, antioxidant activity and off-odor intensity. However, canning also resulted in a significantly ($p<0.05$) higher aroma acceptance. pH and antioxidant activity were significantly ($p<0.05$) affected by storage period. However, for both control and canned extract, storage period did not significantly ($p>0.05$) affect total polyphenol content during 24 weeks of storage.

Keywords: ***Morinda citrifolia L.,*** **canning, storage, antioxidant activity, odour**

Introduction

Mengkudu (*Morinda citrifolia L.)*, originates from Southeast Asia such as Indonesia and Australia (Nelson, 2003). In 2002, mengkudu juice was accepted in the European Union as a novel food (European Commission, Scientific Committee for Food, 2002). In the tropics, mengkudu is much valued medicinally and the plant is normally cultivated for its roots, leaves and fruits (Mohd Zin *et al*., 2002). For reasons that mengkudu is so much valued, uses and demand of mengkudu is not only high in its producing countries but also in other countries such as United States, Japan and Europe (Blanco *et al*., 2006).

Most mengkudu is consumed as extracts from its fruits although leaves, flowers, bark and roots were also used (Dixon *et al.*, 1999; McClatchey, 2002). Many studies have reported on the nutritional and health values of mengkudu (Dixon *et al.*, 1999; Saludes *et al.*, 2002; Mohd Zin *et al*., 2002; Wang and Su, 2001; McKoy *et al.*, 2002). Various methods of preservation could be applied during storage to ensure the shelf life stability of food. Heat treatment is a food preservation method that delivers convenience and ready-to-eat food products to consumers (Leonard *et al*., 1986; Guntensperger and Escher, 1994). Nevertheless, extreme processing to deactivate microorganism and enzymes to ensure the safety of product might reduce and destroy the nutritional values, colour, texture and taste and sensory quality of products as well (Leonard *et al.*, 1986; Kumar *et al.,* 2001).

Several studies have reported on the use of heat processing in the preparation of mengkudu extract such as boiling (Yang *et al*., 2007) and dehydration (Moniz, 1994). Although there are several reports on the use of heat during mengkudu processing, there are no studies carried out on the effects of canned mengkudu during storage on mengkudu extract. Canning and storage may promote undesirable chemical reactions in mengkudu extract that may affect the properties of mengkudu extract. Higher heating temperature during pasteurization of mengkudu extract has been reported to produce a significant reduction of clarity, viscosity and total polyphenol content (Maskat and Tan, 2011).

The period during storage is an important phase in producing safe and quality products. Several studies have reported on the changes occuring during period of storage. Bhupinder *et al*. (1991) reported increased acidity in ready-to-serve bottle of sugar-cane juice with increasing storage time. Jang et al. (2007) reported decreased total polyphenol content after 1 month storage of *C. cassia, C. longa* and *C. rhizoma* which might be due to chemical and enzymatic decomposition. Klimczak *et al*. (2007) also reported that total polyphenol content decreased during 4 months storage of local (Poznan´, Poland) commercial orange juice. Due to the limited information regarding the effect of canning and

*Corresponding author.
Email: *maskatmy@yahoo.com*

storage of mengkudu extract, this study was carried out to determine the effect of canning and storage period on pH, total polyphenol content, antioxidant activity and sensory evaluation.

Materials and Methods

Sample and juice extraction

Fresh mengkudu fruits used were obtained from Bandar Baru Bangi, Selangor. The fruits selected were at maturity stage 4 (hard white fruit) (Blanco *et al*., 2006). Fruits were ripened at room temperature for 2-3 days before extraction. Mengkudu fruits were washed using tap water and cut into small pieces approximately 2-4 cm. The mengkudu pieces were blended with distilled water at a ratio of 1:1 using a food blender (National, Malaysia). The blended mengkudu was then filtered using muslin cloth and centrifuged (Model Sorvall HS 23, Thermo Electron Corporation, U.S.A) at 5000 rpm at a temperature of 8ºC for 20 min.

Storage of mengkudu extract

For the canning process, the mengkudu extract was canned in a 3-piece metal can measuring 66 mm diameter, 92.34 mm length and 0.4 mm thick. The canned samples were heated at 121ºC for 36 min. Storage was carried out for 24 weeks at room temperature. Samples were taken every 8 weeks and analyzed for pH, total polyphenol content, antioxidant activity and sensory evaluation.

pH value

The pH value was measured using a pH meter (Model PHM 210, Radiometer Analytical, France). The pH meter was calibrated using pH 4 and pH 7 buffers. Measurement of pH value was done at room temperature using 10 ml of samples.

