International Journal of Agricultural Technology 2022Vol. 18(4):1837-1846
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Physical properties and nutritional value of durian juice produced from durian chips by-products

Boonna, S., Phuangborisut, S. and Chanawanno, T.*

Department of Food Innovation and Business, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-ok Chanthaburi Campus, Thailand.

Sureeporn, B., Saranrat, P. and Tanawat, C. (2022). Physical properties and nutritional value of durian juice produced from durian chips by-products. International Journal of Agricultural Technology 18(4):1837-1846.

Abstract One of the most popular of the processed durian as durian chips which is being widely consumed in Thailand. There are many by-products and wastes in the process such as flesh, shell, and seeds. Those utilization is important for product development with economic value and decreasing environmental problems. Durian juice was firstly formulated from flesh and water at a ratio of 1:5. The different amounts of ripe durian flesh (0, 5, 10, 15, and 20%) on the physical properties such as color value (L*, a*, and b*), viscosity, and sensory attributes of durian juice were studied. An increase in the amount of ripe durian flesh resulted in the increased L* and b* color values ($p<0.05$). Moreover, the viscosity of durian juice tended to increase with the higher amount of ripe durian flesh used. Sensory attributes as evaluated using the 9-point hedonic scale showed that consumers rated with the maximum overall acceptability of 7.08 for the formulation with 15% ripe durian flesh. This durian juice formulation had a pH of 6.6, a total soluble solid of 8.3 °Brix, a viscosity of 73.0 cP, and antioxidant activity as analyzed using DPPH assay of 4.07%. The chemical compositions and nutritional value of the final product (15% ripe durian flesh) were investigated. It contained 6.33% carbohydrate, 0.29% protein, 0.1% fat, 1.96% fiber, 0.24% ash, 0% cholesterol, 21.81 mg/100g calcium, 0.036 mg/100g vitamin B1, and 37.15 kCal/100g. The results indicated that durian juice produced from the waste flesh in durian chip processing is a good source of many important substances, especially fiber and calcium.

Keywords: By-products, Processed durian, Utilization, Nutritional value

Introduction

Durian (*Durio zibethinus* Murr) is a seasonal tropical fruit in Southeast Asia that is also popular in many countries. It is widely being cultivated in tropical countries such as Malaysia, Indonesia, and Thailand (Tan *et al*., 2019). The world's largest exporter of durian in recent years is Thailand (Charoenphun and Kwanhian, 2018) and currently, they are grown in many areas throughout the country. However, more than half of the overall output is in the eastern

***Corresponding Author:** Chanawanno, T.; **Email:** tanawat_ch@rmutto.ac.th

region, particularly in Chanthaburi province. Durian fruits typically contain 10-30% flesh, 50-60% shell, and 10-20% seed (Purnomo *et al*., 2016). Durian is rich in nutritional value and a source of carbohydrates, especially flour and sugar. It also contains hemicellulose, which is a type of dietary fiber, and a considerable amount of phenolics, flavonoids, and carotenoids. The durian flesh contains protein, carbohydrates, sugar, fats, vitamin C, vitamin B1, vitamin B2, vitamin E, potassium, phosphorus, calcium, iron, and odor volatiles (Rusmiati *et al*., 2015). While the durian seed segment consists of mostly 50-70% carbohydrates (Mirhosseini *et al*., 2015); the durian shell contains 4.84% ash, 13.09% hemicellulose, and 15.45% lignin (Jun *et al*., 2010). The additional valuable health properties of durian fruit are mostly connected with antioxidant properties and its composition particularly fatty acid composition (Ashraf *et al*., 2010). There are reports that the glycaemic index of durian was the lowest in comparison with papaya and pineapple (Daniel *et al*., 2008). In addition to eating fresh fruit, durian is also used as an ingredient in various food products i.e., ice cream, pudding, and juices. The diversity of processed durian can be found in the local market as, durian powder (Chin *et al*., 2008), juice (Norjana and Noor Aziah, 2011), jam, candy, toffees, ice cream, wine, fruit milkshakes (Lim, 2012), and natural bioactive compounds (Lee and Rajeev, 2015).

