

# Effect of Type and Concentration of Encapsulating Agents on Physicochemical, Phytochemical, and Antioxidant Properties of Red Dragon Fruit Kombucha Powdered Beverage

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## ABSTRACT

Kombucha is a healthy beverage from the fermentation of sugared tea with a symbiotic culture of bacteria and yeast (SCOBY). There is a growing interest in kombucha due to the reported health benefits. The original kombucha is prepared using only sweetened black tea infusion. The development of kombucha, however, has been reported to incorporate other plant water extracts. A previous study showed that kombucha beverage using red dragon fruit (RDF) as an alternative substrate gave the highest antioxidant activity at 15 days of fermentation. RDF kombucha instant powder could be a new food product development due to its longer shelf life, convenience, and low distribution cost. This study aimed to determine the best concentration of encapsulating agent for RDF kombucha powdered beverage which could retain the antioxidant properties. RDF kombucha was spray dried using maltodextrin, gum arabic, and inulin as the encapsulating agents with various concentrations (5%, 10%, and 15%). Gum arabic was the best encapsulating agent since it gave the highest values of drying yield, pH, and total phenolic content retention compared to the other two encapsulating agents. Within the observed concentrations, the incorporation of gum arabic resulted in RDF kombucha powder with a similar appearance, red color, and antioxidant retention. Thus, the 5% addition of gum arabic is recommended for future preparations of RDF kombucha powdered beverage.

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## 1. INTRODUCTION

Kombucha is a healthy fermented beverage from the fermentation of sugared tea with a symbiotic culture of bacteria and yeast (SCOBY). Although kombucha was initially prepared from sweetened black tea infusion, the development of kombucha has been involving other plant extracts. There is a growing interest in this kind of beverage due to the reported health benefits. Kombucha was reported to have medicinal effects against cancer and cardiovascular diseases. It reduced inflammatory problems and promoted digestive functions [1].

Red dragon fruit (RDF) was firstly introduced in Indonesian market in 2003. The RDF plantation has grown very fast due to the well acceptance of this fruit by consumers [2]. The development of beverages using RDF will further increase the market value of this fruit. Previous study showed that kombucha beverage using RDF as an alternative substrate had the highest antioxidant activity at 15 days of fermentation [3]. For preservation, spray drying can be used to turn the RDF kombucha into powder that increases the stability of the products in terms of nutrients and other active components such as phenolic compounds and antioxidants, reduces the storage capacity, suppresses transport cost, and prevents any kind of molecular deterioration.

RDF kombucha instant powder could be a new food product development due to its longer shelf life, convenience, and low distribution cost. High molecular weight encapsulating agents, such as maltodextrin, gum arabic, and inulin are often added to fruit juices as drying aids before spray drying. High glass transition temperature ( $T_g$ ) in these encapsulating agents helps increase the  $T_g$  of the feed solution, reducing the stickiness of the powder during spray drying, thus increasing the process yield and efficiency [4]. The present study determined the effect of a variety of encapsulating agents and their concentration on the encapsulation efficiency (drying yield), physicochemical (moisture content, pH, and color), phytochemical (phenolic content), and antioxidant properties of RDF kombucha spray dried powder, in order to get the optimal type and concentration of the encapsulating agent.

## 2. EXPERIMENTAL SECTION

### 2.1 Material and Instrument

Red dragon fruits (RDF) (*Hylocereus polyrhizus*) from local market were juiced with additional water with the ratio of 1:4, filtered, and pasteurized. The SCOBY was as described in [3]. Maltodextrin (DE 19-20), gum arabic, and inulin were used as encapsulating agents. Instruments used were a spray dryer (Model 190 Mini Spray Dryer, Buchi, Postfach, Flawil, Switzerland), a spectrophotometer (Cary 60 UV-Vis, Agilent Technologies, Palo Alto, CA, USA), and a chromameter CR 410 (Model CR-410, Minolta Corp., Osaka City, Osaka, Japan).

