

PROPERTIES OF DIETARY FIBER FROM RICEBERRY BRAN AND ITS APPLICATION IN YOGURT

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Abstract

A soluble dietary fiber is polysaccharide that is beneficial for health. This research aimed at finding the optimum ratio between Riceberry bran and water in extraction of fiber from Riceberry bran, and its application in increasing stability in yogurt. The results showed that the ratio of Riceberry bran to water of 1: 10 gained a maximum percentage of dietary fiber at 1.77%. The polysaccharide content of Riceberry bran extract (RBE) was 234.23 µg/mg. For the addition of RBE (0-0.3%) in yogurt, 0.2 and 0.3% significantly decreased the syneresis index of yogurt ($p \leq 0.05$), which was compared to the control yogurt during refrigerated storage. pH and titratable acidity (TA) values of the control and RBE-added (0.1-0.3%) yogurt were not significantly different, but had significantly increased number of lactic acid bacteria at 14 days of storage. The addition of 0.1-0.3% RBE tended to decrease L^* value (a prediction of food whiteness), however, there were no effects on sensory characteristic of the yogurt as compared to the control. Therefore, dietary fiber extracted from Riceberry bran could be used as an ingredient to improve the functional properties of yogurt.

Keywords: Riceberry bran, Dietary fiber, Yogurt

Introduction

Yogurt is considered as healthy food since it contains viable bacteria beneficial for gastrointestinal tract (Hashim *et al.*, 2009). It is made by fermentation of milk with specific lactic acid bacteria (LAB) namely, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (Serafeimidou *et al.*, 2012; Vianna *et al.*, 2017; Fazilah *et al.*, 2018). The addition of dietary fiber into yogurt would make it even healthier and improve its functional properties when compared with plain yogurt. Previous researchers have studied

the effects of dietary fiber on physicochemical and sensory properties as well as survival of probiotic bacteria in yogurt. Aportela-Palacios *et al.* (2005) reported that dietary fiber from wheat-bran could decrease syneresis of yogurt. Yogurts fortified with asparagus shoots fiber had improved consistency (Sanz *et al.*, 2008). Oat and date fibers also improved the body and texture of yogurts (Fernández-García *et al.*, 1998; Hashim *et al.*, 2009). Citrus fiber presence in fermented milks also enhanced bacterial growth and survival of the tested

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probiotic bacteria (Sendra *et al.*, 2008). Tomic *et al.* (2017) also suggested that insoluble triticale fiber exhibited promising potential to be used as a fortification in the production of fiber enriched yogurt.

Rice bran is a co-product of the rice milling industry with approximately 10% content. Rice bran is used as feed for animals (Thamnarathip *et al.*, 2016), and is very inexpensive. Rice bran is an excellent source of dietary fiber which contains total dietary fiber of 27.04-30.98% (insoluble dietary fiber of 24.99-25.53% and soluble dietary fiber of 2.25-5.45%) (Abdul-Hamid and Luan, 2000; Wan *et al.*, 2012). Riceberry rice is a dark purple grain; (*Oryza Sativa*), a specific breeding line developed by crossbreeding Hom Nil rice (Thai black rice) and Khao Dawk Mali 105 (Thai jasmine rice or Thai fragrant rice) (Thamnarathip *et al.*, 2016). Riceberry is popularly consumed in Thailand because of its high nutritional value (Leardkamolkarn *et al.*, 2011). Increasing Riceberry consumption is accompanied by increased Riceberry bran production, a low value byproduct of rice processing (Peanparkdee *et al.*, 2018). It has been reported that total dietary fiber recovered from Riceberry bran was 80.20 g/100g dry sample and that it exhibited the best antioxidant properties (Srikaeo *et al.*, 2017). Thus, the development of yogurts fortified with dietary fiber from Riceberry bran would increase value of Riceberry bran which is a low value byproduct, improve the functional properties of yogurt and might be a good option for consumers who are health conscious. Therefore, the objective of this work was to investigate the optimum ratio of Riceberry bran to water in order to receive the highest yield of fiber content. In addition, the effects of dietary fiber fortification on yogurt quality during cold storage were estimated based on the measurement of pH, acidity, lactic acid bacteria, syneresis index, color, and sensory properties.

Materials and Methods

Materials

Riceberry bran was obtained from Pak Thong Chai Mill, Nakhon Ratchasima, Thailand. All other employed chemicals and reagents were of analytical grade.

