บทความวิจัย

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บทคัดย่อ

ผลิตภัณฑ์อาหารที่มีส่วนประกอบหลักจากพืชถือเป็นอีกทางเลือกหนึ่งสำหรับผู้บริโภคที่ให้ความสนใจในสุขภาพและผู้บริโภคที่ประสบปัญหาการแพ้น้ำตาลแล็คโตส งานวิจัยนี้มีจุดประสงค์เพื่อพัฒนาโยเกิร์ตพร้อมดื่มจากนมถั่วเหลืองเสริมด้วยไซเลียมฮัสค์และควินัว และศึกษาการยอมรับของผู้บริโภคที่มีต่อผลิตภัณฑ์ที่ได้ถูกพัฒนาแล้ว การศึกษาสัดส่วนที่เหมาะสมของถั่วเหลืองและน้ำในการผลิตนมถั่วเหลืองประกอบด้วยสัดส่วนโดยน้ำหนักที่ต่างกัน คือ 1 : 3, 1 : 4 และ 1 : 5 ตามลำดับ หัวเชื้อโยเกิร์ตถูกเติมลงในนมถั่วเหลืองและบ่มที่อุณหภูมิ 43 องศาเซลเซียส เป็นเวลา 12 ชั่วโมง หลังจากผ่านการบ่มแล้วโยเกิร์ตถั่วเหลืองแต่ละสูตรจะถูกผสมด้วยน้ำในอัตราส่วน 1 : 1 โดยน้ำหนักเพื่อทำเป็นโยเกิร์ตพร้อมดื่ม ผลจากการทดสอบทางประสาทสัมผัส พบว่าสูตรที่มีอัตราส่วน 1 : 4 เป็นสูตรที่ได้รับคะแนนความชอบมากที่สุด การศึกษาปริมาณของน้ำเชื่อมที่ใช้เติมลงในโยเกิร์ตพร้อมดื่มประกอบด้วยน้ำเชื่อมที่ความเข้มข้นแตกต่างกันประกอบด้วย 0%, 4%, 8%, 12% และ 16% โดยความเข้มข้นที่ได้รับคะแนนความชอบมากที่สุดคือสูตรที่เติมน้ำเชื่อม 8% ไซเลียมฮัสค์และควินัวในอัตราส่วนที่แตกต่างกัน 3 อัตราส่วนโดยน้ำหนัก ประกอบด้วย อัตราส่วน 1 : 3, 1 : 5 และ 1 : 7 ถูกเติมลงไปในโยเกิร์ตพร้อมดื่ม โดยสัดส่วนที่ได้รับคะแนนความชอบมากที่สุดคือ สัดส่วนที่ใช้ไซเลียมฮัสค์และควินัวในอัตราส่วน 1 : 5 ผลิตภัณฑ์สุดท้ายได้ผ่านการวิเคราะห์คุณสมบัติทางกายภาพ ทางเคมี ทางจุลชีววิทยา และการยอมรับของผู้บริโภค โยเกิร์ตพร้อมดื่มจากนมถั่วเหลืองเสริมด้วยไซเลียมฮัสค์และควินัวมีปริมาณโปรตีน 5.88 ± 0.07% และมีปริมาณกากใย 5.6 ± 0.13% ขณะที่ผลิตภัณฑ์ที่ปราศจากไซเลียมฮัสค์และควินัวมีปริมาณโปรตีน 1.41 ± 0.09% และมีปริมาณกากใย 0.59 ± 0.16% มีผู้บริโภคจำนวน 83% ยอมรับโยเกิร์ตพร้อมดื่มเสริมไซเลียมฮัสค์และควินัว และ 65% ตัดสินใจซื้อหากมีผลิตภัณฑ์นี้จำหน่ายในท้องตลาด

คำสำคัญ: โยเกิร์ตพร้อมดื่ม, ไซเลียมฮัสค์, ควินัว, การทดสอบทางประสาทสัมผัส, นมถั่วเหลือง

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Research Article

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Development of Soy Yogurt Drink Fortified with Quinoa and Psyllium Husk