Durian chips are processed durian fruits with a delicious crispy taste usually made from Monthong variety, the most popular durian cultivar in Thailand. It is categorized into a kind of food snack and is widely consumed in Thailand and in many countries. During the production process, there are a large number of wastes left such as shells, seeds, and the section of flesh adjacent to the seed (Figure 1A). Most of these are being dumped as garbage, thus, this can cause environmental pollution. Nowadays, technology has been used to create innovation for added value to waste materials of durian, that is extraction of important bioactive compounds i.e. antioxidant, anti-inflammatory, and inhibition of pathogenic microorganisms, development of polysaccharide gel from durian shell, hydrocolloid extraction such as gum, which, used as an emulsifier in food products, extraction of pectin and carboxymethyl cellulose for using in the production of edible coatings and biofilms, the production of flour from soft durian, seeds, and shells for using as an ingredient for the production of gluten-free pasta (Charoenphun *et al*., 2018). However, there have not studied on the utilization of the flesh adjacent to the seed, it is interesting to develop food products and to reduce the amount of agricultural waste. Nowadays, consumers concern and demand for healthy foods. Fruit juice are one option for consumers because it is highly nutritious. It is high in sugars, glucose, fructose, and sucrose, which have become an essential source of energy (Norjana and Noor Aziah, 2011). Furthermore, it is a good source of vitamins and minerals, good nutritious fruit, and some research studied the production of durian juice and method to improve its quality. In 2011, Norjana and Noor Aziah studied the quality improvement of durian juice after pectinase enzyme treatment. Additionally, Bourneow and Santimalai (2016) investigated the process of optimization for microbial reduction in durian juice by using a pulsed electric field. Charoensuk *et al*. (2018) examined the optimal formulation of durian juice with the addition of coconut milk and the stabilizer (gellan gum) and evaluated the sensory and pulp stability after sterilization. However, the utilization of waste products in durian chips processing.

The main objective of this study was to develop durian juice by using durian chip waste products and ripe durian flesh as the raw materials. Furthermore, the physical properties, chemical composition, sensory evaluation, and nutritional value of durian drinks were investigated.

Materials and methods

Materials

The raw material in this study was unripe durian flesh as durian chips processing waste products (Figure 1A) which provided by Pentiwa Community Enterprise in Chanthaburi, Thailand. After removing unwanted parts such as seed shells (Figure 1B), the unripe durian flesh was cleaned and cooked, then cooled to room temperature (30-35 ℃). The cooked flesh was put into a plastic bag and frozen at -18 ℃ to preserve the quality before being used to prepare the durian juice.

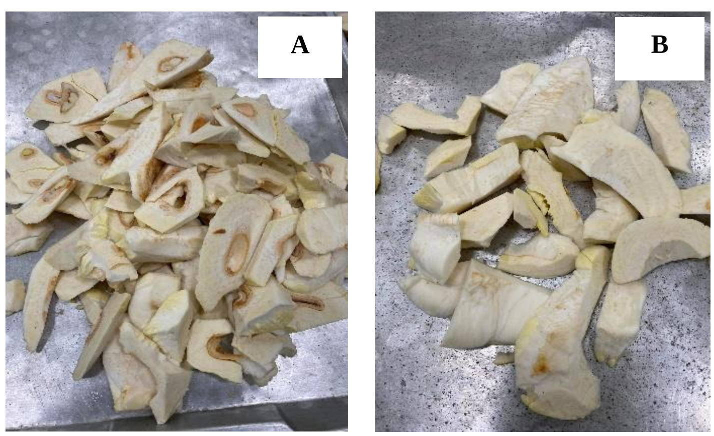

Figure 1. Unripe durian flesh from durian chips processing waste product before (A) and after (B) removing the seed shells