Total polyphenol content

Total polyphenol content (TPC) of the mengkudu extract was analysed according to AOAC (1995) using Folin-Ciocalteau reagent. Samples were diluted 10-fold with distilled water. The results were expressed in epicatechin acid equivalent (EAE) (ppm) based on a standard curve of epicatechin.

Antioxidant activity

Ferric thiocyanate method (FTC) adapted from Mohd Zin et al. (2002) was used. The results were shown as percentage (%) of antioxidant activity.

Sensory evaluation

Sensory evaluation for off-odour intensity and aroma acceptance was conducted using hedonic test. Fifty consumer panelists were used to evaluate both control and stored mengkudu extracts using a 9-point hedonic scale (Condelli *et al*., 2006). The anchor words for intensity of aroma were 'extremely weak' and 'extremely strong' while for the 'acceptance of aroma', the anchor words were 'extremely dislike" and 'extremely like', representing 1- and 9-point scale respectively. One ml of samples were prepared in a 20 ml amber bottle with a screw cap and labeled with random 3-digit codes to prevent any visual bias. Panelists were instructed to open the cap and smell the sample to evaluate.

Statistical analysis

For each measurement, three replications were performed. Data were analyzed by ANOVA and Duncan test using a statistical software (SAS version 6.12). Differences were reported as significant at $p<0.05$.

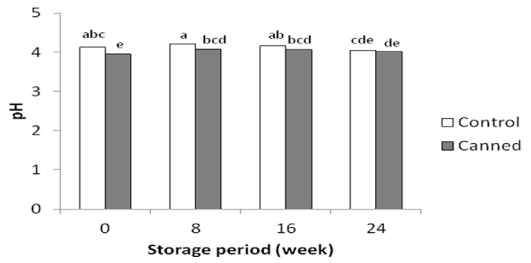
Results and Discussion

pH values

Figure 1 shows the effect of canning and storage period on pH value. Canned samples had a significantly ($p<0.05$) lower pH value after storage up to 8 weeks. Heat processing during canning may have contributed to the decrease in pH value. During fruit juice processing, changes and/or losses of certain compounds are likely to occur. The decreased pH may have been caused by chemical changes due to thermal degradation, Maillard reactions or oxidation induced by heating (Mikkelsen and Poll, 2002; Kato *et al*., 2003). Extending the storage beyond 8 weeks did not result in any significant difference in pH between both treatments. For the control sample, no significant changes in pH were observed up to 16 weeks of storage. After 24 weeks of storage, control extract showed a significant ($p<0.05$) reduction in pH compared to 8 and 16 weeks of storage. However, compared to 0 week, no significant ($p>0.05$) difference was observed. pH value for canned extract showed a significantly ($p<0.05$) higher pH after storage for 8 and 16 weeks. Storage of canned extracts for 24 weeks did not show any significant difference when compared to canned extracts stored for 0, 8 and 16 weeks.

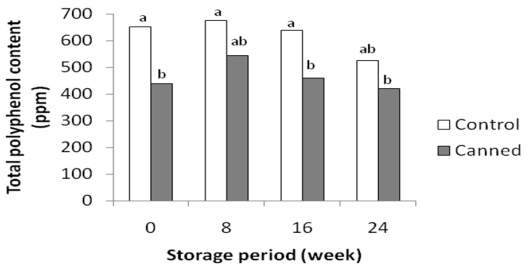
Total polyphenol content (TPC)

Mengkudu was reported to have a number of polyphenol compounds that contributed to their nutritional value (Wang and Su, 2001). Results (Figure 2) shows TPC was significantly ($p<0.05$) reduced after canning. Maskat and Tan (2010) also reported a decrease in TPC of mengkudu extract



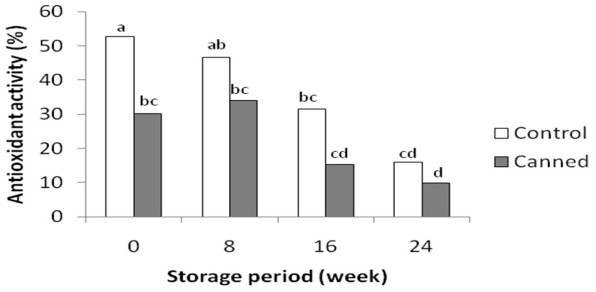
a-e : means with different letters indicate a significant difference at p<0.05