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Abstract

Plant-based food products have been considered as an alternative to health-conscious consumers and consumers with lactose intolerance. This research aimed to develop soy yogurt drink fortified with quinoa and psyllium husk and to study consumers' acceptability on the developed product. The study on suitable ratio between soybean and water to produce soy milk was conducted with different ratios by weight including 1 : 3, 1 : 4 and 1 : 5, respectively. The yogurt starter cultures were added and were incubated at 43°C for 12 hours. After incubation, water was added to soy yogurt with the ratio of 1 : 1 w/w to make soy yogurt drink. The preferred ratio between soybean and water for making soy yogurt was 1 : 4. Liquid sucrose with different concentrations (0%, 4%, 8%, 12%, and 16% v/v) was mixed into the soy yogurt drink. The most liked formula was the one with 8% liquid sucrose. Psyllium husk and quinoa were added to soy yogurt drink with three different ratios including 1 : 3, 1 : 5, and 1 : 7 w/w, respectively. The ratio of 1 : 5 was the favorite formula. Physical, chemical, microbiological and consumers' acceptability of developed product were determined. Soy yogurt drink fortified with quinoa and psyllium husk contained 5.88 ± 0.07% of protein and 5.60 ± 0.13% of crude fiber whereas the product without quinoa and psyllium husk had 1.41 ± 0.09% of protein and 0.59 ± 0.16% of crude fiber. Eighty-three percent of consumers accepted the product. Sixty-five percent of consumers decided to buy the product if it would be commercially available.

Keywords: Soy Yogurt Drink, Psyllium Husk, Quinoa, Sensory Evaluation, Soy Milk

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1. Introduction

One of the major problems when consumers drink milk or consume milk products is inability to fully digest and absorb lactose in milk that results in gastrointestinal symptoms called lactose intolerance. Lactose intolerance is a condition in which people have digestive symptoms such as bloating, diarrhea, and gas after drinking milk or eating milk products. This means that consumers with lactose intolerance are almost impossible to take any advantages from milk. Lactose intolerance is very common in people around the world. Over 70% of world population have lactose intolerance and more than 90% of Asian people have this problem including Thai people [1], [2].

Lactose-free products have been considered as excellent choices for consumers with lactose intolerance. Plant-based milk made from cereal such as rice, almond, and soy is the product that consumers with lactose intolerance can consume and replace the milk and milk products. Soy milk is simply made from soybeans and water. Because all ingredients come from plants, soy milk is naturally free of cholesterol, very low saturated fat and no lactose [3]. Nowadays, consumers are becoming health conscious and tend to spend more amount of their money on healthy drinks. Soy milk is preferred by the consumers due to its nutritional values such as high protein (as much protein as cow's milk), vitamin A, and vitamin B-12 [4]. Moreover, soy milk can be fortified with other essential vitamins and minerals such as calcium and vitamin D [5]. Therefore, soy milk is considered as a healthy beverage and a popular alternative to dairy milk for consumers with lactose intolerance. In addition to regular soy milk, fermented soy milk is also available.

Fermented soy milk has been developed by food product developers. Soy yogurt is a product made from fermentation process with yogurt starter cultures including *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilus*. This product is lactose free for consumers who like eating yogurt, but avoid consuming milk-related products. However, regular soy yogurt still has problems from its unpleasant smell (beany smell) [6], sour taste and thick mouthfeel affecting consumer acceptance [7]. The researchers would like to develop the product from soy yogurt to soy yogurt drink which has thinner mouthfeel. This drinkable form of soy yogurt was created for convenience purpose. Consumers who love to consume soy yogurt can drink this developed product easily. Moreover, taste and smell of the soy yogurt drink would be modified to gain better acceptance level.

