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Effect of *Stevia rebaudiana* on the Bioactive Compounds from Agarwood Leaf (*Aquilaria* spp.) by Lactic Fermentation and Spray Drying

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Agarwood (*Aquilaria* spp) has high economic value. However, essential oil production from agarwood is a time-consuming process. Additionally, agarwood leaves have not been utilized even though they contain various bioactive ingredients. In this study, agarwood leaves were fermented using *Lactobacillus plantarum* ATCC 8014 with or without *Stevia* (4, 8, and 12%; v/v). The fermented fluid was mixed with maltodextrin (15%; w/v) and subjected to spray drying (inlet temperature, 120℃; outlet temperature, 65–70℃). The contents of polyphenols, polysaccharides, saponins, and flavonoids and the viability of *L. plantarum* were determined. Fermentation enhanced the levels of bioactive compounds. The contents of polyphenol (69.19 ± 4.05 mg GAE/g of sample), polysaccharide (20.75 ± 0.98 mg GE/g of sample), saponin (305.23 ± 4.21 mg OAE/g of sample), and flavonoid (7.86 ± 0.72 mg QE/g of sample), and the viability of *L. plantarum* (8.72 ± 0.17 log CFU/ml) were markedly upregulated in the samples containing *Stevia* (12%; v/v). This indicated that the supplementation of *Stevia* during fermentation decreases the fermentation time (9 h), upregulates bioactive compound production in agarwood leaves, enhances microencapsulation during spray drying, and increases the viability of *L. plantarum* under simulated gastric digestion conditions.

Keywords: *Aquilaria* spp, bioactive compounds, fermentation, spray drying, *Stevia rebaudiana*

Introduction

Agarwood plant (*Aquilaria* spp.) originated in Southeast Asia is known for the value of the essential oil produced in wood stems [1]. In addition to the traditional medicinal uses, it is also used in perfumes manufacture or flavoring ingredients in food products. Because of these outstanding benefits, the wood body of frankincense is the most concerning part. However, the agarwood plant usually took more than ten years for the good quality of essential oil harvest [1], so the economic issue in this period should be considered. Besides the source of agarwood essential oil, previous studies have shown many bioactive compounds were found in agarwood leaves including, phenolic acids, benzophenones, xanthonoid, flavonoids, saponins, alkaloids, and steroids; ingredients showing different pharmacological effects [2, 3]. Medicinal value of agarwood leaves was proven capable antihyperglycemic [4]; antioxidants [3, 4], and antibacterial [3]. These studies suggested that using agarwood leaves would be a potential approach that not only brings economic meaning during the awaiting of essential oil but also create a new product line that brings many health benefits.

The extraction efficiency of bioactive compounds plays an important role to fully exploit these components from

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agarwood leaves. Various approaches are available such as microwave-assisted extraction, ultrasound-assisted extraction, and lactic fermentation, that improved the extraction efficiency of bioactive compounds from medicinal plants [5, 6]. Microwave-assisted extraction or ultrasonic-assisted extraction is the process of mechanically acting on the plant cell wall to disrupt and improve extraction efficiency [5]. However, this mechanical process often causes overheating during the treatment leading to the effect of bioactive compounds [7]. Unlike microwave or ultrasonic extraction, fermentation is conducted at a constant temperature and does not cause overheating during the fermentation process. Also, fermentation could promote the metabolism of biological substances that alter product properties for higher value [8]. Among other fermentation processes, lactic fermentation is being widely used in which *Lactobacillus plantarum* is most frequently used in the fermentation of plant-based food products [9]. In addition, fermentation caused destruction and alterations that increase the bioactive substances [9]. During growing, probiotic strains will convert sugars into lactic acid and create antibacterial compounds such as hydrogen peroxide, bacteriocins, reducing the pH of the product facilitates the inhibition of harmful microorganisms [10]. However, agarwood leaf is not a familiar substrate source for probiotic bacteria that could delay the extraction of bioactive compounds. Besides, agarwood leaves contain high tannins and saponins contents, resulting in an acrid and strong bitter taste [2]. Therefore, providing the substrate source for probiotic bacteria as well as reducing the sensory effect of the fermentation extract should be considered in which the use of stevia (*Stevia rebaudiana*) could achieve these values. Stevia is 300 times sweeter than sucrose and does not affect blood glucose levels thanks to the active ingredient steviol in its composition [11]. Stevia has been approved by the Food and Drug Administration for safety and is widely used in the food industry as a sugar substitute [11]. Besides, the ingredients in stevia have been shown to stimulate the growth of probiotic bacteria [12, 13].