### 2.2 Fermentation of Red Dragon Fruit Filtrate.

The starter culture was 2.5 kg of SCOBY which was previously grown in RDF juice. The culture was transferred into a 20 L glass jar and the RDF pasteurized filtrate was added to make the total volume of 17 L. The fermentation was as described in [3] which took 15 days. The fermented beverage was filtered through a muslin cloth and a 60 mesh screen to remove the cellulose shells which had developed and gathered in the covered jar. The volume of the filtered sample was 16.5 L.

### 2.3 Encapsulation Process

Encapsulation of the RDF kombucha after 15 days of fermentation was performed using maltodextrin (DE 19-20), gum arabic, and inulin as encapsulating agents. Each encapsulating agent was applied in three different concentrations, i.e., 5%, 10%, and 15%. The 750 mL of filtered RDF kombucha was used for each concentration. Each mixture was homogenized at 6,000 rpm for 10 minutes using a homogenizer (Model Ultra Turrax T-50, IKA Labortechnik, Staufen, GI, Germany) until a good dispersion was obtained. Afterward, the samples were subjected to spray drying.

## 2.4 Spray Drying

Spray drying was performed using a laboratory scale spray dryer with the inlet air temperature of 170 °C and the outlet air temperature of 70 °C. Each treatment was fed into the drying chamber using a feed flow rate of 500 mL/h and a nozzle air flow rate of 600 NL (Liters at normal conditions)/h. Spray dried powder was collected and transferred into sealed plastic bags. The moisture content of the powder was determined using a moisture analyzer.

## 2.5 Drying Yield

The drying air may carry some resultant powder out of the drying chamber and some solids may stick in the drying chamber. Therefore, the yield of the spray drying was calculated by dividing the weight of the final powder (in dry basis) collected at the bottom of the cyclone to the weight of total solids in the feed sample with encapsulating agents (in dry basis) [4]. It was expressed as Equation 1.

$$\text{Yield (\%)} = \frac{\text{Weight of the solids in powder}}{\text{Weight of solids in the feed}} \times 100\% \quad (1)$$

## 2.6 Reconstitution of Spray Dried Samples for Further Analyses

In order to analyze the antioxidant activity, the total phenolic content, and the pH after spray drying process, the resultant powder was reconstituted to achieve the same moisture content as in the initial feed.

## 2.7 pH Value

pH measurement was determined by using the pH meter (Model pH 700, Eutech Instruments, Thermo Fisher Scientific, Waltham, MA, USA) in triplicates for each reconstituted sample.

## 2.8 Total Polyphenols

Total polyphenols were tested with Folin-Ciocalteu reagent according to a previous publication [5]. Gallic acid was used as the standard solution.

Thus, the results were presented as micrograms of gallic acid equivalent (GAE) per milliliter of reconstituted sample.

## 2.9 Antioxidant Activity

Antioxidant activity was measured using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, following a previous publication [5].

## 2.10 Color Properties

The tristimulus color parameters of the RDF kombucha powder were measured using a chromameter and were recorded as CIELab coordinates. Total color differences ( $\Delta E^*$ ) were calculated using Equation 2 [6]. Since all resultant powder was red in color, thus we also took the approach to calculate the color index for red grape (CIRG) using Equation 3 [7].

$$\Delta E^* = \sqrt{(\Delta a^*)^2 + (\Delta b^*)^2 + (\Delta L^*)^2} \quad (2)$$

With  $\Delta E^*$  = total color difference  
 $\Delta L^*$  = difference in lightness  
 $\Delta a^*$  = difference in green-red coordinate  
 $\Delta b^*$  = difference in blue-yellow coordinate

$$\text{CIRG} = \frac{180-H}{L^*+C} \quad (3)$$

With  $\text{CIRG}$  = color index for red grape  
 $H$  = hue angle, calculated as  $\arctan(b^*/a^*)$  in degrees  
 $L^*$  = lightness  
 $C$  = chroma, calculated as  $[(a^*)^2 + (b^*)^2]^{0.5}$