Durian drink preparation

The durian juice was firstly formulated from flesh and water at a ratio of 1:5. The frozen cooked unripe durian flesh was thawed and blended with water using a food blender (Nanotech, Model NT010). Then, different amount of flesh ripe durian (0%, 5%, 10%, 15%, and 20%) was added by blending and homogenization for 1 minute using a homogenizer (Fry king, Model 202A). Next, the total soluble solid was adjusted to 8% (w/w) with sugar. After that, the durian juice was heated to 75-85 ℃ and hot-fill in sterilized glass bottles of 180 mL capacity. Finally, all the durian juice were sterilized at 118 ℃ for 30 minutes.

Physical properties analysis

The color was investigated using the color meter (Nippon Denshoku, ZE2000) and expressed as L*, a*, and b*. The viscosity measurement was conducted using a viscometer (Model DV-III Ultra, Brookfield) with spindle No. 31 rotated at 200 rpm at 28+0.5 ℃ (Charoensuk *et al*., 2018).

Chemical properties analysis

The pH value and total soluble solids (TSS) were measured using pH meter (Extech PH100ExStik pH meter), and portable Otago Hand Refractometer (N1) of 0-32%, respectively. The TSS was reported as degrees Brix (°Brix). The antioxidant activity was determined using DPPH assay according to Zhu *et al*. (2006) with slight modification. In brief, 2.9 ml of DPPH (2,2-diphenyl-1-picrylhydrazyl) solution (0.1 mM in 95% ethanol) was mixed with the sample (0.1 ml). Then, the solution was incubated in a dark condition for 30 minutes. The absorbance was measured using a spectrophotometer at 517 nm. Ascorbic acid was used as the positive control. The percentage radical scavenging activity was calculated using the following equation:

$$\text{DPPH radical scavenging activity (\%)} = \frac{(A0 - A1)}{A0} \times 100$$

When A0 and A1 are the absorbance of control sample (containing all reagents except the sample) and the absorbance of test sample, respectively.

Sensory evaluation

The sensory evaluation of durian juice was conducted using a 9-point hedonic scale (1 = extremely dislike and 9 = extremely like) with 200 untrained panelists from the staff and students of the Department of Product Development and Management Technology (Faculty of Agro-industrial Technology, Rajamangala University of Technology Tawan-ok Chanthaburi Campus Chanthaburi, Thailand) to evaluate the following attributes as appearance (color), aroma, taste, flavor, texture, and overall acceptability.

Chemical compositions and nutritional value determination

Chemical compositions including moisture content, protein, fat, ash, crude fiber, and calculated total carbohydrates were analyzed according to AOAC method (2000). The calories were measured using the in-house method TE-CH-169 based on the method of analysis for Nutrition Labelling (1993) at the Central Laboratory (Co. Ltd, Thailand). For the nutritional facts of durian juice, it was also determined using the standard procedure as shown in Table 4 at the Central Laboratory Co. Ltd. Thailand.

Statistical analysis

Analysis of variance was carried out using SPSS software (SPSS Inc., Cary, NC, USA). The differences between mean values were established using Duncan's multiple range test. All measurements and analyses were conducted in three replications.

Results

Physical properties of durian drinks

Durian drink formulation was firstly developed using unripe durian flesh mixed with water at a ratio of 1:5. Then, the different amounts of ripe durian flesh at 5%, 10%, 15%, and 20% (w/w) on the physical and chemical properties and sensory attributes of the durian drink were studied. The color and viscosity measurements showed that when the amount of ripe durian flesh increased, the brightness (L*), redness (a*), and yellowness (b*) values were also raised ($p<0.05$) (Table 1). The color appearance of all durian drinks is illustrated in Figure 1. For the viscosity of durian drink, it tended to increase with the higher amount of flesh ripe durian added ($p<0.05$). All drinks had a viscosity in the range of 74-102 cP.