For extracting fluid from the herb, the preservation and maintenance of the bioactive compounds are very important. The making of powder products by spray drying method is commonly used because it offers many advantages such as; ease of use, prolonged storage time [14, 15]. Also, this method was proven effective in the packaging of food ingredients sensitive to heat as polyphenols, anthocyanins, β-carotene, and carotenoids, as well as protect microorganisms under the effect of high-temperature spray drying because the carrier acts as a coating material [16, 17]. Although many studies on the extraction of biological compounds from medicinal plants using fermentation processes, studies on agarwood leave supplemented with stevia and evaluated the ability to maintain these compounds as well as the viability of probiotic bacteria was poorly reported. Therefore, this study evaluated the effect of fermentation, rate supplement stevia, and spray drying process on the extraction efficiency of bioactive compounds from agarwood leaves. The evaluation criteria are the total polyphenols, total polysaccharides, total saponins, total flavonoid contents, and *L. plantarum* viability. The *L. plantarum* survival in SGF (Simulated gastric fluid) and SIF (Simulated intestinal fluid) after spray drying process was also evaluated in this study.

Materials and Methods

Materials

Aquilaria spp leaves (Fig. 1) from Dong Nai province, which is located at 10°51′20.0″N 106°57′28.3E in the Southeast region of Vietnam. Aquilaria spp leaves (5–6 years old) were selected in the same color and size, washed, and dried with absorbent paper. The leaves were then milled by a blender (HR2118/01, Netherlands). 100 ml of water was added to 4 ± 0.01 grams of sample, the mixture used for the fermentation process.

Stevia (*Stevia rebaudiana)* after collecting samples in Hung Yen province, which is located at 20°39′N 106°04′E

Fig. 1. *Aquilaria* spp. leaves.

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in the northern part of Vietnam. Stevia was dried and crushed by the blender. 140 ml of water added to 4 ± 0.01 grams of fresh grass soaked in a water bath (WNE 22, Germany) at 65℃, 3 h. Obtain the extract and add it to the fermentation process.

Lactobacillus plantarum ATCC 8014 strain was obtained from the strain collection of the Faculty of Food Science and Technology, the Ho Chi Minh City University of Food Industry. The strain was incubated on Man Rogosa Sharpe (MRS) medium at 37℃ in 24 h. Biomass was collected by centrifuge (Z206A, Hermle, Germany) and suspended in 10 ml of saline water (0.9% w/v) for the fermentation process.

Fermentation process

The milled agarwood was fermented by *L. plantarum* (7 log CFU/ml) with or without the addition of stevia (4; 8; and 12% v/v) at 37℃. Samples were examined for bioactive compounds and *L. plantarum* density every 3 h during 36 h of fermentation. The density of *L. plantarum* was determined on the MRS medium after 48 h of incubation at 37℃.