Quinoa (*Chenopodium quinoa* Willd.) is a type of grain that originated in South America [8]. Quinoa is becoming famous for consumers who concern about their health due to its unique nutritional profile, as it contains a significant amount of protein, antioxidants, vitamins, and minerals when compared to other types of grain [9]. Psyllium husk is a soluble fiber derived from the seeds of Plantago ovata. Because of its excellent water solubility, psyllium husk can absorb water and become a thick, viscous compound that resists digestion in the small intestine [10]. It is used as a dietary supplement fortified breakfast cereals and baked goods [11]. With the health benefits of quinoa and psyllium husk, they were selected to add into the product

for increasing protein and fiber content. This study aims to develop a suitable formula for making soy yogurt drink and to study consumer acceptability on the developed product.

2. Material and Methods

2.1 Raw materials

Soybeans (Nat-pharm, Thailand), quinoa (Nat-pharm, Thailand), psyllium husk (Nat-pharm, Thailand), and liquid sucrose (Mitr phol Sugar Group, Thailand) were purchased from local markets in Chiang Rai and Bangkok, Thailand. Starter cultures used for making yogurt were *Streptococcus thermophilus* and *Lactobacillus delbereuckii subsp. Bulgaricus*. They were purchased from Thailand Institute of Scientific and Technological Research (TISTR), Pathum Thani, Thailand.

2.2 Preparation starter culture

Streptococcus thermophiles and *Lactobacillus delbereuckii subsp. bulgaricus* were reconstituted by plating out in MRS agar and incubated micro-aerophilically at 37°C for 48 hours. The preparation was performed according to Bergey's manual of determinative of bacteriology [12]

2.3 Experiment 1: The study on suitable ratio between soybean and water to make soy milk and soy yogurt drink

2.3.1 Preparation of soy milk

Dry soybeans were weighted, washed, and soaked in excess water added with 5% $NaHCO_3$ for 15 hours. After removing outer skin of soybeans, they were heated at 100°C for 30 minutes. The cooked soybeans and boiled water were blended with different ratio including 1 : 3, 1 : 4, and 1 : 5 by weight. Soy milk form all formulas were heated again at 65°C for 30 minutes after that they were filtered and kept at 4°C for making soy yogurt.

2.3.2 Preparation of soy yogurt and soy yogurt drink

A single colony of each starter culture (Streptococcus thermophilus and Lactobacillus delbereuckii subsp. Bulgaricus) was added into soymilk (10 mL). All materials were mixed and incubated in the water bath at 43°C for 12 hours. The soy milk mixed with starter cultures from previous step then was measured pH value which had to be in the range of 4.2–4.5 before adding to soy milk in each formula (1 : 3, 1 : 4, and 1 : 5). All formulas were incubated in the water bath at 43°C for 12 hours to make soy yogurt. Soy yogurt in each formula was blended with boiled water with the ratio 1 : 1 w/w by blender until the mixture was homogenized. Physical, chemical, and sensory properties of each formula were determined. The most liked formula based on sensory properties would be used in experiment 2.

2.4 Experiment 2: The study on suitable quantity of liquid sucrose to add to soy yogurt drink

The most liked soy yogurt drink from experiment 1 was added with different volumes of liquid sucrose including 0%, 4%, 8%, 12%, and 16% v/v. Physical, chemical, and sensory properties of each formula were evaluated. The most liked formula based on sensory properties would be used in experiment 3.

2.5 Experiment 3: The study on suitable ratio between psyllium husk and quinoa to add to soy yogurt drink

The most liked soy yogurt drink from experiment 2 was added with different ratios between soaked psyllium husk and cooked quinoa including 1 : 3, 1 : 5, and 1 : 7 w/w, respectively. Each formula was blended by a blender to make the final product had homogeneous mixture. Physical, chemical, and sensory properties of each formula were evaluated. Consumer acceptability, microbiological, and proximate analysis would be conducted for the most liked soy yogurt drink with psyllium husk and quinoa.

2.6 Determination physical properties of soy yogurt drink

2.6.1 Color

Colors for all samples were measured by Minolta Chroma Meter (Model CR-210, Ramsey, NJ, USA) with three parameters including whiteness (L*), and two color channels (a* and b*).

