บทความวิจัย

# ผลของรำข้าวไรซ์เบอร์รี่ต่อการพัฒนาผลิตภัณฑ์โยเกิร์ตนมแพะพร้อมดื่มเชิงหน้าที่

ศนิ จิระสถิตย์*
ภาควิชาวิทยาศาสตร์การอาหาร คณะวิทยาศาสตร์ มหาวิทยาลัยบูรพา

* ผู้นิพนธ์ประสานงาน โทรศัพท์ 09 7126 6854 อีเมล: sani@go.buu.ac.th
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**บทคัดย่อ**

ศึกษาการใช้ประโยชน์จากรำข้าวไรซ์เบอร์รี่ในการพัฒนาโยเกิร์ตนมแพะพร้อมดื่มเชิงหน้าที่ โดยเสริมรำข้าวไรซ์เบอร์รี่เป็นสารเชิงหน้าที่ในโยเกิร์ตพร้อมดื่มเพื่อปรับปรุงประโยชน์ต่อสุขภาพ โยเกิร์ตพร้อมดื่มสี่สูตรเตรียมจากนมแพะเสริมด้วยรำข้าวไรซ์เบอร์รี่ 0, 1, 2 และ 3% (w/v) ซึ่งในระหว่างการเก็บรักษานาน 8 วัน ที่อุณหภูมิ 4 องศาเซลเซียส พบว่า ปริมาณของแข็งที่ละลายได้ทั้งหมด ค่าความเป็นกรด-ด่าง ปริมาณกรดที่ไตเตรทได้ จำนวนแบคทีเรียกรดแลคติก และจำนวนยีสต์และราเปลี่ยนแปลงอย่างไม่มีนัยสำคัญทางสถิติเมื่อเสริมรำข้าวไรซ์เบอร์รี่ ($p \geq 0.05$) โยเกิร์ตนมแพะพร้อมดื่มทุกสูตรมีจำนวนแบคทีเรียกรดแลคติกที่มีชีวิตในปริมาณสูง (> 8 log cfu/mL) ระหว่างการเก็บรักษา กิจกรรมการต้านอนุมูลอิสระ DPPH ของโยเกิร์ตนมแพะพร้อมดื่มเพิ่มขึ้นเมื่อเติมรำข้าวไรซ์เบอร์รี่ ($p < 0.05$) อย่างไรก็ตาม การยอมรับทางประสาทสัมผัสลดลงเมื่อเติมรำข้าวไรซ์เบอร์รี่ ($p < 0.05$)

**คำสำคัญ**: โยเกิร์ตพร้อมดื่ม นมแพะ รำข้าวไรซ์เบอร์รี่ การเก็บรักษา

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Research Article

# Effect of Riceberry Bran on Product Development of Functional Drinkable Goat Milk Yogurt

Sani Jirasatid*
Department of Food Science, Faculty of Science, Burapha University, Chon Buri, Thailand

* Corresponding Author, Tel. 09 7126 6854, E–mail: sani@go.buu.ac.th DOI: 10.14416/j.kmutnb.2020.11.001
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## Abstract

The utilization of Riceberry bran in the development of functional drinkable goat milk yogurt was investigated in this study. Riceberry bran was fortified into drinkable yogurt as a functional ingredient in order to improve the health benefits. Four drinkable yogurt formulations were made from goat milk fortification with 0, 1, 2 and 3% (w/v) Riceberry bran. During 8 days of storage at 4°C, total soluble solids, pH, titratable acidity, the counts of lactic acid bacteria, and yeast and mold did not change significantly with the addition of Riceberry bran ($p \geq 0.05$). Drinkable goat milk yogurt formulations maintained high viability of lactic acid bacteria (> 8 log cfu/mL) during this storage period. DPPH radical scavenging activities of drinkable goat milk yogurts increased with the addition of Riceberry bran ($p < 0.05$). However, sensory acceptability declined with the addition of Riceberry bran ($p < 0.05$).

**Keywords**: Drinkable Yogurt, Goat Milk, Riceberry Bran, Storage

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## 1. Introduction

Drinkable yogurt is a dairy beverage generally made from bovine milk and has a rich nutrition [1]. However, health issues related to allergic and gastrointestinal disorders as well as requests for novel dairy products have prompted alternatives to bovine milk. Goat milk is regarded to have greater nutritional value than that of other mammalian species and also contains many biologically active ingredients with therapeutic value [1], [2]. Compared to bovine milk, goat milk is easier digested, less allergenic and has higher concentrations of calcium, vitamin B6, vitamin A, potassium, niacin, chloride, copper, manganese, selenium, and short- and medium-chain fatty acids [1], [3].