Enzyme Inhibition of Riceberry Bran

Since rice bran is a source of highly active lipolytic enzymes, lipolysis continues with prolonged storage yielding high levels of free fatty acids in the oil, resulting in a drastic quality reduction of the rice bran. Therefore, enzymes in

rice bran must be inactivated. Enzyme inhibition of Riceberry bran was performed according to the method of Wood *et al.* (1989). One hundred grams of Riceberry bran was mixed with 1 L of 75% ethanol, boiled at 85°C for 4 h, and cooled down to 50°C. Then, 1 L of 95% ethanol was added into the mixture and stirred for 15 min. Ethanol was discarded and the solid was dried at 50°C in hot air oven for the ethanol to evaporate. Samples were kept at 4°C for fiber extraction.

Extraction of Crude Fiber from Riceberry Bran

Enzyme inhibited Riceberry bran was extracted in water (pH 7.0) with ratios of Riceberry bran to water of 1:5, 1:10, and 1:20, incubated at 55°C for 5 h. pH of the mixtures were adjusted to 5 with 2 M HCl to precipitate the protein. Then, the mixtures were centrifuged at 6,000×g for 10 min. Supernatants were collected, the pH adjusted to 7.0 with 2 M NaOH and centrifuged at 6,000×g for 10 min. Supernatants were immediately mixed with absolute ethanol at a ratio of 1:1, kept at 4°C overnight for complete precipitation of fiber and centrifuged at 6,000×g for 10 min. Pellets were collected and dried at 50°C in hot air oven. Pellets, referred to crude fibers extract or Riceberry bran extracts (RBEs), were packed and kept in 4°C until use.

Determination of Total Polysaccharide of Riceberry Bran Extract

Total polysaccharide of RBEs was determined using Phenol- sulfuric acid method as described by Dubois *et al.* (1956). Crude fibers (RBEs) were solubilized in water at a ratio of 1:10. Two hundred microliters of solubilized samples were mixed with 200 µL of 5% phenol (w/v). Then, 1 mL of 98% sulfuric acid was added into the mixture, vortexed and incubated at room temperature for 30 min. Absorbance was measured at 490 nm. Glucose solution at concentrations of 2.5-40 µg/mL were used as the standard.

Determination of Water Holding Capacity (WHC) of Riceberry Bran Extract

RBE (0.0670 g) was mixed with 1 mL of distilled water and left at room temperature for 10 min. The mixture was centrifuged at 2,000×g for 15 min. Supernatants were discarded. The remaining pellet was weighted. Water holding capacity was calculated as Equation (1) (Committee on Codex Specifications, 1981).

$$\text{Water Holding Capacity (\%)} = \frac{\text{Sample weight after liquid separation}}{\text{Initial sample weight}} \times 100 \quad (1)$$

Preparation of Yogurt supplemented with Riceberry Bran Extract

Milk was heated until temperature reached 60°C. Then, 0.0, 0.1, 0.2 and 0.3% of RBE were added under continued stirring. Samples were pasteurized at 85°C for 5 min and cooled to 40°C. Then, yogurt starter cultures (*Streptococcus thermophilus*+*Lactobacillus delbrueckii* subsp. *bulgaricus*) were added into the mixtures, filled in plastic cups, and incubated at 40°C for 6-10 h. The control (yogurt without addition of RBE) and the yogurt supplemented with 0.1-0.3% RBE were kept at 5°C for 21 days. Samples were collected at days 1, 7, 14 and 21 for further analysis.

Changes in Properties of the Yogurt Supplemented with Riceberry Bran Extract (RBE) during Storage

Measurement of pH and Total Acidity

The pH of the control yogurt and yogurt supplemented with RBE at concentrations of 0.1-0.3% at days 0, 7, 14, and 21 of storage time was measured using pH meter (Dynamica, pH master LAB, N.T., Hong Kong). TA value was performed following Rinani Shima *et al.* (2012) method with some modification. Nine grams of samples was mixed with 18 mL of water and titrated with 0.1 N NaOH and calculated as a lactic acid equivalent expressed as % total acidity (w/w) following Equation (2):

$$\text{Lactic acid (\%)} = \frac{\text{ml of alkali} \times \text{Normality of alkali}}{\text{Weight of sampling}} \times 9 \quad (2)$$

Determination of Lactic Acid Bacteria (LAB)

Lactic acid bacteria were determined according to AOAC (2000) with some modification. Five grams of each yogurt sample was mixed with 45 mL of 0.1% peptone water, homogenized using a stomacher (MAXICATOR 3500 mL, IUL micro, Barcelona, Spain). Subsequently, serial dilutions were carried out using 0.1% peptone water. Lactic acid bacteria were enumerated using the spread-plate technique on MRS agar plates and incubated anaerobically in candle jar system at 37°C for 24-48 h. Plates with 25-250 colonies were counted. LAB load was expressed as log Colony Forming Unit (log CFU/g).