2.6.2 Viscosity

Viscosity for all samples was measured by a Brookfield digital viscometer (Brookfield engineering laboratories, Inc., Middleboro, MA, USA). All measurements were done at room temperature (24 ±1°C).

2.7 Determination chemical properties of soy yogurt drink

2.7.1 Total soluble solid

Total soluble solid for all samples was measured by hand-held refractometer (Atago, Temecula, CA, USA.

2.7.2 Ash

Samples were weighted (2–5 grams) and placed in crucibles. The crucibles were heated on hot plate to remove moisture content until the samples were dry.

The dried samples in crucibles were put in muffle furnace at 525°C for 5 hours until grayish white residue were obtained. Total ash content was calculated as grams/100 grams Dry Weight (DW). [13]

2.7.3 Protein

Protein content was determined by Micro kjheldhal method. [13]

2.7.4 Crude fiber

Crude fiber was determined by the Weende method. [13]

2.7.5 Titratable acidity

Acidity were determined by titration with 0.1 N NaOH and expressed as g/L of lactic acid. [13]

2.7.6 pH

pH values were measured by using a pH meter.

2.8 Determination biological characteristics of soy yogurt drink fortified with quinoa and psyllium husk

2.8.1 Lactic acid bacteria

Sample preparation was done by adding 1 mL of homogeneous soy yogurt drink fortified with quinoa and psyllium husk to 9 mL of water. Dilution series from $(10)^{-1}$ to $(10)^{-5}$ were prepared. Spread plate technique was used after transferring 0.1 mL of each diluted sample to MRS agar plates. All plates were incubated at 35°C for 48 hours under microaerophilic conditions. The identification was performed according to Bergey's manual of determinative of bacteriology [12]

2.8.2 Total plate count

Soy yogurt drink fortified with quinoa and psyhllium husk samples were prepared as mentioned in total plate count. Dilution series from $(10)^{-1}$ to $(10)^{-5}$ were prepared and poured plate by transferring 1 mL of sample to PCA media. The plates were invert and incubated plates at 35°C for 48 hours. [14]

2.8.3 Yeast and molds

Soy yogurt drink fortified with quinoa and psyhllium husk samples were prepared as mentioned in total plate count. Dilution series from $(10)^{-1}$ to $(10)^{-5}$ were prepared and poured plate by transferring 1 mL of sample to PDA media. The plates were incubated at 25°C for 5 days. [15]

2.9 Sensory evaluation of soy yogurt drink

Sensory evaluation of soy yogurt drink samples was studied by using 9-point hedonic scale (9 = "like extremely" and 1 = "dislike extremely"). Samples were evaluated by 30 sensory panelists. Each formula of soy yogurt drink was evaluated with the sensory attributes including appearance linking, texture linking, odor linking, flavor linking and overall linking.

2.10 Experiment 4: Consumer acceptance and purchase intent on final product

A consumer acceptance test (n=100) was conducted in Chiang Rai with Central Location Test type (CLT) at D1 cafeteria of Mae Fah luang university. Consumers were asked to evaluate the samples and provide acceptability rating scores for appearance linking, texture linking, flavor linking and overall linking by using 9-point hedonic scale (9 = "like extremely" and 1 = "dislike extremely"). The binomial type questions (yes/no) were used to evaluate overall product acceptance and purchase intent.

2.11 Statistical analysis

Physical properties, chemical properties, and sensory scores were subjected to analyze of variance (ANOVA) using SPSS version 18.0 for Windows and Duncan's multiple range test (DMRT) was performed to locate the differences among samples. Data were expressed as means ± standard deviation.

Logistic regression was performed to identify sensory characteristics influencing overall acceptance and purchase intent.

3. Results and Discussions

3.1 Study on suitable ratio between soybean and water to make soy yogurt drink

Chemical and physical properties of soy yogurt drink with different ratios between soybean and water are shown in Table 1. For chemical properties, Total Soluble Solid (TSS) and pH value were not significant difference among 3 formulas whereas acidity was only parameter that decreased significantly. For physical properties, viscosity, L* value, and b* value, were all parameters that had some effects when varying water content. Viscosity and b* value decreased significantly when adding more water content but L* value had opposite effect. L* value increased significantly, especially on the yogurt drink on ratio of 1 : 5 (soybean: water) that had the maximum amount of water among 3 formulas. However, adding water in the product did not have effect on a* value.