Spray drying process

Agarwood extract mixture after fermentation was supplemented with maltodextrin (PCT0611, India) 15% (w/v) and spray-dried with parameters: 4.5 ml/min, injector diameter 0.5 mm, the pressure was 2 atm, the inlet temperature was 120℃, the outlet temperature was 65–70℃. The bioactive compounds content and the *L. plantarum* viability were checked before and after the spray drying process through microencapsulation efficiency to evaluate the effect of the drying process. Microencapsulation efficiency (ME) was calculated based on the following formula:

$$ME(\%) = \frac{\sum \text{bioactive compounds content or density of } L.\ plantarum \text{ after drying}}{\sum \text{bioactive compounds content or density of } L.\ plantarum \text{ before drying}} \times 100\%$$

Analytical method

Determination of total phenolic content. Total phenolic content was conducted as described by Vuong *et al.* (2013) with some changes [18]. 1 ml of the diluted sample 10 times into a test tube, then add 5 ml of Folin-Ciocalteu reagent, mix, allow 5 min to occur, then 4 ml of 7.5% sodium carbonate (w/v), let stand in the dark for 1 h. The absorbance was measured with a wavelength of 765 nm. Results are expressed in mg gallic acid equivalent per gram of sample (mg GAE/g sample) based on the gallic acid calibration curve.

Determination of total polysaccharide content. Total polysaccharide content was conducted according to the description of Ly *et al.* (2019) with some changes [19]. 1 ml of sample, add 5 ml of ethanol 96℃, hold at 4℃ for 24 h. Centrifuge the precipitate, dissolve the precipitate, and add to 10 ml with hot water at 70℃. Aspirate 2 ml of the above diluent into a test tube and add 8 ml of the anthrone reagent in concentrated sulfuric acid medium. Allow to stand at room temperature for 30 min and measure the absorbance at 630 nm. The results were calculated by mg D-glucose equivalent per gram of sample (mg GE/g sample) which was based on the calibration curve of D-glucose.

Determination of total flavonoid content. Total flavonoid content was described by Zhishen *et al.* (1999) with some changes [20]. 1 ml of the sample into a 10 ml volumetric flask containing 4 ml of distilled water twice. Then add 0.3 ml of 5% sodium nitrite (w/v) and shake well. After 5 min, add 0.3 ml of 10% aluminum chloride (w/v), continue for 5 min, add 2 ml of 1 M sodium hydroxide, and add to volume with distilled water twice. Allow to stand at room temperature for 10 min and measure the absorbance at 510 nm. Results were expressed in mg quercetin equivalent per gram of sample (mg QE/g sample) based on the quercetin calibration curve.

Determination of total saponin content. Total saponin content was performed as described by Chen *et al.* (2007) with some changes [21]. 0.2 ml of the diluted sample 5 times into a test tube. Vanillin-acetic acid 0.2 ml, 5% (w/v), and 1.2 ml of perchloric acid were added, mixed well, and placed in a water bath at 70℃ for 20 min. The mixture was cooled rapidly for 2 min and made up to 5 ml with ethyl acetate. The absorbance is measured at 550 nm. Results were calculated using mg oleanolic acid equivalent per gram of sample (mg OAE/g sample) which was based on the calibration curve of oleanolic acid.

Test for the viability of *L. plantarum* in SGF and SIF. The experiment was carried out as described by Gbassi *et al.* (2009) [22]. Simulated gastric fluid (SGF) consisting of 9 g/l NaCl + 3 g/l pepsin adjusted pH to 2.5 with 5 M HCl and Simulated intestinal fluid (SIF) consisting of 9 g/l NaCl + 3 ml/l beef bile adjusted pH to 6.5 with 5 M NaOH.

The 4 g sample was incubated in 36 ml of SGF medium for 2 h at 37℃, the sample was then transferred to SIF medium and incubated for 4 h at 37℃. The viability of *L. plantarum* was assessed on the MRS medium after 48 h of incubation at 37℃.

Statistical analysis. All experiments were repeated three times, results presented as mean ± standard deviation. Results were calculated using Microsoft Office Excel 2019 software and SPSS 20.0 statistical software. ANOVA analysis results with 95% confidence, comparing the differences between the treatments through the Tukey and Duncan test.