Measurement of Syneresis Index

Syneresis index measurement of yogurt was performed according to the method of Keogh and O'Kennedy (1998) with some modification. Five

grams of sample was placed into a centrifuge tube and centrifuged (Dynamica, Velocity 18R, N.T, Hong Kong) at 1,500×g for 2 min. The liquid was collected by using Pasteur pipette. Syneresis (%w/w) was calculated as Equation (3):

$$\text{Syneresis (\%w/w)} = \frac{\text{the weight of the liquid}}{\text{Initial sample weight}} \times 100 \quad (3)$$

Color Measurement

The color of samples was measured in terms of CIE L*, a*, b* values using a colorimeter (Hunter Lab, Miniscan EZ 4500L, Virginia, USA). L* value indicates the level of lightness or darkness, while a* and b* values indicate the color position on the axes of red-green and blue-yellow, respectively.

Sensory Evaluation

Sensory evaluation of the control and yogurt supplemented with 0.1-0.3% RBE was conducted using a 9-point hedonic scale. Twenty-five untrained panelists evaluated the acceptability of color, appearance, firmness, viscosity, aroma, taste, texture, and overall acceptability.

Statistical Analyses

All experiments were carried out in triplicate and data were expressed as means±standard deviations. Data were analyzed using analysis of variance (ANOVA) and means comparison was done using Duncan's multiple range test (DMRT), at 95% confidence level using a PASW Statistics 18 Release 18.0.0 software.

Results and Discussion

Riceberry Bran Extract (RBE)

The Riceberry bran extracted at the ratio of Riceberry bran to water of 1:10 contained the highest crude fiber content of 1.77% and total polysaccharide content of 234.23 µg/mg RBE (Table 1). This implied that the ratio of Riceberry bran to water of 1:10 was the maximum amount of soluble dietary fiber.

Water holding capacity of all samples was not significantly different and ranged from 93.22-95.39% ($p>0.05$, Table 1). This result indicated that crude fiber extract had the property to absorb water and swell up and might have a potential use as stabilizer in food. Therefore, Riceberry bran extracted at ratio of Riceberry bran to water of 1:10 was chosen for yogurt supplementation.

Table 1. Fiber content, total polysaccharide content and water holding capacity of RBE at various ratios of Riceberry bran to water.

Ratio of Riceberry bran: Water	Fiber Content (%)	Total Polysaccharide Content (µg/mg)	Water Holding Capacity (%) ^{ns}
1:5	0.62±0.04 ^b	179.38±5.77 ^b	93.48±0.14
1:10	1.77±0.14 ^a	234.23±4.68 ^a	93.22±0.54
1:20	0.67±0.15 ^b	223.77±22.36 ^a	95.39±0.15

^{ns} means not significant difference in the same column ($p>0.05$). Different superscript letters within the same column indicate means with significant differences ($p\leq0.05$)

Table 2. Changes in pH of yogurt supplemented with Riceberry bran extract (RBE) at various concentrations during storage.

Samples	pH Value			
	Day 1	Day 7 ^{ns}	Day 14 ^{ns}	Day 21
Control yogurt	4.12±0.02 ^b	4.06±0.00	3.95±0.19	4.11±0.02 ^b
Yogurt+0.1%RBE	4.13±0.00 ^b	4.02±0.02	3.83±0.02	4.13±0.04 ^b
Yogurt+0.2%RBE	4.25±0.01 ^a	4.06±0.04	3.86±0.07	4.25±0.09 ^{ab}
Yogurt+0.3%RBE	4.20±0.05 ^{ab}	4.04±0.00	3.92±0.13	4.29±0.02 ^a

^{ns} means not significant difference in the same column ($p>0.05$)

Different superscript letters within the same column indicate means with significant differences ($p\leq0.05$)

Table 3. Changes in titratable acidity (TA) of yogurt supplemented with Riceberry bran extract (RBE) at various concentrations during storage.