Figure 1. pH of control (uncanned) and canned mengkudu extract stored for 24 weeks.



a-b : means with different letters indicate a significant difference at p<0.05

Figure 2. Total polyphenol of control (uncanned) and canned mengkudu extract stored for 24 weeks.



a-d : means with different letters indicate a significant difference at p<0.05

Figure 3. Antioxidant activity of control (uncanned) and canned mengkudu extract stored for 24 weeks.

after heat treatment. Ciou *et al*. (2011) reported a significant ($p<0.05$) decrease in TPC when heating temperature of water caltrops was increased to 50ºC or higher. Results also showed a significantly ($p<0.05$) lower TPC for canned samples compared to control samples after 16 weeks of storage. However, no significant difference was observed between control and canned samples after 8 and 24 weeks of storage. For both control and canned samples, no significant effects of storage period were observed during 24 weeks of storage.

This fluctuation phenomenon was also reported by Piljac-Zegaract *et al.* (2009) from their study on dark fruits juice during frozen storage which showed increasing TPC for the first 13 days followed by a decrease and again increase at the end of storage on the 29th day. Similarly, in their study of polyphenolic content and antioxidant activity of orange juice during storage, Klimczak *et al*. (2007) first observed a decrease in the TPC after 4 months in storage, followed by a significant increase at the end of storage (6 months). Vinson *et al*. (2001) suggested that during storage, some compounds are formed which reacted with the Folin–Ciocalteu reagent and significantly enhance the phenolic content. This occurred because the Folin-Ciocalteu reagent lacks selectivity (Escarpa and Gonzalez 2001) resulting in it reacting not only with phenols but also with other reducing compounds such as carotenoids, amino acids, sugars and vitamin C (Vinson *et al*. 2001).

Antioxidant activity

Effects of canning and storage period on antioxidant activity are shown in Figure 3. Antioxidant activity decreased significantly ($p<0.05$) for control extract during 24 weeks of storage compared to 0 week. Yang *et al*. (2007) reported a similar reduction in antioxidant acitivity of mengkudu extract stored at room temperature for 3 months. Similar results showing the reduction of antioxidant activity were also reported by Klimczak *et al*. (2007) and Igual et al. (2010) during storage of orange juice and grapefruit juice, respectively. Antioxidant activity for mengkudu extract after canning showed no significant difference until 16 weeks of storage. Prolonged storage up to 24 weeks showed a significant ($p<0.05$) reduction in antioxidant activity.

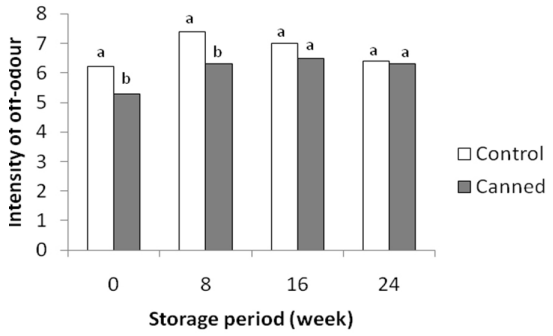
Before storage (0 week), antioxidant activity was significantly ($p<0.05$) higher for control sample compared to canned samples which showed that canning significantly ($p<0.05$) reduced the antioxidant activity of the mengkudu extracts. Yang *et al*. (2007) in their study also reported a reduction in antioxidant activity of mengkudu juice as a result of heat treatment. Walkowiak-Tomczak (2007) in his study on changes in antioxidant activity of black chokeberry juice concentrate solutions during storage also reported antioxidant activity reduction with increased temperature. Results of this study, seems to suggest that the decrease in antioxidant activity of the mengkudu extracts may be caused by the destruction of polyphenols due to thermal heating. TPC showed a significant reduction after canning of mengkudu extract (Figure 2). Antioxidant activity of mengkudu extract showed no significant ($p>0.05$) differences between control and canned samples after 8 to 24 weeks of storage.