Table 1 Chemical and physical properties of soy yogurt drink with different ratios between soybean and water

Formula (Soybean : Water)	TSS (°Brix)	pH	Acidity (g/L)	Viscosity (cP)	L*	a*	b*
1 (1 : 3)	1.83 ± 0.12^{a}	4.00 ± 0.01^{a}	0.56 ± 0.01^{a}	10.13 ± 0.06^{a}	80.99 ± 0.15^{b}	–2.44 ± 0.02^{a}	9.17 ± 0.08^{a}
2 (1 : 4)	1.82 ± 0.12^{a}	4.01 ± 0.01^{a}	0.53 ± 0.01^{b}	6.46 ± 0.25^{b}	81.30 ± 0.34^{b}	–2.47 ± 0.05^{a}	8.76 ± 0.10^{b}
3 (1 : 5)	1.83 ± 0.12^{a}	4.01 ± 0.01^{a}	0.45 ± 0.01^{c}	6.10 ± 0.22^{c}	81.89 ± 0.18^{a}	–2.49 ± 0.02^{a}	7.42 ± 0.08^{c}

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)
Mean values ± standard deviation (n=3)

Table 2 Sensory evaluation results of soy yogurt drink with different ratios between soybean and water by using 9-point hedonic scale (n=30)

Formula (Soybean : Water)	Appearance	Odor	Flavor	Texture	Overall
1 (1 : 3)	5.9 ± 1.3^{a}	3.7 ± 1.4^{b}	3.5 ± 1.1^{b}	4.0 ± 1.0^{b}	4.3 ± 1.0^{b}
2 (1 : 4)	6.0 ± 1.3^{a}	4.6 ± 1.1^{a}	4.2 ±1.2^{a}	5.2 ± 1.1^{a}	5.0 ± 1.0^{a}
3 (1 : 5)	5.9 ± 1.3^{a}	3.4 ± 1.2^{b}	3.4 ±1.5^{b}	3.7 ± 1.4^{b}	3.9 ± 1.2^{b}

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)

Among 3 formulas, the ratio of 1 : 5 (soybean : water) contained the highest water content. Higher water content in the product could increase amount of solvent affecting lower concentration of acidity (lactic acid) and made the samples had lower viscosity. Moreover, adding more water to the product affected to product's color by increasing whiteness and decreasing yellowness of the product due to decreased concentration of soy yogurt drink.

Sensory evaluation results of the soy yogurt drink made from different ratios between soybean and water are shown in Table 2. Except for appearance liking, the other sensory attributes (odor liking, flavor liking, texture liking, and overall liking) were significant difference among 3 formulas. The soy yogurt drink made from the ratio 1 : 4 (soybean : water) was rated the highest hedonic scores in all significant sensory attributes. This formula was selected and used to conduct the study on suitable quantity of liquid sucrose to add to soy yogurt drink.

3.2 Study on suitable quantity of liquid sucrose to add to soy yogurt drink

Chemical and physical properties of soy yogurt drink with different quantities of liquid sucrose are shown in Table 3. All chemical and physical properties of soy yogurt drink affected significantly when increasing amount of liquid sucrose to soy yogurt drink samples. Total Soluble Solid (TSS), pH value, and viscosity increased when increasing amount of liquid sucrose. On the contrary, decreased values on acidity, L*, a*, and b* value were found in the samples that had higher quantities of liquid sucrose. Total soluble solids are solids that are dissolved within a substance and a common total soluble solid is sugar. According to a study of

Table 3 Chemical and physical properties of soy yogurt drink with different quantities of liquid sucrose