Sensory attributes of durian drinks

The sensory attributes of durian drinks are presented in Table 2. The liking score of aroma, taste, flavor, texture, and overall acceptability of the durian drinks with 15%ripe durian flesh was significantly higher than the other formulas which were 6.72, 6.78, 6.53, 6.66, and 7.08, respectively. However, the liking score of aroma, taste, flavor, texture, and overall acceptability of the durian juice with 20% ripe durian flesh were significantly lower than those of the 15% ripe durian flesh and similar to the control (without ripe durian flesh), indicating that ripe durian flesh can be added in the durian juice formulation up to 15%.

Table 1. Physical properties of durian juice prepared from various amounts of ripe durian flesh

Ripe durian flesh (%, w/w)	**Color**			**Viscosity (cP)**
	L*	a*	b*	
0	45.10e	4.31c	1.91e	73.9d
5	50.47d	5.25b	3.59d	75.5d
10	55.38c	6.14a	5.65c	80.3c
15	58.83b	6.57a	7.12b	91.0b
20	60.91a	6.82a	9.04a	102.2a

[a-e] Mean values with different letters in each column are significantly different (p<0.05).

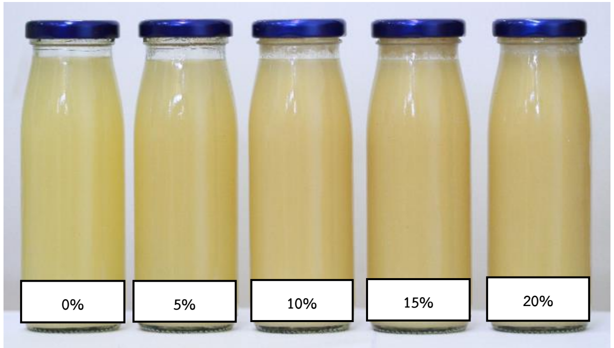

Figure 2. Durian juice prepared from various amount of flesh ripe durian (0%, 5%, 10%, 15%, and 20%, respectively)

Table 2. Sensory attributes of durian juice prepared from various amount of ripe durian flesh

Ripe durian flesh (%, w/w)	**Appearance**	**Aroma**	**Taste**	**Flavor**	**Texture**	**Overall acceptability**
0	5.90b	5.79c	5.69c	5.45c	5.81bc	5.69c
5	5.94b	5.80c	5.72c	5.50c	5.81bc	5.69c
10	6.14b	6.37b	6.32b	5.88b	5.90b	6.62b
15	7.14a	6.72a	6.78a	6.53a	6.66a	7.08a
20	7.20a	5.88c	5.92c	5.74bc	5.53c	5.92c

[a-c] Mean values with different letters in each column are significantly different (p<0.05).

Chemical properties, proximate analysis, and nutritional value of durian juice

The chemical properties of durian drink prepared from 15% (w/w) ripe durian flesh is shown in Figure 3. The durian drink with 15% ripe durian flesh had a total soluble solid of 8.3 °Brix and the pH was 6.6. Furthermore, it exhibited a slightly antioxidant activity which was observed to be 4.07%. The chemical compositions of the durian juice with 15% ripe durian flesh are revealed in Table 3. The major compositions were 91% moisture, followed by 6% carbohydrate 2%, crude fiber, and the total calories was 37%.