Yogurt is obtained by fermentation of milk with cultures of *Lactobacillus delbruekii* spp. *bulgaricus* and *Streptococcus salvarius* ssp. *thermophilus*. These yogurt bacteria are considered as probiotics [4], [5]. Yogurt containing many bioactive compounds enhances health benefits including balancing gut microbiota, improved immune response and lessened the occurrence of diarrhea [1], [5]. World Health Organization [6] suggested yogurt consumption in the management of acute diarrheal disorders. In addition, the fortification of bioactive compounds such as fiber, prebiotic and plant phenolic acid in yogurt confer advantages in nutritional value, antioxidant function and diversity of functional food products available to consumers [7]–[9].

Rice bran is the outer layer of rice. It is a by-product of the milling process and contains high levels of phytochemicals such as dietary fiber, fatty acids and antioxidant compounds [7], [10], [11]. In particular, bran of Riceberry rice (*Oryza sativa* L.) is rich in antioxidants [12], [13]. Many previous studies showed that rice bran has positive effects on human health in terms of preventing oxidative damage of HepG2 cells [10], reduction of atherosclerotic plaque formation [14] and promoting growth of probiotics [15].

Recently some studies have focused on fortification of rice bran in foods to improve nutritive value and health benefit [7], [8], [16]. El-Shibiny *et al*. [16] reported that an addition of rice bran (2–6%) improved the nutritive and health benefits of functional processed cheese, but its sensory attributes decreased with supplementation of rice bran. However, the studies about the application of Riceberry bran as functional ingredient in food product are still rare. Additionally, the impact of Riceberry bran on sensory characteristics of product needs evaluation. This study examined the effect of Riceberry bran fortification on the physicochemical, microbiological and sensory properties of drinkable goat milk yogurts during refrigerated storage.

## 2. Materials and Methods

### 2.1 Materials

Goat milk was obtained from Agricultural Farm (Nakhon Ratchasima, Thailand), pasteurized at 80°C for 30 min and maintained at 4±1°C for the duration of the experiment (maximum 48 h). Fine Riceberry bran was obtained from a local market (Chon Buri, Thailand). Yogurt starter culture was obtained from commercial plain yogurt (*Lactobacillus delbruekii* spp. *bulgaricus* and *Streptococcus salvarius* ssp. *thermophilus*). Coconut sugar was purchased from Baan Farm Wan Ltd (Nonthaburi, Thailand). Coconut sugar syrup was prepared by mixing 150 mL sterile water and 200 g coconut sugar in order to adjust its total soluble solid of 50°Brix, heated at 60°C for 5 min in a water bath (Model 11DT-1, Heto, Denmark) and kept at 4±1°C.

### 2.2 Preparation of drinkable yogurt and sample treatments

Sucrose (5% w/v) was added to pasteurized goat milk [17] and separated into 4 treatment units; Riceberry bran was added to 3 units (w/v) at 1% (termed RB1), 2% (termed RB2) and 3% (termed RB3). One unit received no Riceberry bran and was the RB0 (control). Unit contents (100 mL) were dispensed into sterilize glass containers. Samples were heated at 90°C in a water bath for 10 min and then cooled rapidly to 45°C [17]. They were inoculated with 9% (v/v) commercial plain yogurt [18]. Milk samples were fermented at 40°C for 15 h (in order to achieve approximately 8.5 log cfu/mL of lactic acid bacteria). From preliminary test, 10 mL coconut sugar syrup per yogurt (100 mL) was subsequently added to improve sensory characteristics including product taste and sweetness, with high scores of consumer acceptance. The clot was broken vigorously by manual stirring with a glass rod under aseptic condition to obtain drinkable yogurt. Finally, product was sealed and stored at (4±1°C) for 8 days. After processing, physicochemical and microbiological analyses were conducted at 2-days intervals during cold storage. Antioxidant activity and sensory analyses were performed only on the initial day (0 day) of storage.

### 2.3 Physicochemical analysis

The pH of drinkable yogurt was measured with a calibrated pH meter (Lab 850, Schott, Germany) [19]. Total soluble solid (°Brix) was measured with a handheld refractometer at 25°C (Master, Atago, Japan). Titratable acidity was analyzed by titration of 10 g sample and 10 mL deionized water with 0.1 N NaOH. Phenolphthalein was used as an indicator. Titratable acidity was expressed as % lactic acid (v/w) [20].