Formula (Quantity of liquid sucrose)	TSS (°Brix)	pH	Acidity (g/L)	Viscosity (cP)	L*	a*	b*
1 (0%)	1.86 ± 0.12^{e}	4.07 ± 0.01^{d}	0.53 ± 0.01^{a}	6.56 ± 0.09^{e}	78.54 ± 0.54^{a}	-2.51 ± 0.02^{a}	8.35 ± 0.32^{a}
2 (4%)	6.13 ± 0.12^{d}	4.14 ± 0.01^{c}	0.20 ± 0.01^{b}	8.48 ± 0.37^{d}	76.21 ± 0.23^{b}	-2.55 ± 0.40^{b}	7.91 ± 0.55^{a}
3 (8%)	10.13 ± 0.12^{c}	4.22 ± 0.01^{b}	0.16 ± 0.01^{c}	11.86 ± 0.26^{c}	74.30 ± 0.04^{c}	-2.57 ± 0.01^{b}	6.84 ± 0.53^{b}
4 (12%)	14.06 ± 0.12^{b}	4.28 ± 0.01^{a}	0.13 ± 0.01^{d}	14.37 ± 0.23^{b}	73.97 ± 0.40^{c}	-2.59 ± 0.04^{b}	6.30 ± 0.11^{b}
5 (16%)	18.06 ± 0.12^{a}	4.30 ± 0.01^{a}	0.09 ± 0.01^{e}	18.30 ± 0.44^{a}	72.08 ± 0.06^{d}	-2.74 ± 0.02^{c}	6.16 ± 0.06^{b}

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)
Mean values ± standard deviation (n=3)

Table 4 Sensory evaluation results of soy yogurt drink soy yogurt drink with different quantities of syrup by using 9-point hedonic scale (n=30)

Formula (Quantity of liquid sucrose)	Appearance	Odor	Flavor	Texture	Overall
1 (0%)	5.3 ± 2.2^{b}	4.5 ± 2.1^{a}	2.9 ± 2.5^{c}	4.1 ± 1.9^{c}	3.6 ± 2.3^{c}
2 (4%)	5.9 ± 1.8^{ab}	5.1 ± 2.1^{a}	4.8 ± 2.2^{b}	5.1 ± 1.7^{b}	4.7 ± 2.0^{b}
3 (8%)	5.9 ± 1.4^{ab}	5.1 ± 2.0^{a}	6.3 ± 2.0^{a}	6.2 ± 1.5^{a}	6.4 ± 1.6^{a}
4 (12%)	6.2 ± 1.4^{a}	5.6 ± 1.8^{a}	6.8 ± 1.6^{a}	6.1 ± 1.5^{a}	6.7 ± 1.7^{a}
5 (16%)	6.4 ± 1.7^{a}	5.6 ± 1.8^{a}	6.1 ± 2.1^{a}	6.4 ± 1.5^{a}	6.5 ± 1.8^{a}

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)

Cadena *et al*. [16], sucrose is a soluble solid that has a significant influence in relation to °Brix. Therefore, the samples that contained higher amount of liquid sucrose showed a much higher °Brix due to the increase in soluble solids. The same results on the relationship between sucrose concentration and viscosity were found in the research done by Hidayanto *et al*.. [17] Viscosity depends on the type and composition of the material. Increasing of the concentration of sucrose would follow by increasing viscosity of the solution.

Sensory evaluation results of the soy yogurt drink made from different quantities of liquid sucrose are shown in Table 4. Except for odor liking, other sensory attributes were significant difference among 5 formulas. The soy yogurt drink samples made from 8, 12, 16% of liquid syrup were not significantly different for all sensory attributes. To reduce the cost of production, soy yogurt drink added with 8% of liquid sucrose was selected to be the suitable formula for the next study (study on suitable quantities of psyllium husk and quinoa to add to soy yogurt drink).