Sensory evaluation

Effect of canning and storage on off-odor intensity is shown in Fig 4. Intensity of off-odor for canned extract was significantly ($p<0.05$) lower at the beginning (0 week) and after 8 weeks of storage

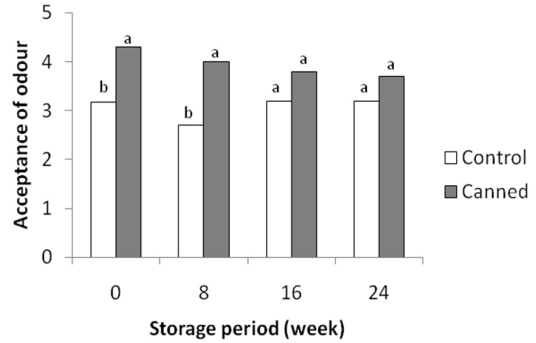
compared to control samples. Canning resulted in a significant ($p<0.05$) reduction in intensity of off-odor at the beginning of storage (0 week) and this effect was maintained until 8 weeks of storage. However, no significant difference in off-odour intensity was observed between control and canned samples after 16 and 24 weeks of storage.

Aroma acceptance showed a significantly ($p<0.05$) higher score for canned samples compared to control samples before and after 8 weeks of storage (Fig 5). However, no significant difference was observed between control and canned samples after 16 and 24 weeks of storage. Results showed that canning produced better aroma acceptance at the beginning and after 8 weeks of storage in tandem with the reduction in off-odour intensity. Consequently, it can be assumed that canning caused a reduction in off-odour intensity resulting in an increased aroma acceptance. However, the improved aroma acceptance did not last the whole period of storage used in this study. The observed results may be due to the formation of other compounds during storage that may change the flavor and odor of stored noni extract (Vinson *et al*., 2001). Thus, it may be possible that other off-odour than what initially was present may have developed and contributed to the results of aroma acceptance.



a-b : means within each storage period with different letters indicate a significant difference at $p<0.05$

Figure 4. Intensity of off-odour as perceived by panelists (n=50) of control (uncanned) and canned mengkudu extract stored for 24 weeks



a-b : means within each storage period with different letters indicate a significant difference at $p<0.05$

Figure 5. Acceptance of odour as perceived by panelists (n=50) of control (uncanned) and canned mengkudu extract stored for 24 weeks

Conclusion

Canning and storage period of mengkudu extract have a significant ($p<0.05$) effect on all the properties of mengkudu extract evaluated. Canning resulted in a significant ($p<0.05$) reduction in pH, total polyphenol content, antioxidant activity and off-odor intensity. Canning also resulted in a significantly ($p<0.05$) higher aroma acceptance. pH, antioxidant activity and off-odor intensity were significantly ($p<0.05$) affected by storage period. However, for both control and canned extract, storage period did not significantly ($p>0.05$) affect total polyphenol content during 24 weeks of storage.

Acknowledgements

The authors would like to express their gratitude to Universiti Kebangsaan Malaysia and the Ministry of Science, Technology and Innovation of Malaysia for the fund provided under the grant of 06-01-02-SF 0182.

References

Association of Official Analytical Chemists. 1995. Official Methods of Analysis (16th ed.). Arlington: AOAC Press.

Blanco, Y.C., Vaillant, F., Perez, A. M., Reyenes, M., Brillouet, J. M. and Brat, P. 2006. Critical Review: The noni fruit (*Morinda citrifolia L.*): A review of agricultural research, nutritional and therapeutic properties. Journal of Food Composition and Analysis 19: 645–654.

Bhupinder, K., Sharma, K.P. and Harinder, K. 1991. Studies on the development and storage stability of ready to serve bottled sugar-cane juice. International Journal of Tropical Agriculture 9(2): 128-134.

Condelli, N., Dinella, C., Cerone, A., Monteleone, E. and Bertuccioli, M. 2006. Prediction of perceived astringency induced by phenolic compounds II: Criteria for panel selection and preliminary application on wine samples. Food Quality and Preference 17: 96–107

Dixon, A.R., McMillen, H. and Etkin, N.L. 1999. Ferment this: the transformation of Noni, a traditional Polynesian medicine (*Morinda citrifolia, Rubiaceae*). Ecological Botony 53: 51–68.

Escarpa, A. and Gonza´ lez, M.C. 2001. Approach to the content of total extractable phenolic compounds from different food samples by comparison of chromatographic and spectrophotometric methods. Analytica Chimica Acta 427, 119–127.

European Commission Scientific Committee of Food. 2002. Opinion of the Scientific Committee on Food of Tahitian Nonis Juice. SCF/CS/DOS/18 ADD 2. Belgium.