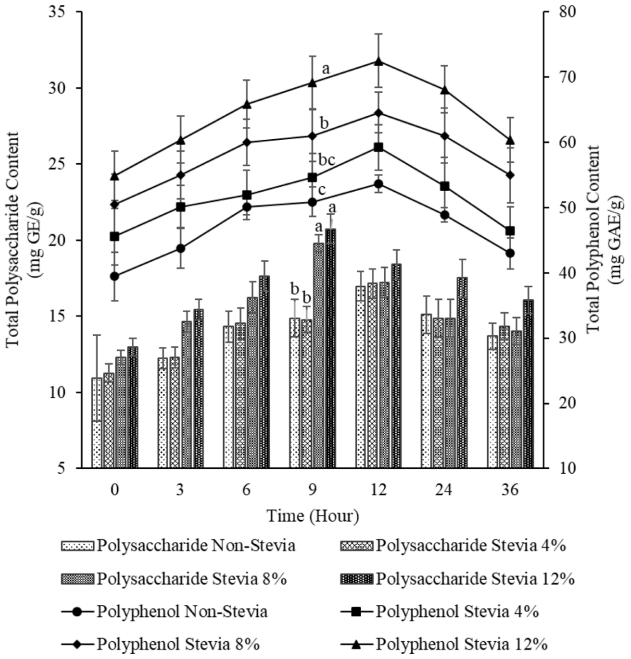

Fig. 2. Effects of fermentation and mixing ratio of stevia on the total content of polysaccharide and polyphenol. [abc]the mean values between the four samples, the character differences have statistically significant differences ($p < 0.05$).

Results and Discussion

Effect of the fermentation process and mixing ratio of stevia on bioactive compounds from agarwood leaves

The effect of the lactic fermentation process with or without stevia supplement on the ability to extract bioactive compounds was shown in Figs. 2, 3. In the sample without adding stevia, the content of polyphenol, saponin, and polysaccharide increased significantly ($p < 0.05$) after 12 h of fermentation compared to initial time with the corresponding content 53.65 ± 1.38 mg GAE/g sample; 211.9 ± 3.15 mg OAE/g sample; and 16.97 ± 0.97 mg GE/g sample (Figs. 2 and 3). The stevia supplement samples at a concentration of 4% (v/v), was shown a similar trend of increase. However, when the stevia concentration increased to 8% and 12% (v/v), the bioactive ingredients from agarwood leaves achieved the highest value after 9 h of fermentation, and 12% (v/v) of the stevia reached the highest level in terms of the total content of polyphenols, polysaccharides, saponins with 69.19 ± 4.05 mg GAE/g sample; 20.75 ± 0.98 mg GE/g sample; and 305.23 ± 4.21 mg OAE/g sample, respectively (Figs. 2 and 3).

The results show that *L. plantarum* the extraction and metabolism of bioactive compounds from agarwood leaves. The positive effects of lactic fermentation on the extraction of biologically active substances from plants have been reported in previous studies. Research by Septembre *et al.* (2018) reported the improvement of phenolic compounds through polymer hydrolysis due to lactic fermentation on fresh fruits and vegetables [9]. Similarly, Limón *et al.* (2015) indicated that lactic fermentation by *L. plantarum* increased the phenolic compounds content in kidney beans [6]. These results would be due to lactic bacteria possessing significant enzymes during extraction such as amylase, β-glucosidase, decarboxylase, peptidases, phenolic acid decarboxylases, proteinase, tannase [23]. These enzymes cause structural disruption of the plant cell wall, leading to the release or synthesis of various compounds [23]. However, the bioactive compounds tended to decline with prolonged fermentation time (Figs. 2 and 3). During the fermentation process, the lactic bacteria produce organic acids that decrease pH over fermentation time. Sestelo *et al.* (2004) suggested that among produced enzymes, β-glucosidase begin to be inactivated when the pH drops below 4 [24]. Besides, the presence of lactic bacteria contributes to simple phenolic conversion and reduction of