### 2.4 DPPH antioxidant analysis

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity was determined as described by Demirci *et al*. [7] and calculated according to Equation (1):

$$\%\ \text{DPPH radical scavenging activity} = \left(\frac{A_0 - A_1}{A_0}\right) \times 100 \qquad (1)$$

where $A_0$ is the absorbance of the control and $A_1$ is the absorbance of the sample

### 2.5 Microbiological analysis

Samples (10 mL) were homogenized with 90 mL of 0.1% sterile peptone and diluted in a 10-fold serial. Yogurt bacteria was analyzed as counts of lactic acid bacteria (LAB) cultured using spread plate technique on deMan Rogosa Sharpe (MRS) agar (Difco Laboratories, India). Plates were incubated anaerobically at 35°C for 48 h using the anaerobic jars (BD GasPak$^{TM}$EZ anaerobe container system, Becton Dickinson Pty Ltd) [21]. Yeast and mold were enumerated using compact dry YM (Nissui Pharmaceutical Co. Ltd). Plates were incubated at 30°C for 4–5 days [22]. Colony counts on each plate were recorded. The plates containing 20–200 colonies were expressed as log colony-forming units per mL (log cfu/mL).

**2.6 Sensory evaluation**

Sensory evaluation of 4 formulations of drinkable goat milk yogurts was conducted by 30 un-trained student panelists from Department of Food Science, Burapha University, Thailand. Panelists were served 10 mL of each sample at 6°C in a small white glass coded with a random three-digit number. Assessment of appearance, texture, color, taste, odor, flavor and overall acceptability was performed on a nine-point hedonic scale ranging from 9 (like very much) to 1 (dislike very much) [23].

**2.7 Statistical analysis**

Data were expressed as mean ± standard deviations. Data of physicochemical, microbiological and sensory properties of samples were subjected to analysis of variance (ANOVA). Tukey' s multiple comparison tests were conducted to determine significant differences of means with a $p < 0.05$.

**3. Results and Discussion**

**3.1 Physicochemical characteristics and antioxidative activity**

The pH values or TSS of drinkable goat milk yogurts unfortified and fortified with Riceberry bran insignificantly differed ($p \geq 0.05$) and were similar throughout storage at 4°C for 8 days ($p \geq 0.05$) (Table 1). According to the amounts of Riceberry bran added to TSS of drinkable yogurts, rice bran generally contained carbohydrate (41–48%) as the major chemical component [24], but may have low amounts of soluble solid compounds such as glucose. Thus, the addition of only 1–3% of Riceberry rice had no measurable influenced on TSS of drinkable yogurts.

Higher titratable acidity was observed in drinkable goat milk yogurts with Riceberry bran as compared to RB0, but values did not significantly different among all samples measured ($p \geq 0.05$). Titratable acidity of each sample increased, but not significantly with storage period ($p \geq 0.05$) (Table 1). Minor change in titratable acidity had no impact on pH. According to Ray and Montet [5], *L. delbruekii* spp. *bulgaricus* and *S. thermophilus* are homofermentative bacteria that metabolize glucose and then produce lactic acid as well as adenosine triphosphate (ATP) that drives cell metabolism. Therefore, the slight increase in titratable acidity suggests metabolism is maintained by bacteria during cold storage. Moreover, the higher level of post acidification in drinkable goat milk yogurts fortified with Riceberry bran, particularly RB3 and RB2 could be attributed to positive influence of Riceberry bran as carbon source on yogurt culture [25].

These results are in accord with findings of Hussien *et al*. [8] that the addition of 1% full fat rice bran had no influenced on pH and/or lactic acid of yogurts relative to that without full fat rice bran. The pH values of yogurts fortified with full fat rice bran and without full fat rice bran were constant during storage at 5°C for 7 days. Further, Demirci *et al*. [7] found titratable acidity of all yogurts supplemented with rice bran (1, 2 and 3%) and in the absence rice bran increased slightly between 1 to 7 days of storage. Higher titratable acidity was obtained in yogurts supplemented with rice bran as compared to plain yogurt.