### 3. RESULT AND DISCUSSION

#### 3.1 Visual Appearance

The appearance of red dragon fruit kombucha spray dried results using three different encapsulating agents at three different concentrations were presented (Figure 1). The appearances of RDF kombucha powder varied depending on the encapsulating agents. The RDF kombucha powder prepared with maltodextrin at concentrations of 5% and 10% were fused and clumped due to inadequate encapsulating agents. As expected, the RDF kombucha powder prepared with maltodextrin at concentration of 15% displayed powdery looks with smooth surfaces and lack of surface cracks, agglomerates, and clumps, as observed using naked eyes. Maltodextrin, either alone or in conjunction with gum arabic, is often used in spray-drying of hygroscopic water-soluble products, e.g., fruit juices, sugars, or polyols, since it can reduce the hygroscopicity and simultaneously increase the yield of powders [8]. The RDF

kombucha powder prepared with gum arabic at all concentrations showed powdery looks with smooth surfaces, and neither surface cracks nor agglomerates were observed. The RDF kombucha powder prepared with inulin at any concentrations was sticky and agglomerated powders; this could be due to the hygroscopic nature of inulin [9]. Their particles were large and hard with surface cracks. A similar finding was obtained by Lorenço et al. [10] on spray-dried pineapple peel extracts. They observed a large degree of agglomeration of the spray-dried products that were prepared with inulin while other powders prepared with either maltodextrin or gum arabic displayed an intermediate cohesiveness and quite good flowability. Their finding was in alignment with our finding, that gum arabic was the best encapsulating agent for RDF kombucha compared to maltodextrin and inulin. According to Daza et al. [11] in their study on spray-drying of *Cagaita (Eugenia dysenteria DC.)* fruit with added carrier agents, a better yield was obtained when gum arabic was used instead of inulin.

Type of Encapsulating Agent	Concentration of encapsulating agent		
	5%	10%	15%
Maltodextrin			
Gum Arabic			
Inulin			

**Figure 1.** Various appearances of RDF kombucha powder prepared with three different encapsulating agents at three different concentrations.

### 3.2 Yield

The best yield was obtained from RDF kombucha powder which was prepared with gum arabic. The second best yield was achieved by the RDF kombucha powder prepared with maltodextrin. The RDF kombucha with added inulin resulted in sticky and agglomerated powder. It clung to the inner surface of the spray dryer, particularly the drying chamber and the cyclone, and therefore a low product yield was obtained (Table 1).

Adding encapsulating agent will improve the drying yield. Gum arabic is the most effective agent in this study, as indicated by the highest yield. Gum arabic has a higher glass transition temperature than maltodextrin and inulin since gum arabic has higher molecular weight [12]. There is a relationship between molecular weight and glass transition temperature [13]. Inulin was

a poor carrier which was reflected by the sticky and clumped products following spray drying. The lower yield, which decreases the drying efficiency of the inulin added RDF kombucha, was explained by the crystalline configuration of the resultant powder and the increase in wall deposition [14]. Proteins in gum arabic have a big effect on the high-protein-content film forming on the particle surface due to the migration to the droplet-air interface. With the help of this film, the feed will create a glassy skin with high  $T_g$  when subjected to hot air inside the dryer, which inhibited adhesion of the particles to the spray dryer chamber, and thus produced a high yield. Another possible reason was the low surface tension of the feed when added by gum arabic. Therefore, gum arabic can act as an effective encapsulating agent for the spray drying of sugar-rich solutions [15].

**Table 1.** Yield and moisture content of RDF kombucha powder prepared with three different encapsulating agents at three different concentrations, and the pH of the reconstituted kombucha

Encapsulating agent	Concentration (%)	Yield (%)	Moisture content (%)	pH
Maltodextrin	5	65.63 ± 0.11	1.59 ± 0.16	3.58 ± 0.02
	10	53.09 ± 8.07	1.06 ± 0.15	3.47 ± 0.01
	15	74.24 ± 2.24	1.11 ± 0.15	3.44 ± 0.04
Gum Arabic	5	80.11 ± 0.58	0.95 ± 0.19	3.79 ± 0.00
	10	81.97 ± 0.92	2.06 ± 0.05	3.86 ± 0.00
	15	91.30 ± 7.17	1.05 ± 0.19	3.86 ± 0.04
Inulin	5	32.40 ± 0.93	0.99 ± 0.04	3.53 ± 0.00
	10	41.67 ± 4.07	1.40 ± 0.16	3.51 ± 0.01
	15	45.85 ± 1.80	1.04 ± 0.12	3.52 ± 0.04