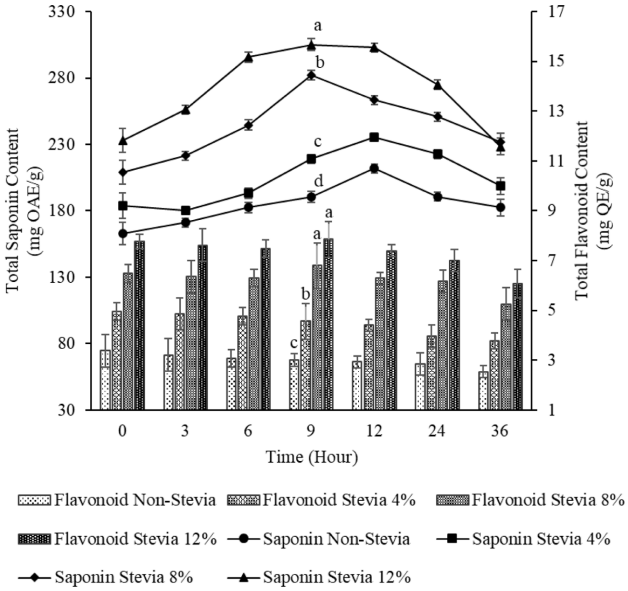

Fig. 3. Effects of fermentation and mixing ratio of stevia on the total content of saponin and flavonoid. [abc]the mean values between four samples, the character differences have statistically significant differences ($p < 0.05$).

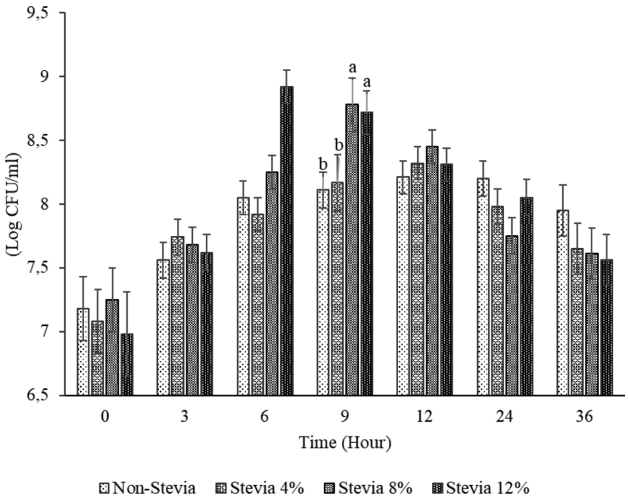

Fig. 4. Effects of fermentation and mixing ratio of stevia on *L. plantarum* viability. [abc]the mean values between four samples, the character differences have statistically significant differences ($p < 0.05$).

phenolic compounds with high molecular weight, so the polyphenol content was reduced during long-term fermentation [19]. However, the flavonoid content did not find a similar trend in both samples that content with or without stevia. Flavonoid content decreased from the early stages of fermentation though a significant difference compared to initial time was not recorded ($p > 0.05$) (Fig. 3). Limón *et al.* (2015) also observed a decrease in flavonoid content after kidney bean fermentation with *L. plantarum* ATCC 14917 strain [6]. Lee *et al.* (2018) indicated that the total flavonoid content in soybeans was not significantly affected by the fermentation process and genetics of *L. plantarum* P1201 strain leading to there was no increase in content like polyphenol content [25].

The study results also indicated that the *L. plantarum* viability increased significantly during the fermentation process compared to initial time (Fig. 4). This showed that the extracted fluid of agarwood leaf could provide the necessary substrate source for the *L. plantarum* growth. The results also indicated that there was no significant difference between the samples with or without stevia at a concentration of 4% (v/v). However, by increasing stevia concentration of 8% to 12% (v/v), the viable *L. plantarum* was improved as well as reducing the fermentation time which required 9 h to reach the best results compared to 12 h in the samples without stevia (Figs. 2 and 3). Also, the bioactive compounds significantly higher than the samples without stevia.