Sample	Titratable Acidity (g/L)			
	Day 1 ^{ns}	Day 7	Day 14 ^{ns}	Day 21 ^{ns}
Control yogurt	0.91±0.00	0.94±0.01 ^a	1.14±0.01	1.27±0.18
Yogurt+0.1%RBE	0.89±0.06	0.89±0.02 ^b	1.17±0.05	1.32±0.14
Yogurt+0.2%RBE	0.96±0.07	0.72±0.05 ^c	1.16±0.12	1.33±0.20
Yogurt+0.3%RBE	0.94±0.01	0.97±0.08 ^a	1.01±0.05	1.26±0.02

^{ns} means no significant difference in the same column ($p>0.05$)

Different superscript letters within the same column indicate means with significant differences ($p\leq0.05$)

Physical, Chemical and Biological Changes in the Properties of Yogurt Supplemented with 0.1-0.3% Riceberry Bran Extract (RBE) during Storage

pH Value and Titratable Acidity

pH value of yogurts supplemented with 0.1-0.3% were not significantly different as compared with the control (Table 2). However, at days 1 and 21, the pH value of yogurt supplemented with 0.2% RBE and 0.3% RBE was slightly higher than that of the control and yogurt supplemented with 0.1% RBE. These results were similar to Hashim *et al.* (2009) who reported that addition of date fiber (DF) or wheat bran (WB) could increase the pH value of yogurts. Fernández-García *et al.* (1998) also reported that oat fiber yogurt had a significantly higher pH (4.31) compared with the control yogurt (4.17). Whereas, pH value of yogurts containing *Bifidobacterium bifidum* Bb-12 and yogurt cultures (*S. thermophilus*+*L. Bulgaricus*), and barley-based β -glucan, and oat-based β -glucan was comparable with control yogurt (Ozcan and Kurtuldu, 2014). Our results indicated that the addition of RBE could affected the pH value depending on storage time. TA values of the control and yogurts fortified with RBE were comparable at days 1, 14, and 21 of

storage. Hashim *et al.* (2009) reported that the addition of date fiber or wheat bran had no effect on yogurt acidity (1.05-1.08%) when compared to the control, however, it increased the pH value.

The TA of yogurts incorporating fibers (inulin, pea, oat, and wheat) at concentrations of (1-2.5%) did not vary for all samples (Dabija *et al.*, 2018). Crispín-Isidro *et al.* (2015) also suggested that the addition of inulin concentrations (2%-6%) had no effect on TA due to a buffering effect of the protein.

When storage times were compared within the same treatment, the pH value of all yogurts tended to decrease during the storage period until day 14 and slightly increase at day 21 of storage (Table 2). While the TA values tended to increase during the storage period (0.72-1.33%) (Table 3), they were higher than the minimum requirement (0.6%) for yogurt (The Ministry of Public Health, 2013). Vianna *et al.* (2017) also reported that the pH values of probiotic yogurt decreased throughout the storage period while TA values increased. The pH decrease in association with TA increase in corn milk and cow milk yogurts during storage were also reported by Supavititpatana *et al.* (2010). The decrease in pH value and the increase in TA value could be attributed to the yogurt microorganisms

activity during storage period, where the fermentation of lactose produces lactic acid (Costa and Conte-Junior, 2015; Costa *et al.*, 2016; Vianna *et al.*, 2017). The after-acidification during the storage of yogurt occurs because of the enzymatic activity of lactic acid bacteria, which continues at a reduced rate during refrigeration, but does not completely stop (Supavititpatana *et al.*, 2010). Our results were similar to previous reports.

Lactic Acid Bacteria (LAB)

At day 1 of storage, lactic acid bacteria counts (7.78-7.90 log CFU/g) in all yogurts were higher than the minimum requirement of 10^7 CFU/g (The Ministry of Public Health, 2013) (Table 4). However, at the end of storage (28 days), lactic acid bacteria count of the yogurt fortified with 0.1% RBE (6.94 log CFU/g) and 0.3% RBE (6.43 log CFU/g) were slightly lower than the minimum requirement, except for the control and 0.2% RBE samples (Table 4). Supavititpatana *et al.* (2010) reported that numbers of *S. thermophilus* and *L. bulgaricus* in cow milk yogurt decreased during storage at 5°C for 35 days. Lactic acid bacteria counts of the control and yogurt supplemented with 0.1-0.3% RBE were not significantly different among samples at days 1, 7, and 21 of storage. However, at day 14 of storage, the lactic acid bacteria counts of the yogurt supplemented with 0.1-0.3% RBE were significantly higher than control yogurt ($p \leq 0.05$, Table 4). It has been reported that the addition of inulin at concentration of 1 to 5% (w/v) did not significantly influence the survival rates of either *S. thermophilus* or *L. acidophilus* in fermented milk during refrigerated storage at 4°C for 6 weeks

(Varga *et al.*, 2006). Our results indicated that the addition of 0.1-0.3% RBE did not have an effect on the viability of lactic acid bacteria in refrigerated yogurt, although a slight increase in viability at day 14 was observed.