### 3.3 Moisture Content

The moisture content of all RDF kombucha powder was less than 3% (Table 1), which met the Indonesian National Standard for instant beverage powder products according to SNI 01-4320-1996 [16]. The obtained moisture content was aligned with the previous studies of Tonon et al. [17] and Quek et al. [18] for spray-dried açai and watermelon beverages, respectively. The low viscosity of feed samples could result in low moisture content of the end product [4]. The evaluation of instant tea with moisture content

less than 5% showed improved stability during packaging and storage [19].

### 3.4 pH Values

The RDF kombucha powder prepared with gum arabic displayed the highest pH after being reconstituted (Table 1). The finding indicated that the types of the encapsulating agents had an influence on the pH of the reconstituted RDF kombucha, although no significant correlation was observed. This study was in compliance with the results of Kha et al. [20], who found that the pH of the Gac

fruit aril powder was not significantly different between different encapsulating agent concentrations. The lowest acceptable pH should be above 3.0. Otherwise, it will not be recommended for direct consumption since it negatively affects the digestive system [21].

### 3.5 Polyphenol Content

The study showed that the types of encapsulating agents affected total phenolic content. The highest phenolic content was observed in 10% gum arabic ( $19.21 \pm 1.64$  mg GAE/100 ml) (Figure 2). This was possibly due to the degree of polymerization of gum Arabic. It has a lower degree of polymerization in comparison to maltodextrin and inulin. Maltodextrin and inulin with their high polymerization capability tend to go for self structural changes and configuration, thus gave lower protection to the phenolic compounds. Therefore, the phenolic compounds of the micro-encapsulated particles were prone to oxidation and their content decreased [22].

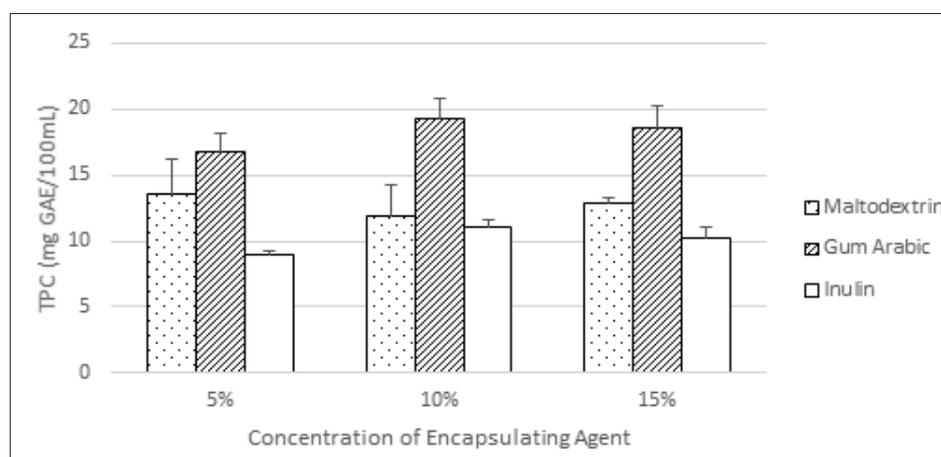
Meanwhile, gum arabic has a low polymerization ability with a small possibility of structural changes and configuration. Thus, gum arabic produced microencapsulated particles which had strong protection against oxidation, resulting in a higher amount of total phenolic content. The conformational changes due to the structural degradation led to the rearrangement of the compound structure, which in the end affected the phenolic content [4].