Improving the extraction efficiency of bioactive compounds as well as increase the probiotic viability after the fermentation process plays an important role. The results also showed that the density of *L. plantarum* has relative to the content of bioactive substances from agarwood leaves. The increase in *L. plantarum* density increased the extraction efficiency of bioactive compounds in which the addition of stevia (8% and 12% v/v) increased *L. plantarum* viability and reduced the required time to acquire the bioactive compounds (Figs. 2, 3, and 4). Previous studies have shown that stevia contains fructo-oligosaccharides (FOS), a prebiotic form that could stimulate lactic bacteria growth [12]. Besides, the main sweetener component of stevia is steviol glucoside has also been shown to be a sugar substitute for probiotic fermentation, that significantly improved the *L. acidophilus* growth [13]. These showed that the addition of stevia to the lactic fermentation process of agarwood leaves could improve benefit bacteria, increases the efficient extraction of bioactive substances, and enhances sensory value to post-fermentation products. Increasing stevia concentration (up to 16% v/v) was not improved ($p > 0.05$) the sensory value, the content of the bioactive compounds, and

the viable *L. plantarum* compared to the lower concentration (12% v/v) (data not shown). The results obtained from the study showed that the supplementation of 8% and 12% stevia was necessary to shorten the fermentation time while ensuring the highest concentration of probiotic bacteria (Figs. 2–4).

Effect of spray-drying on bioactive compounds and *L. plantarum* viability

The effect of spray drying on bioactive compounds and the *L. plantarum* viability was shown in Fig. 5. The results showed that the microencapsulation efficiency in the sample without adding stevia was 47.49%; 62.44%; 47.22%; 66.92%; and 84.82%, corresponding to the total content of polyphenol; polysaccharide; saponin; flavonoid; and *L. plantarum* survival rate, respectively (Fig. 5). The samples contain stevia showed improve microencapsulation efficiency of bioactive compounds and the probiotic bacteria survival after the spray-drying process. The stevia concentration of 8% and 12% (v/v) reached the microencapsulation efficiency of the total of polyphenol, polysaccharide, saponin, flavonoid, and *L. plantarum* viability was 51.2% and 53.55%; 61.55% and 63.64%; 54.55% and 64.64%; 68.13% and 69.63%; and 88.61% and 92.45% respectively.

The spray drying process creates a powder product, making it easy to use and prolonging product storage time. However, for bioactive substances and probiotics, high temperatures in the spray-drying process should concern. Tchabo *et al.* (2019) indicated that an increase in inlet temperature of 120 to 160℃ decreased the total content of polyphenols, flavonoids, and other bioactive compounds [26]. Besides, increase the temperature would be destroyed saponins, which are heat-sensitive [27]. The recovery rate of polyphenols decreased 73% when the spray-drying temperature was 140℃ [28] and the survival rate of the probiotic decreased to 80% when the inlet temperature was 155℃ [29] whereas, the remaining the total content of polyphenol and flavonoid was up to 62% and 73% respectively when the spray drying temperature was 100℃ [30]. However, the spray drying temperature below 120℃ results in low powder yield and high powder moisture [26]. In the present study, the spray-drying process with an inlet temperature of 120℃ showed a significant impact on the bioactive compounds in agarwood leaves as well as *L. plantarum* survival (Fig. 5). An increase in the inlet temperature caused a more decrease in the bioactive compounds and *L. plantarum* survival, whereas a decrease in inlet temperature caused high powder moisture (data not shown). These results indicated that the inlet temperature affected bioactive compounds and probiotic viability during the spray drying process. Therefore, the choice of wall materials is necessary to improve the microencapsulation efficiency.