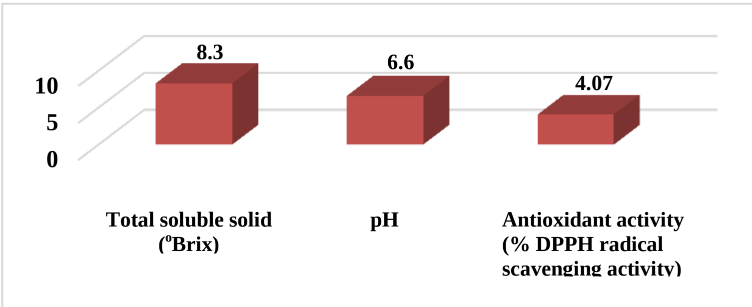

Figure 3. Chemical properties of durian drink prepared from 15% (w/w) ripe durian flesh

The nutritional facts of durian drink prepared from 15%(w/w) ripe durian flesh is presented in Table 4. The durian drink with 15% ripe durian flesh for 1 serving (180 mL) had the total calories of 60 Kcal. It contained 14 g of carbohydrates, 9 g of sugar, 0.5 g of total fat, and 10 mg of sodium. In addition, it comprised of dietary fiber and vitamin B1 (thiamine) which was equivalent to 4% of the recommended daily intake (%RDI). Interestingly, it consisted of a high level of calcium and potassium at the content of 40 and 190 mg, respectively.

Table 3. Chemical compositions and energy of durian juice prepared from 15% (w/w) ripe durian flesh

Chemical compositions	**Value (g/100 g)**
Carbohydrate	6.33 $\pm$ 0.32
Protein	0.29 $\pm$ 0.00
Total fat	0.11 $\pm$ 0.05
Crude fiber	1.96 $\pm$ 0.43
Ash	0.24 $\pm$ 0.01
Moisture	91.32 $\pm$ 0.02
Total Calories*	37.15

*Total Calories was analyzed using In-house method TE-CH-169 based on Method of Analysis for Nutrition Labeling (1993) p.106

Table 4. Nutritional facts for 1 serving size of 180 ml durian juice

Nutritional Facts	Per 1 serving size (180 mL)	%RDI	Standard Procedure
Calories (Kcal)	60	-	In-house method TE-CH-169 based on Method of Analysis for Nutrition Labeling (1993) p.106
Total Fat (g)	0.5	1	AOAC (2019) 922.06
Cholesterol (mg)	0	0	In-house method based on TE-CH- 143 based on AOAC (2019) 994.10
Carbohydrate (g)	14	5	In-house method TE-CH-169 based on Method of Analysis for Nutrition Labeling (1993) p.106
Protein (g)	<1	0	AOAC (2019) 981.10
Dietary fiber (g)	1	4	In-house method TE-CH-076 based on AOAC (2019) 985.29
Vitamin B1 (mg)	0.06	4	In-house method TE-CH-057 based on AOAC (2019) 942.23
Calcium (mg)	40	4	In-house method TE-CH- 134 based on AOAC (2019) 984.27
Sodium (mg)	10	0	In-house method TE-CH- 134 based on AOAC (2019) 984.27
Potassium (mg)	190	4	In-house method TE-CH- 134 based on AOAC (2019) 984.27
Iron (mg)	0.2	0	In-house method TE-CH- 134 based on AOAC (2019) 984.27

Discussion

The color value (L*, a*, and b*) of durian juice varied which depended on the amount of ripe durian flesh. The brightness (L*), redness (a*), and yellowness (b*) color values tended to increase as the amount of ripe durian flesh. It might be due to the ripe durian flesh having a higher content of carotenoid. According to the study of Wisutiamonkul *et al*. (2017), they suggested that ripening process of fruit induced the carotenoid accumulation in the durian. Moreover, Wisutiamonkul *et al*. (2015) also pointed out that pulp color was deeper yellow in Chanee cultivar than in Monthong cultivar, which was associated with α-carotene and β-carotene concentrations.