### 3.6 Antioxidant Activity

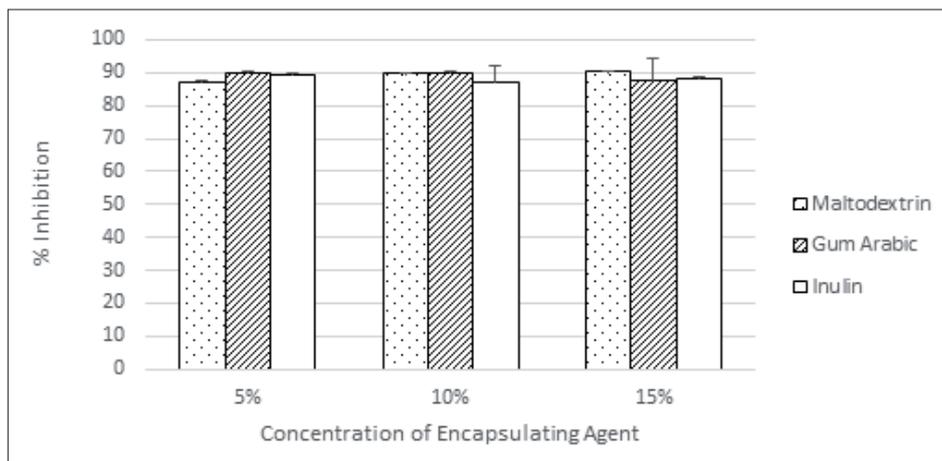
The types and the concentrations of encapsulating agents had almost no effect on the antioxidant activity of RDF kombucha powders since the results were quite similar among samples (Figure 3). This finding is in alignment with a previous study on spray dried of açai by Tonon et al. [17] and pineapple peel extract by Lourenço et al. [10]. The main concern was the ability of encapsulating agents to retain the antioxidant properties of the spray dried powder product. The highest antioxidant activity was observed in maltodextrin with concentration of 15%, which exhibited the percentage of inhibition at  $90.44 \pm 0.20\%$ . Usually, total phenolic content and antioxidant activity have a high correlation [23]. However, in this study sample with the highest polyphenol (10% gum Arabic) did not have the highest antioxidant activity. Nevertheless, the antioxidant activity of all RDF kombucha powder was similar one to another. This might be due to the high concentration of samples (Figure 3).

### 3.7 Color

Since gum arabic showed a superior character as the encapsulating agent for spray dried RDF kombucha, the resultant powder was subsequently subjected to color analysis.  $\Delta E^*$  showed how different the investigated sample from the standard white tile [6]. The greatest  $\Delta E^*$  was shown by 10% incorporation of gum arabic,



**Figure 2.** Total phenolic content of spray dried RDF kombucha using various concentrations of encapsulation agents.



**Figure 3.** Antioxidant activity of spray dried RDF kombucha using various types and concentrations of encapsulation agents, expressed as percent inhibition against DPPH.

although it was not so much different from the RDF kombucha powder with 5% of gum arabic. Incorporating 15% of gum arabic resulted in RDF kombucha powder with the least  $\Delta E^*$ , since more addition of gum arabic increased the  $L^*$  in a bigger magnitude compared to either  $a^*$  or  $b^*$ . The increase of  $L^*$  was in alignment with the study of Daza et al. [11] on spray-drying of cagaita (*Eugenia dysenterica* DC.) fruit extracts with the incorporation of gum arabic. The  $L^*$  of powdered cagaita fruit extracts increased with increasing concentrations of gum arabic due to the dilution effect of the carrier, which was a white powder.

In order to give a better illustration of how the red color of the RDF kombucha powder changed with increasing concentration gum arabic, the *CIRG* was calculated. Minor differences were observed in the *CIRG* of all powdered samples, indicating that the red color was similar one to another.

#### 4. CONCLUSIONS

Gum arabic gave the best desired properties for the spray dried RDF kombucha powder compared to maltodextrin and inulin. RDF kombucha powder, prepared with gum arabic at 5–15% concentrations, displayed a powdery appearance which was free of agglomerates and clumps with a similar red color as expressed by a narrow *CIRG* range ( $1.69 \pm 0.06 - 1.72 \pm 0.17$ ). The superiority of gum arabic as an encapsulating agent was shown by high yield ( $80.11 \pm 0.58 - 91.30 \pm 7.17$ ) and relatively high pH ( $3.79 \pm 0.00 - 3.86 \pm 0.04$ ). Although the antioxidant of all RDF kombucha powder was nearly not affected by either different types of encapsulating agents or their concentrations, gum arabic was the best in retaining the total phenolic content. Therefore, gum arabic in the range of 5-15% of concentrations is recommended for future preparations of RDF kombucha powder. In particular, the lowest concentration at

**Table 2.** Color properties and total color differences of spray dried RDF Kombucha using gum arabic as the encapsulating agent.