Syneresis Index

Whey drainage or syneresis occurs during storage of yogurt due to yogurt gel losing the ability to entrap the serum phase, thus rendering weakness in the gel network, which can adversely affect the yogurt product's acceptability (Lucey, 2004; Salvador and Fiszman, 2004). The syneresis index of the control and yogurt supplemented with 0.1 and 0.2% RBE tended to decrease with an increase in storage period; up to 21 days (Table 5). The addition of RBE at concentrations of 0.1-0.3% in yogurt tended to decrease the syneresis index when compared to control yogurts during the same period (Table 5). Ozcan and Kurtuldu (2014) reported that yogurt supplemented with β -glucan significantly decreased whey separation or syneresis in all yogurts. Authors have suggested that these phenomena could be related to the gelling capacity of β -glucans and their high ability to cross-link gel network and elastic casein-protein-glucan matrix. An increase in the level of additional fibers leads to a decrease in the syneresis values due to water holding capacity of the fibers absorbing the whey released by the gel structure (Dabija *et al.*, 2018). The higher syneresis of the control yogurt possibly resulted from the less gel strength (Supavititpatana *et al.*, 2010). Raising the increments of overall solid content positively affects the density of the matrix and decreases syneresis (Amatayakul *et al.*, 2006).

Table 4. Changes in lactic acid bacteria of yogurt supplemented with Riceberry bran extract (RBE) at various concentrations during storage.

Sample	Lactic Acid Bacteria (log CFU/g sample)			
	Day 1 ^{ns}	Day 7 ^{ns}	Day 14	Day 21 ^{ns}
Control yogurt	7.83±0.16	6.71±0.04	6.87±0.07 ^b	7.27±0.16
Yogurt+0.1%RBE	7.78±0.04	6.99±0.18	7.19±0.03 ^a	6.94±0.04
Yogurt+0.2%RBE	7.84±0.04	6.41±1.01	7.08±0.08 ^a	7.44±0.04
Yogurt+0.3%RBE	7.90±0.05	6.87±0.25	7.07±0.07 ^a	6.43±0.05

^{ns} means no significant difference in the same column ($p > 0.05$)

Different superscript letters within the same column indicate means with significant differences ($p \leq 0.05$)

Table 5. Change in syneresis index of yogurt supplemented with Riceberry bran extract (RBE) at various concentration during storage.

Samples	Syneresis Index (%)			
	Day 1	Day 7 ^{ns}	Day 14	Day 21
Control yogurt	14.08±2.18 ^a	12.90±0.21	12.27±1.31 ^a	11.131±0.61 ^a
Yogurt+0.1%RBE	12.22±1.35 ^{ab}	11.23±2.49	10.61±1.75 ^{ab}	9.24±0.31 ^b
Yogurt+0.2%RBE	9.66±0.69 ^{bc}	9.83±1.32	6.01±0.51 ^c	5.52±0.12 ^c
Yogurt+0.3%RBE	7.93±1.42 ^c	10.71±0.22	8.79±0.62 ^{bc}	7.40±0.04 ^d

^{ns} means no significant difference in the same column ($p > 0.05$)

Different superscript letters within the same column indicate means with significant differences ($p \leq 0.05$)

Therefore, the addition of 0.1-0.3% RBE increased total solids content of yogurt resulting in stronger gel network and leading to decreased syneresis. In addition, RBE exhibited high water holding capacity and could absorb higher amounts of water than the control yogurt resulting in decreased syneresis.

The syneresis index of the yogurts supplemented with 0.2 and 0.3% RBE was not significantly different within each day (1, 7, and 14), except for day 21 of storage, where the syneresis index of the yogurt fortified with 0.3% RBE exhibited higher value than that of 0.2% RBE (Table 5). High concentrations of RBE might have disturbed the gel network of protein resulting in higher syneresis in the yogurt fortified with 0.3% RBE than that of 0.2% RBE. These results suggested that fortifying yogurt with 0.2% RBE is optimal to decrease syneresis.