Gutensperger, B. and Escher, F.E. 1994. Thermal processing retortable plastic containers with metal lids in stream and water with comparison to metal cans. Journal of Food Science 53(6): 1877-86.

Igual, M., Garcian-Martinez, E., Camacho, M.M. and Martinez-Navarrete, N. 2010. Effect of thermal treatment and storage on the stability of organic acids and the functional value of grapefruit juice. Food Chemistry 118: 291–299.

Jang, H.D., Chang, K.S., Huang, Y.S., Hsu, C.L., Lee, S.H. and Su, M.S. 2007. Principal phenolic phytochemicals and antioxidant activities of three Chinese medicinal herbs. Food Chemistry 103: 749-756.

Kato, T., Shimoda, A.M., Suzuki, J., Kawaraya, A., Igura, N. and Hayakawa, I. 2003. Changes in the odors of squeezed apple juice during thermal processing. Food Research International 36: 777.

Klimczak, I., Malecka, M., Szlachta, M. and Gliszczynska-Świglo, A. 2007. Effect of storage on the content of polyphenols, vitamin C and the antioxidant activity of orange juices. Journal of Food Composition and Analysis 20: 313-322.

Kumar, M.A., Ramesh, M.N. and Nagaraja, R.S. 2001. Retrofitting of a vertical retort for on-line control of the sterilization process. Journal of Food Engineering 47:89-96.

Leonard, J.R. 1986. Estimating thermal degradation in processed foods. Journal of Agriculture and Food Chemistry 34:392-6

Maskat, M.Y. and Tan, S.M. 2011. Effect of heat treatment on the physico-chemical properties of mengkudu (*Morinda citrifolia*) extract. International Food Research Journal 18(3): 966-970.

McClatchey, W. 2002. From Polynesian healers to health food stores: changing perspectives of *Morinda citrifolia* (Rubiaceae). Integral Cancer Therapy 1: 110–120.

McKoy, M.L.G., Thomas, E.A. and Simon, O.R. 2002. Preliminary investigation of the anti-inflammatory properties of an aqueous extract from *Morinda citrifolia* (Noni). Pharmacological Society 45: 76–78.

Mikkelsen, B.B. and Poll, L. 2002. Decomposition and transformation of aroma compounds and anthocyanins during blackcurrant juice processing. Journal of Food Science 67: 3447.

Mohd Zin, Z., Abdul-Hamid, A. and Osman, A. 2002. Antioxidative activity of extracts from Mengkudu (*Morinda citrifolia L.*) root, fruit and leaf. Food Chemistry 78: 227-231

Moniz, H. 1994. Noni (*Morinda citrifolia L.*) as a pharmaceutical product. United States Patent, Application No. 949994.

Nelson, S.C. 2003. Noni Cultivation and Production in Hawaii. In: Proceedings of the 2002 Hawaii Noni Conference. University of Hawaii at Nanoa. College of Tropical Agriculture and Human Resources. Hawaii.

Piljac-Žegaract, J., Valek, L., Martinez, S. and Belščak, A. 2009. Fluctuations in the phenolic content and antioxidant capacity of dark fruit juices in refrigerated storage. Food Chemistry 113(2): 394-400

Saludes, J.P., Garson, M.J., Franziblau, S.G. and Aguinaldo, A.M. 2002. Antitubercular constituents from the hexane fraction of *Morinda citrifolia L.* (Rubiaceae). Phytotherapic Research 16: 683–685.

SAS. (1988). SAS User's Guide. Release 6.03. SAS Institute. Cary, NC.

Vinson, J. A., Su, X., Zubik, L. and Bose, P. 2001. Phenol antioxidant quantity and quality in foods: fruits. Journal of Agricultural and Food Chemistry 49, 5315-5321.

Walkowiak-Tomczak, D. 2007. Changes In Antioxidant Activity Of Black Chokeberry Juice Concentrate Solutions During Storage. Acta Sci. Pol., Technol. Aliment. 6(2), 49-55

Wang, M.Y. and Su, C. 2001. Cancer preventive effect of *Morinda citrifolia* (Noni). Annals of the New York Academy of Sciences 952: 161–168.

Yang, J., Paulino, R., Janke-Stedpronsky, S. and Abawi, F. 2007. Free-radical-scavenging activity and total phenols of noni (*Morinda citrifolia L.*) juice and powder in processing and storage. Food Chemistry 102: 302-308.