Concentration of gum arabic (%)	$L^*$	$a^*$	$b^*$	$\Delta E^*$	<i>CIRG</i>
5%	$63.96 \pm 3.51$	$17.06 \pm 4.89$	$11.70 \pm 3.83$	$35.14 \pm 4.34$	$1.70 \pm 0.22$
10%	$65.64 \pm 4.77$	$21.47 \pm 1.29$	$10.72 \pm 2.35$	$35.89 \pm 2.41$	$1.72 \pm 0.17$
15%	$68.77 \pm 0.79$	$19.51 \pm 1.57$	$9.92 \pm 1.10$	$31.99 \pm 0.58$	$1.69 \pm 0.06$

Note :

The color properties of standard white tile are as follow:  $L^*$  (93.27),  $a^*$  (0.16), and  $b^*$  (3.18)

5% of gum arabic is recommended to produce RDF kombucha powder since it gave similar physicochemical, phytochemical, and antioxidant properties to 10% and 15% of gum arabic. The main difference was in the drying yield.

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## REFERENCES

- [1] Dufresne, C. and Farnworth, E., 2000, 'Tea, kombucha, and health: A review', *Food Research International* 33(6): 409-421, doi: 10.1016/S0963-9969(00)00067-3
- [2] Rizal, M., 'Prospek pengembangan buah naga (*Hylocereus costaricensis*) di Kabupaten Kutai Kartanegara, Kalimantan Timur Development prospect of dragon fruit (*Hylocereus costaricensis*) in Kutai Kartanegara District, East Kalimantan', In *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia*, Volume 1, Nomor 4, Juli 2015, ISSN: 2407-8050, halaman: 884–888 (in Bahasa Indonesia), doi: 10.13057/psnmbi/m010440
- [3] Maryati, Y., 'Pengembangan pangan fungsional berbasis polifenol dari sayuran dan buah terfermentasi sebagai pengikat kolesterol untuk pencegahan penyakit degeneratif', *Pusat Penelitian Kimia LIPI, Indonesia, Laporan Insinas 2018* (in Bahasa Indonesia)
- [4] Sangeeta, S., Kumar, M. N., and Lata, M.C., 2015, 'Effect of spray drying of four fruit juices on physicochemical, phytochemical, and antioxidant properties', *Journal of Food Processing and Preservation* 39(6): 1656–1664, doi: 10.1111/jfpp.12395.
- [5] Maryati, Y., Susilowati, A., Artanti, N., Lotulung, P.D.N, and Aspiyanto, 2020, Effect of fermentation on antioxidant activities and betacyanin content of functional beverages from dragon fruit and beetroot, *Jurnal Bioteknologi dan Biosains Indonesia* 7(1): 48–58 (in Bahasa Indonesia)
- [6] Pathare, P.B., Opara, U.L., and Al-Said, F.A., 2013, Colour measurement and analysis in fresh and processed foods, *Food Bioprocess Technology* 6(1): 36–60, doi: 10.1007/s11947-012-0867-9
- [7] Carreño, J. and Martínez, A., 1995, Proposal of an index for the objective evaluation of the colour of red table grapes, 28(4): 373–377
- [8] Thevenet, F., 2010, Acacia gum (gum arabic), In A. Imeson (Ed.) : *Food Stabilisers, Thickeners and Gelling Agent*, John Wiley & Sons Ltd., UK: West Sussex, pp. 11–30, doi: 10.1002/9781444314724.ch2
- [9] Toneli, J., Park, K., Negreiro, A., and Murr, F., 2010, Spray-drying process optimization of chicory root inulin, *Drying Technology* 28: 369–379 doi: 0.1080/07373931003645017
- [10] Lourenço, S.C., Moldão-Martins, M., and Alves, V.D., 2020, Microencapsulation of pineapple peel extract by spray drying using maltodextrin, inulin and Arabic gum as wall matrices, *Foods* 9: 718, doi: 0.3390/foods9060718
- [11] Daza, L.D., Fujita, A., Fávoro-Trindade, C.S., Rodrigues-Ract, J.N., Granato, D., and Genovese, M.I., Effect of spray drying conditions on the physical properties of Cagaita (*Eugenia dysenterica* DC.) fruit extracts, *Food and Bioprocess Processing* 97: 20–29, doi: 10.1016/j.fbp.2015.10.001
- [12] Du, J., Ge, Z.Z., Xu, Z., Zou, B., Zhang, Y., and Li, C.M., 2014, 'Comparison of the efficiency of five different drying carriers on the spray drying of persimmon pulp powders', *Drying Technology* 32(10): 1157–1166, doi: 10.1080/07373937.2014.886259
- [13] Kingwatee, N., Apichartsrangkoon, A., Chai-kham, P., Worametrachanon, S., Techarung, J., and Pankasemsuk, T., 2015, 'Spray drying *Lactobacillus casei* 01 in lychee juice varied carrier materials', *LWT - Food Science and Technology* 62(1): 847–853, doi: 10.1016/j.lwt.2014.12.007
- [14] Yousefi, S., Emam-Djomeh, Z., and Mousavi, S.M., 2011, 'Effect of carrier type and spray drying on the physicochemical properties of powdered and reconstituted pomegranate juice (*Punica granatum* L.)', *Journal of Food Science and Technology* 48(6): 677–684, doi: 10.1007/s13197-010-0195-x
- [15] Tontul, I. and Topuz, A., 2017, 'Spray-drying of fruit and vegetable juices: Effect of drying conditions on the product yield and physical properties', *Trends in Food Science and Technology* 63: 91–102, doi: 10.1016/j.tifs.2017.03.009
- [16] The Indonesian National Standard for instant beverage powder products (SNI 01-4320-1996), *Badan Standardisasi Nasional, Indonesia: Jakarta* (in Bahasa Indonesia)