In terms of viscosity, durian juice with a high amount of ripe durian flesh showed a more viscous texture. Previous research reported that the chemical composition of the durian fruit contains a high amount of carbohydrates especially starch and sugar (Charoenphun *et al*., 2018). This may be due to carbohydrate i.e. starch of ripe durian flesh which can swell during heating to increase viscosity. Viscosity is a physical attribute that is commonly associated with the quality of liquid food products. Viscosity loss is undesirable in ready-to-drink as juices or concentrates because the beverage loses its body, resulting in colloid system destabilization (Norjana and Noor Aziah, 2011). However, when adding ripe durian flesh up to 20%, it was found that the rating score of the aroma, flavor, and taste was reduced. This might be caused by the excessive addition of ripe durian flesh which resulted in the formation more intense in smell and odor. While the liking score in texture attribute was significantly minimized and different from the other formulations because the texture of durian juice with 20% ripe durian flesh which was consistent with the viscosity. Nevertheless, the liking score in appearance (color)was higher than other formulations, but it did not show a difference when compared with the durian juice with 15% ripe durian flesh ($p<0.05$). It may be due to the color of the durian juice with 20% ripe durian flesh being more yellowish.

The antioxidant activity using DPPH assay, the durian juice with 15% ripe durian flesh had a DPPH radical scavenging activity of 4.07%, which was reduced from durian flesh and cooked durian flesh. The result is related to the heating during hot filled in the glass bottle and the impact of high temperature (118 ℃) and long time duration (30 minutes) during the sterilization process. It denoted that heating had an effect in the reduction of the antioxidant capacity of durian. A similar result was reported by Manurakchinakorn *et al*. (2016) in that the pasteurization at a temperature of 85-90 ℃ for 2-5 minutes to decrease the number of important substances such as anthocyanin, vitamin C, and antioxidants of mangosteen juice.

From the chemical composition and nutritional value determination of developed durian juice with 15% ripe durian flesh, it showed relatively low energy product (65 Kcal per 1 serving, 180 mL) but relatively high fiber content of 2% which is equivalent to the 4% recommended daily intake (%RDI). Charoenphun *et al*. (2018) reported that durian contains soluble and non-soluble polysaccharide, which is fiber, especially hemi-cellulose. Durian also consists of important minerals such as calcium and potassium, and vitamin B1 (Rusmiati *et al*., 2015), which was observed in durian juice in this study. Therefore, this kind of drink is supposed to be a healthy alternative to non-alcoholic juice.

In conclusion, this study revealed that unripe durian flesh, which is durian chips waste products, can potentially be used as a raw material to prepare the durian juice. The addition of ripe durian flesh in durian juice formulation at various amounts affected the physical properties (both color and viscosity) and sensory attributes of durian juice. The ripe durian flesh could be added in the formulation up to 15% while maintaining the overall sensory attributes. These findings suggested that the durian drink prepared in this study was an alternative source of fiber, calcium, and potassium. Further research on the unripe durian flesh of durian chips waste products as a raw material for the development of other kinds of food products is recommended.

Acknowledgements

This research was financially supported by the Office of National Higher Education Science Research and Innovation Policy Council through Program Management Unit on Area Based Development-PMUA (A13F630080) and Rajamangala University of Technology Tawan-ok.

References

AOAC (2019). Official methods of analysis of AOAC International, 21st edn., Association of Analytical Communities, Rockville, Maryland, USA.

Ashraf, M. A., Jamil Maah, M. and Yusoff, I. (2010). Estimation of Antioxidant Phytochemicals in Four Different Varities of Durian (*Durio zibethinus murray*) Fruit. Middle-East Journal of Scientific Research, 6:465-471.

Bourneow, C. and Santimalai, S. (2016). Process Optimization for Microbial Reduction in Durian Juice by Using Pulsed Electric Field. Journal of Science and Technology Mahasarakham University, 35:619-625.

Charoenphun, N. and Kwanhian, W. (2018). Effect of Flour from Durian Waste on Quality of Gluten Free Pasta. Thai Science and Technology Journal, 26:803-814.

Charoenphun, N., Setarnawat, S. and Sai-Ut, S. (2018). Chemical Composition and Trends in Utilization of By-products and Wastes from 4 Types of Tropical Fruit Processing. Thai Science and Technology Journal (TSTJ), 28:113-128.