**Table 1** Physicochemical parameters of drinkable goat milk yogurts fortifying riceberry bran at different concentrations

| Parameters | Days | Drinkable Goat Milk Yogurt Formulations | | | |
|---|---|---|---|---|---|
| | | RB0 | RB1 | RB2 | RB3 |
| pH | 0 | $4.90 \pm 0.05^{ns,NS}$ | $4.76 \pm 0.01^{NS}$ | $4.78 \pm 0.01^{NS}$ | $4.74 \pm 0.06^{NS}$ |
| | 2 | $4.62 \pm 0.26^{ns}$ | 4.74 ± 0.05 | 4.72 ± 0.03 | 4.74 ± 0.06 |
| | 4 | $4.71 \pm 0.08^{ns}$ | 4.77 ± 0.02 | 4.81 ± 0.07 | 4.73 ± 0.01 |
| | 6 | $4.75 \pm 0.15^{ns}$ | 4.75 ± 0.05 | 4.70 ± 0.00 | 4.73 ± 0.02 |
| | 8 | $4.72 \pm 0.09^{ns}$ | 4.81 ± 0.03 | 4.81 ± 0.08 | 4.77 ± 0.07 |
| TSS (°Brix) | 0 | $16.50 \pm 0.71^{ns,NS}$ | $16.00 \pm 1.41^{NS}$ | $17.50 \pm 3.45^{NS}$ | $15.50 \pm 0.71^{NS}$ |
| | 2 | $15.50 \pm 0.71^{ns}$ | 16.50 ± 0.71 | 16.00 ± 0.00 | 17.50 ± 2.12 |
| | 4 | $15.50 \pm 0.71^{ns}$ | 16.50 ± 0.71 | 19.00 ± 2.83 | 17.00 ± 0.00 |
| | 6 | $16.50 \pm 0.71^{ns}$ | 16.50 ± 0.71 | 17.00 ± 0.00 | 17.50 ± 0.71 |
| | 8 | $15.50 \pm 0.71^{ns}$ | 16.50 ± 0.71 | 18.50 ± 2.12 | 18.00 ± 1.41 |
| Titratable acid (% lactic acid) | 0 | $0.97 \pm 0.13^{ns,NS}$ | $1.15 \pm 0.03^{NS}$ | $1.21 \pm 0.04^{NS}$ | $1.27 \pm 0.07^{NS}$ |
| | 2 | $1.07 \pm 0.21^{ns}$ | 1.13 ± 0.00 | 1.18 ± 0.10 | 1.17 ± 0.18 |
| | 4 | $1.04 \pm 0.23^{ns}$ | 1.20 ± 0.14 | 1.30 ± 0.25 | 1.26 ± 0.19 |
| | 6 | $1.19 \pm 0.16^{ns}$ | 1.21 ± 0.16 | 1.41 ± 0.17 | 1.46 ± 0.01 |
| | 8 | $1.21 \pm 0.11^{ns}$ | 1.22 ± 0.02 | 1.47 ± 0.20 | 1.47 ± 0.17 |
| DPPH (% inhibition) | 0 | $11.55 \pm 0.42^{c}$ | $32.98 \pm 3.86^{b}$ | $40.31 \pm 0.31^{b}$ | $54.92 \pm 0.08^{a}$ |

*RB0 = drinkable yogurt without riceberry bran, RB1 = drinkable yogurt containing riceberry bran at 1% (w/v), RB2 = drinkable yogurt containing riceberry bran at 2% (w/v), RB3 = drinkable yogurt containing riceberry bran at 3% (w/v), TSS = total soluble solid, DPPH = DPPH radical scavenging activities

$^{a,b,c}$ values in same row have different superscript differ significantly ($p < 0.05$), $^{ns}$ not significant in same row ($p \geq 0.05$),

$^{NS}$ not significant in same column for each property ($p \geq 0.05$)

Means ± standard deviation

DPPH radical scavenging activities of drinkable goat milk yogurt formulations ranged between 11.55–54.92% (Table 1). The strong antioxidative characteristic of Riceberry bran resulted in greater antioxidant activities (3–5 times) of drinkable yogurts fortified with Riceberry bran when compared to control (RB0) ($p < 0.05$). As expected, the addition of 3% Riceberry bran was associated with the highest DPPH radical scavenging activity (54.92%). Suttiarporn *et al*. [13] reported bran of Riceberry rice had strong total antioxidant activity with 97.83%. Antioxidant activity in Riceberry bran obtained from five major groups of phytochemical compounds including γ-oryzanol, phenolic acids, vitamin E, flavonoids and anthocyanins [12]. This result was in agreement with finding of Demirci *et al*. [7], who observed that DPPH radical scavenging activities of yogurts improved significantly with supplementation of rice bran (1–3%) as compared with plain yogurt.