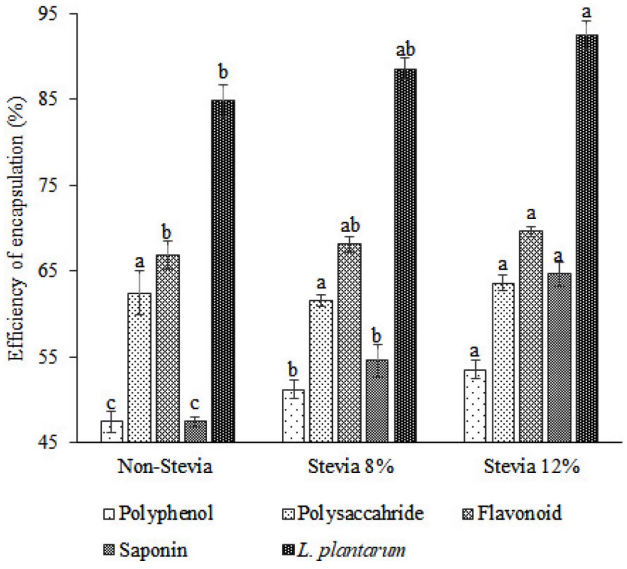

Fig. 5. Effect of spray drying on bioactive compounds and *L. plantarum* viability. [abc]the mean values between the three samples, the character differences have statistically significant differences ($p < 0.05$).

Maltodextrin is a commonly used carrier in spray drying because of its properties as a prebiotic that protects probiotic bacteria, improves the recovery efficiency of bioactive compounds, is cheap, and prevents adhesion to the wall of equipment when spray drying [15, 16]. However, to further improve the protective effect of the wall materials, adjuvant compounds are often used. Research by Çam *et al.* (2018) showed that maltodextrin combined with gum arabic at different proportions (0–100%) did not show the difference in polyphenol content, but was effective in storing essential oils and increasing the sensory value of soluble mint tea [31]. Mahdi *et al.* (2019) showed that combinations of different carriers gave different polyphenol microencapsulation efficiencies, 87.20% for spray-drying with a mixture of maltodextrin, gum arabic, and modified starch and 72.11% for with a mixture of maltodextrin, modified starch, and whey pro-

tein [32]. Maltodextrin in combination with whey protein improved the *Lactobacillus rhamnosus* viability, and the *L. rhamnosus* viability was more increased significant by partial replacement of maltodextrin to sucrose or trehalose [14]. Besides, the previous studies also indicated that prebiotics act as an effective supporting ingredient for the spray drying process. Research by Kalita *et al.* (2018) indicated that the combination of maltodextrin and FOS improved the *L. plantarum* viability after the spray drying process [33]. Similarly, the study of Sosa *et al.* (2016) showed that the survival of *L. plantarum* strain was 93% when combining maltodextrin and galacto-oligosaccharides, whereas only 64% of cells survived spray drying with maltodextrin [34]. These results suggested that the combination of maltodextrin with other carrier ingredients is necessary to improve the efficiency of the drying process. The results obtained from the study showed that the addition of stevia (8% and 12% v/v) significantly improved the spray-drying performance in which the content of bioactive substances, as well as the survival rate of bacteria probiotics, were significantly improved compared to controls containing only maltodextrin (Fig. 5). The role of stevia in the spray-drying process is not well understood. The stevia composition contains fructo-oligosaccharides (FOS), which acts as a prebiotic [12]. Therefore, the positive impact of stevia on bioactive compounds of agarwood leaves and *L. plantarum* survival during the spray drying process could be related to prebiotic ingredients in stevia.

Survival of *L. plantarum* ATCC 8014 strain in simulated gastric digestion after spray drying process

The viability of *L. plantarum* under SGF and SIF condition was presented in Fig. 6. The survival rate of *L. plantarum* was significantly affected ($p < 0.05$) by simulated gastric digestion conditions. In the case of the fermented sample without the addition of stevia, the survival rate of *L. plantarum* was 50.67% and 31.67% after 2 h incubation in SGF and the next 4 h of incubation in SIF (Fig. 6). In the case of fermented samples containing stevia, the survival rate of *L. plantarum* was significantly improved compared to the non-stevia samples. The survival rate of *L. plantarum* in the samples containing stevia 8% (v/v) and 12% (v/v) was 59% and 65% after 2 h of incubation in SGF condition and the next 4 h incubation in SIF condition was 45.33% and 56% (Fig. 6).