- [17] Tonon, R.V., Brabet, C., and Hubinger, M.D., 2008, 'Influence of process conditions on the physicochemical properties of açai (*Euterpe ole-raceae* Mart.) powder produced by spray drying', *Journal of Food Engineering* 88(3): 411–418, doi: 10.1016/j.jfoodeng.2008.02.029
- [18] Quek, S.Y., Chok, N.K., and Swedlund, P., 2007, 'The physicochemical properties of spray-dried watermelon powders', *Chemical Engineering and Processing: Process Intensification* 46(5): 386–392, doi: 10.1016/j.cep.2006.06.020
- [19] Şahin-Nadeem, H., Dinçer, C., Torun, M., Topuz, A., and Özdemir, F., 2013, 'Influence of inlet air temperature and carrier material on the production of instant soluble sage (*Salvia fruticosa* Miller) by spray drying', *LWT - Food Science and Technology* 52(1): 31–38, doi: 10.1016/j.lwt.2013.01.007
- [20] Kha, T.C., Nguyen, M.H., and Roach, P.D., 2010, 'Effects of spray drying conditions on the physicochemical and antioxidant properties of the Gac (*Momordica cochinchinensis*) fruit aril powder', *Journal of Food Engineering* 98(3): 385–392, doi: 10.1016/j.jfoodeng.2010.01.016
- [21] Villarreal-Soto, S.A., Beaufort, S., Bouajila, J., Souhard, J.P., and Taillandier, P., 2018, 'Understanding kombucha tea fermentation: a review', *Journal of Food Science* 83(3): 580–588, doi: 10.1111/1750-3841.14068
- [22] Do, H.T.T. and Nguyen, H.V.H., 2018, 'Effects of spray-drying temperatures and ratios of gum Arabic to microcrystalline cellulose on antioxidant and physical properties of mulberry juice powder', *Beverages* 4(4): 101, doi: 10.3390/beverages4040101
- [23] Aryal, S., Baniya, M.K., Danekhu, K., Kunwar, P., Gurung, R. and Koirala, N. Total Phenolic Content, Flavonoid Content and Antioxidant Potential of Wild Vegetables from Western Nepal. *Plants* 2019, 8, 96; doi:10.3390/plants8040096