### 3.2 Microbiological characteristics

LAB counts of drinkable goat milk yogurts varied between 8.23–8.76 log cfu/mL at the onset of storage, while these values varied within the range of 8.88–9.05 log cfu/mL after cold storage for 8 days ($p \geq 0.05$) (Table 2). LAB counts slightly increased during shelf life, but not significantly ($p \geq 0.05$), except RB1 ($p < 0.05$) (Table 2). Even though supplemented with Riceberry bran, the viability of LAB was not improved. However, LAB counts in all goat liquid yogurts were higher than recommended minimum counts (> 7 log cfu/g) to qualify a yogurt [26]. The high remaining of the living LAB helped to promote the health benefits of the consumers [4]. This result suggests LAB resistance with refrigeration is probably a synergistic effect of *L. delbruekii* spp. *bulgaricus* and *S. thermophilus* [25]. *L. delbruekii* spp. *bulgaricus* produces amino acids and peptides, demanded as growth factors by *S. thermophiles*, while *S. thermophiles* produces folate to sustain the growth of *L. delbruekii* spp. *bulgaricus* [27].

pH is a critical viability factor for probiotic microorganisms with values below 4 being detrimental to probiotics survival [23]. In the present study, pH of each drinkable yogurt formulation was > 4.6 during storage and presumably contributed to survival of yogurt bacteria.

Stability of viable LAB counts in samples probably resulted in the consistency of pH, TSS and/or acidity throughout storage. This was compatible with Demirci *et al*. [7], who reported that *S. thermophilus* counts was almost stable, in contrast to those of *L. delbruekii* spp. *bulgaricus* that rose throughout storage in yogurts with or without rice bran. However, the supplements of rice bran did not significantly improve survival of these microorganisms in yogurts throughout refrigerated storage for 21 days as compared to plain yogurt. In addition, Guler-Akin *et al*. [28] found that fortification of inulin (0.5, 1, 2%) or oat fiber (0.5, 1, 2%) did not affect viability of *S. thermophilus* in apricot drinkable yogurt during storage period for 21 days relative to that of apricot drinkable yogurt without fiber.

**Table 2** Viable counts of LAB (log cfu/mL) in drinkable goat milk yogurts fortifying riceberry bran at different concentrations during 8 days of refrigerated storage

| Days | Drinkable Goat Milk Yogurt Formulations | | | |
|---|---|---|---|---|
| | RB0 | RB1 | RB2 | RB3 |
| 0 | $8.76 \pm 0.00^{ns,NS}$ | $8.23 \pm 0.21^{B}$ | $8.70 \pm 0.38^{NS}$ | $8.68 \pm 0.57^{NS}$ |
| 2 | $8.86 \pm 0.05^{ns}$ | $8.89 \pm 0.03^{AB}$ | 8.93 ± 0.01 | 8.76 ± 0.18 |
| 4 | $9.06 \pm 0.08^{ns}$ | $9.10 \pm 0.02^{A}$ | 8.89 ± 0.40 | 9.07 ± 0.27 |
| 6 | $9.16 \pm 0.06^{ns}$ | $8.94 \pm 0.19^{AB}$ | 9.10 ± 0.34 | 8.74 ± 0.18 |
| 8 | $8.89 \pm 0.08^{ns}$ | $8.88 \pm 0.33^{AB}$ | 9.05 ± 0.38 | 9.00 ± 0.05 |

*RB0 = drinkable yogurt without riceberry bran, RB1 = drinkable yogurt containing riceberry bran at 1% (w/v), RB2 = drinkable yogurt containing riceberry bran at 2% (w/v), RB3 = drinkable yogurt containing riceberry bran at 3% (w/v)

$^{A,B}$ values in same column have different superscript differ significantly ($p < 0.05$), $^{ns}$ not significant in same row ($p \geq 0.05$), $^{NS}$ not significant in same column ($p \geq 0.05$).

Means ± standard deviation

Sanitary microbiological analyses showed yeast and mold counts in liquid yogurt formulations were < 10 cfu/mL throughout refrigerated storage for 8 days, indicating an aseptic technique. Counts of yeast and mold were according to standard the Ministry of Public Health, Thailand (No. 353) R.E. fermented milk, which decided that mold counts should be < 100 cfu/g as well as yeast counts should be < 100 cfu/g in fermented milk without heat treatment after fermentation [29].