Color

The L^* value of yogurt after 1 day of cold storage decreased with an increase in RBE concentration, while a^* and b^* values were not significantly different among samples when compared to the control (Table 6). L^* value is the prediction of food whiteness. These measurements indicated that RBE presented a darkening effect, probably due to the dark color of RBE. Yogurts fortified with 1.5% wheat bran fiber, as compared to the control yogurt, had considerably higher values of a^* and b^* and lower values of L^* due to the yellowish color of wheat bran (Hashim *et al.*, 2009). Therefore, the color of fortified-yogurt with fiber plant is dependent on the color of the fiber source.

Sensory Characteristics Score of Yogurts Supplemented with 0.1-0.3% RBE

The following attributes were scored: color, appearance, firmness, viscosity, aroma, taste, texture, and overall acceptability. All sensory attributes of the control and yogurts supplemented with 0.1-0.3% RBE after 1 day of cold storage had no significant difference ($p>0.05$, Table 7). Overall acceptability of all samples ranged from 5.08 to 6.04 (Table 7). These indicated that the addition of 0.1-0.3% RBE in yogurt had no effect on sensory attribute scores by panelists. Similar results were obtained by Staffolo *et al.* (2004) who reported that yogurts fortified with wheat, bamboo, or inulin fibers were acceptable and had similar sensory properties as plain yogurt. However, yogurt fortified with 1.5-4.5% date fiber had significantly lower ratings for appearance, color, and flavor than that of the control (Hashim *et al.*, 2009). Overall acceptability of yogurts fortified with 1.5-4.5% date fiber ranged from 5.8 to 6.8. Yogurt fortified with 1.5% wheat bran fiber had lower overall acceptance (score 4.2) than the control. The firmness and overall acceptance ratings depended on the level of fortification (Hashim *et al.*, 2009). Yogurt supplemented with 2% wheat fibers exhibited the highest acceptance scores followed by 2.5% pea fibers addition (Dabija *et al.*, 2018). These results indicated that the addition of soluble dietary fiber from plants might affect the sensory quality and acceptability ratings of yogurts depending on the source and level of fiber.

Table 6. Color (L^* , a^* , b^*) of yogurt supplemented with Riceberry bran extract (RBE) at various concentrations during storage.

Samples	L^*	a^{*ns}	b^{*ns}
Control yogurt	89.75±0.21 ^a	0.09±5.31	12.23±1.08
Yogurt+0.1%RBE	87.02±0.36 ^{ab}	-0.18±1.48	12.25±0.62
Yogurt+0.2%RBE	84.96±0.41 ^{bc}	0.71±0.24	12.51±0.96
Yogurt+0.3%RBE	82.31±2.28 ^c	1.68±1.07	12.22±0.43

^{ns} means no significant difference in the same column ($p>0.05$)

Different superscript letters within the same column indicate means with significant differences ($p\leq 0.05$)

Table 7. Sensory characteristics score of yogurts supplemented with Riceberry bran extract (RBE) at various concentrations.

Samples	Color ^{ns}	Appearance ^{ns}	Firmness ^{ns}	Viscosity ^{ns}	Aroma ^{ns}	Taste ^{ns}	Texture ^{ns}	Overall acceptability ^{ns}
Control yogurt	6.12±1.53	5.12±2.08	5.60±1.50	5.56±1.29	5.44±1.52	4.40±1.75	5.12±1.76	5.16±1.72
Yogurt+0.1%RBE	6.04±1.83	5.32±1.86	5.64±1.57	5.64±1.38	6.40±1.25	5.12±1.90	5.24±1.94	6.04±1.88
Yogurt+0.2%RBE	6.40±2.10	5.08±1.89	5.44±1.75	5.88±1.85	6.24±1.71	5.20±1.97	5.32±1.95	5.56±2.06
Yogurt+0.3%RBE	6.00±1.87	4.96±1.88	5.40±1.44	5.16±1.37	5.76±1.64	4.52±1.80	4.84±1.70	5.08±1.84

^{ns} means not significant difference in the same column ($p>0.05$)

Conclusions

These findings suggested that the addition of crude fiber (0.1- 0.3%) derived from Riceberry bran extraction improved the syneresis properties of yogurt during storage and could be used as a functional ingredient in food and provide health benefits.

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