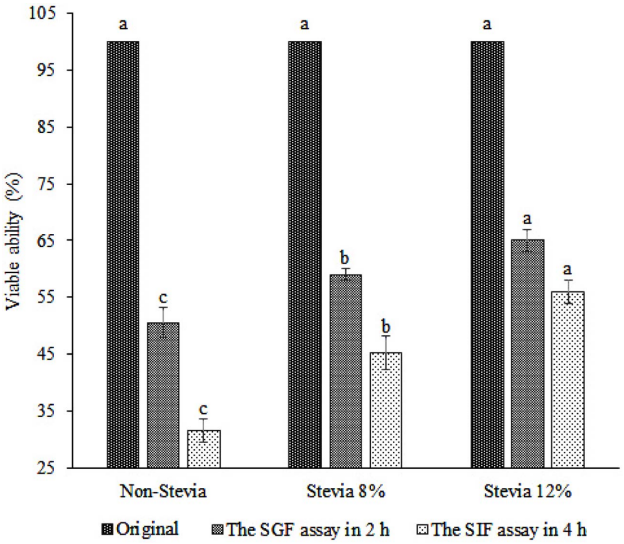

Fig. 6. Survival of *L. plantarum* strains under SGF and SIF conditions. [abc]the mean values between the three samples, the character differences have statistically significant differences (p <0.05).

The viability of probiotic bacteria in gastrointestinal conditions plays an important role, determining the health benefits that this strain brings. In the SGF condition, low pH inhibits microbial growth and reduces viable probiotic bacteria [35]. Depending on the strain, the ability to survive under these conditions varies. Previous studies indicated that free-form probiotic bacteria exhibited poor viability in gastrointestinal conditions. In the study of Ding *et al.* (2007), *L. plantarum* strain decreased by more than 6 log CFU/ml from 10.59 ± 0.41 log CFU/ml to 3.98 ± 0.29 log CFU/ml after 2 h of incubation at pH 2 and *L. acidophilus* also decreased by 6 log CFU/ml under the same conditions [36]. Therefore, microencapsulating these strains is necessary. The use of modified starch or inulin as a coating material formed during spray-drying for probiotic microencapsulation has been tested [29]. These coating materials would potentially increase the viability of probiotic bacteria under simulated gastrointestinal conditions [29, 33]. Additionally, the prebiotic role that enhances probiotic viability has also been proved in previous studies [33]. Maltodextrin has been shown to play a prebiotic role, helping to improve the viability of probiotic bacteria [16, 33]. This provides improved the viability of *L. plantarum* in SGF

and SIF conditions (Fig. 6). Besides, stevia containing FOS ingredients acts as a prebiotic source that helps to increase the survival rate in simulated digestive conditions in fermented juice [12, 37]. Therefore, the combination of maltodextrin and stevia, which all containing prebiotic sources could make a double effect that improved the *L. plantarum* viability (Fig. 6). The results showed that supplementing with stevia (12% v/v) was the most effective for the survival of *L. plantarum* under SGF and SIF (Fig. 6). The *L. plantarum* viability was not significantly different increasing the stevia concentration to 16% (v/v) as well as the sensory was lower than that at stevia concentrations 12% (v/v) (data not shown). This suggested that supplement stevia was not only to reduce the fermentation time require but also to improve the bioactive compounds from agarwood leaves and the *L. plantarum* viability in simulated gastric digestion.

Conclusion

The results showed that *L. plantarum* could grow well in agarwood leaves fluid. The content of bioactive compounds such as the total content of polyphenols, polysaccharides, saponins, and flavonoids achieved the best value after 9 h of fermentation. The spray drying process affected the bioactive compounds from agarwood leaves significantly. The study indicated that the addition of stevia in the fermentation process has many meaningful roles; firstly, it helps to reduce the fermentation time require (9 h of fermentation), improve the extracting efficiency of bioactive compounds from agarwood leaves; second, enhancing microencapsulation efficiency in the spray drying process, and ultimately helping to improve the *L. plantarum* viability under simulated gastric digestion. The study showed the potential application of fermented agarwood leaf as a health benefit product besides agarwood essential oil source.

Conflict of Interest

The authors have no financial conflicts of interest to declare.

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