### 3.3 Sensory evaluation

In Table 3, the fortification of Riceberry bran to drinkable goat milk yogurts negatively influenced to the sensory attributes including appearance, color, taste, odor, flavor and overall acceptability ($p < 0.05$). This was problematic due to bitter taste and red-brown color of Riceberry bran affecting yogurt characteristics. Nonsignificant differences in texture among drinkable yogurt formulations ($p \geq 0.05$) may reflect the fine particle of Riceberry bran. RB1 showed higher overall acceptability scores as compared to the other fortified drinkable yogurts ($p < 0.05$) in which the hedonic term ranged between "like slightly" to "like moderately". Moreover, mean values of all sensory attributes in drinkable yogurt formulations fell in the acceptance range (5–8 scores). This could be associated with dominating coconut sugar sweetener, which enhanced satisfying to goat liquid yogurt. This result was consistent with Demirci *et al*. [7], who found that sensory characteristics of yogurts supplemented with rice bran (1–3%) deteriorated significantly relative to plain yogurt. On the other hand, Hussien *et al*. [8] reported an addition of full fat rice bran with 1% lead to increasing scores of appearance, flavor, and body and texture of yogurt.

## 4. Conclusions

The fortification of Riceberry bran in drinkable goat milk yogurts did not affect significantly with respect to the physicochemical characteristics, pH, TSS

**Table 3** Sensory attributes in drinkable goat milk yogurts fortifying riceberry bran at different concentrations

| Sensory attributes (scores) | Drinkable goat milk yogurt formulations | | | |
|---|---|---|---|---|
| | RB0 | RB1 | RB2 | RB3 |
| Appearance | $7.10\pm1.12^{a}$ | $6.50\pm1.25^{ab}$ | $6.20\pm1.52^{b}$ | $6.30\pm1.29^{b}$ |
| Texture | $6.60\pm1.45^{ns}$ | $6.60\pm1.43$ | $5.87\pm1.63$ | $5.93\pm1.51$ |
| Color | $7.77\pm0.94^{a}$ | $6.60\pm1.38^{b}$ | $6.03\pm1.47^{b}$ | $6.23\pm1.33^{b}$ |
| Taste | $7.63\pm0.96^{a}$ | $6.63\pm1.61^{b}$ | $5.20\pm1.83^{c}$ | $5.40\pm1.45^{c}$ |
| Odor | $7.40\pm1.19^{a}$ | $6.23\pm1.57^{b}$ | $5.40\pm1.59^{bc}$ | $5.63\pm1.10^{c}$ |
| Flavor | $7.63\pm0.85^{a}$ | $6.57\pm1.43^{b}$ | $5.20\pm1.81^{c}$ | $5.33\pm1.40^{c}$ |
| Overall acceptability | $7.70\pm0.65^{a}$ | $6.87\pm1.31^{b}$ | $5.67\pm1.65^{c}$ | $5.67\pm1.21^{c}$ |

*RB0 = drinkable yogurt without riceberry bran, RB1 = drinkable yogurt containing riceberry bran at 1% (w/v), RB2 = drinkable yogurt containing riceberry bran at 2% (w/v), RB3 = drinkable yogurt containing riceberry bran at 3% (w/v)

$^{a,b,c}$ values in same row have different superscript differ significantly ($p < 0.05$), ns not significant in same row ($p \geq 0.05$)

Means ± standard deviation

and titratable acidity as well as the microbiological characteristics, numbers of LAB, and yeast and mold during refrigerated storage for 8 days. Viable counts of LAB in all goat liquid yogurt formulations remained high (> 8 log cfu/mL) throughout their shelf life suggestive of consumers health benefits. Moreover, DPPH radical scavenging activities of drinkable goat milk yogurts were improved greatly with the addition of Riceberry bran. Unfortunately, the sensory attributes of samples fortified with Riceberry bran were lower than that of plain drinkable yogurt. Riceberry bran can be added to drinkable goat milk yogurt at level of 1% to 3%, producing strong antioxidant activity and acceptable consumer sensory properties. However, in order to obtain the great health benefits, it was recommended to add 3% Riceberry bran. Our study suggests Riceberry bran is a by-product with potential application as a functional ingredient in fermented dairy products.

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