Charoensuk, K., Wongekalak, L., Mongkontanawat, N., Nonmoung, W., Suwanposri, A, Tanmanee, P. and Kongsuk, M. (2018). Formulation, Sensory and Pulp Stability of Durian (*Durio zibethinus* Murr) Juice. International Journal of Agricultural Technology, 13:1437-1447.

Chin, S. T., Hamid, N. S. A., Quek, S. Y., Che Man, Y. B., Rahman, R. A. and Hashim, D. M. (2008). Changes of volatiles attribute in durian pulp during freeze- and spray drying process. Food Science and Technology, 41:1899-1905.

Daniel, R. S., Ismail, A. A., Winn, T. and Wolever, T. (2008). Glycemic index of common Malaysian fruits. Asia Pacific Journal of Clinical Nutrition, 17:35-39.

Jun, T. Y., Arumugam, S. D., Latip, N. H. A., Abdullah, A. M. and Latif, P. A. (2010). Effect of activation temperature and heating duration on physical characteristics of activated carbon prepared from agriculture waste. Environment Asia, 3:143-148.

Lee, H. H. and Rajeev, B. (2015). Exploring the potential nutraceutical values of durian (*Durio zibethinus L.*) -An exotic tropical fruit. Food Chemistry, 168:80-89.

Lim, T. K. (2012). Edible medicinal and non-medicinal plants (Vol. 1). Dordrecht Heidolberg, New York: Springer.

Manurakchinakorn, S., Chainarong, Y. and Sawatpadungkit, C. (2016). Quality of mangosteen juice colored with mangosteen pericarp. International Food Research Journal, 23:1033-1039.

Mirhosseini, H., Rashid, N. F. A., Amid, B. T., Cheong, K. W., Kazemi, M. and Zulkurnain, M. (2015). Effect of partial replacement of corn flour with durian seed flour and pumpkin flour on cooking yield, texture properties, and sensory attributes of gluten free pasta, LWT - Food Science and Technology, 63:184-190.

Norjana, I. and Noor Aziah, A. A. (2011). Quality attributes of durian (*Durio zibethinus Murr*) juice after pectinase enzyme treatment. International Food Research Journal, 18:1117-1122.

Purnomo, A., Yudiantoro, Y. A. W., Putro, J. N., Nugraha, A. T., Irawaty, W. and Ismadji, S., (2016). Subcritical water hydrolysis of durian seeds waste for bioethanol production. International Journal of Industrial Chemistry, 7:29-37.

Rusmiati, R., Ashari, S., Widodo, M. A. and Bansir, L. (2015). The nutritional composition of red durians from banyuwangi, Indonesia. Food Science and Quality Management, 37:46-51.

Sullivan, D. M. and Carpenter, D. E. (1993). Methods of analysis for nutrition labeling. Journal of AOAC International, 76:106.

Tan, P. F., Ng, S. K., Tan, T. B., Chong, G. H. and Tan, C. P. (2019). Shelf-life determination of durian (*Durio zibethinus*) paste and pulp upon high-pressure processing. Food Research, 3:221-230.

Wisutiamonkul, A., Ampomah-Dwamena, C., Allan, A. C. and Ketsa, S. (2017). Carotenoid accumulation in durian (*Durio zibethinus*) fruit is affected by ethylene via modulation of carotenoid pathway gene expression. Plant Physiology and Biochemistry, 115:308-319.

Wisutiamonkul, A., Promdang, S., Ketsa, S. and Van Doorn, W. G. (2015). Carotenoids in durian fruit pulp during growth and postharvest ripening. Food Chemistry, 180:301-305.

Zhu, K., Zhou, H. and Qian, H. (2006). Antioxidant and free radical scavenging activities of wheat germ protein hydrolysates (WGPH) prepared with catalase. Process Biochemistry, 41:1296-1302.

(Received: 30 November 2021, accepted: 30 May 2022)