3.3 The study on suitable ratio between psyllium husk and quinoa to add to soy yogurt drink

Chemical and physical properties of soy yogurt drink with different ratios between psyllium husk and quinoa are shown in Table 5. Adding different ratios between psyllium husk and quinoa did not have any effect on Total Soluble Solid (TSS) and acidity. However, pH and viscosity increased

Table 5 Chemical and physical properties of soy yogurt drink with different ratios between psyllium husk and quinoa

Formula (Psyllium husk : Quinoa)	TSS (°Brix)	pH	Acidity (g/L)	Viscosity (cP)	L*	a*	b*
1 (1 : 3)	10.06 ± 0.12^{a}	4.45 ± 0.05^{c}	0.20 ± 0.01^{a}	66.32 ± 0.75^{c}	75.12^{a} ± 0.13^{a}	–2.63 ± 0.04^{b}	5.47 ± 0.14^{a}
2 (1 : 5)	10.00 ± 0.12^{a}	4.51 ± 0.01^{b}	0.21 ± 0.01^{a}	76.19 ± 0.38^{b}	74.34 ± 0.47^{ab}	–2.49 ± 0.16^{b}	4.79 ± 0.56^{b}
3 (1 : 7)	10.13 ± 0.12^{a}	4.58 ± 0.01^{a}	0.22 ± 0.01^{a}	88.63 ± 0.12^{a}	71.41 ± 1.10^{b}	–1.79 ± 0.15^{a}	4.64 ± 0.75^{b}

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)
Mean values ± standard deviation (n=3)

Table 6 Sensory evaluation results of soy yogurt drink with different ratios between psyllium husk and quinoa by using 9-point hedonic scale (n=30)

Formula (Psyllium husk : Quinoa)	Appearance	Odor	Flavor	Texture	Overall
1 (1 : 3)	6.1 ± 1.1^{a}	6.5 ± 1.2^{a}	5.2 ± 1.5^{b}	5.7 ± 1.2^{a}	5.1 ± 1.6^{a}
2 (1 : 5)	6.1 ± 1.2^{a}	6.0 ± 1.1^{ab}	5.9 ± 1.6^{ab}	6.0 ± 1.4^{a}	5.6 ± 1.8^{a}
3 (1 : 7)	6.1 ± 1.2^{a}	5.8^{b} ± 1.2^{b}	6.2 ± 1.1^{a}	6.3 ± 1.1^{a}	5.7 ± 1.6^{a}

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)

significantly on the formula that contained higher amount of quinoa. Both phyllium husk and quinoa played an important role on product's viscosity. Phyllium husk hydrates slowly in water creating viscous solution due to soluble dietary fiber [18]. Quinoa starch is rich in amylopectin affecting the viscosity of the product that quinoa was added [19]. For this study, phyllium husk and quinoa were blended together in order to have homogeneous mixture. Thus, the starch molecule in quinoa was broken and then amylose and amylopectin released to the soy yogurt drink. During heating process, the starch in quinoa was gelatinized causing an increase in viscosity. Based on the result in Table 5, samples that had higher amount of quinoa tended to have lower L* and b*value, and higher a* values. That means the soy yogurt drink with high amount of quinoa would have less whiteness, less green color, and less yellow color. The color change is thought to be an effect of starch and skin color of quinoa. The starch will change from opaque to translucent when it is cooked. With the amount of quinoa and blending effect, the blended sample which had more quinoa content would have lower intensity of whiteness and yellowness.

Only two sensory attributes were significant difference among 3 formulas (Table 6). The sensory panelists rated appearance liking, texture liking, and overall liking to be the same level (not significant difference, $p > 0.05$). Thus, odor and flavor liking were two main sensory attributes in determining the final product. The soy yogurt drink fortified with psyllium husk and quinoa at ratio 1 : 5 was rated the most liked formula among 3 formulas and this formula would be selected to conduct a consumer acceptance and purchase intent test.

3.4 Consumer acceptance and purchase intent test on final product

The mean scores on product's acceptability including appearance liking, taste liking, texture liking, and overall liking are shown on Table 7. The final product of soy yogurt drink fortified psyllium husk and quinoa was rated 5.6 for appearance liking, 6.0 for taste liking, 5.8 for texture liking, and 6.1 for overall liking. Eighty-three percent of consumers accepted the soy yogurt drink fortified psyllium husk and quinoa. For the purchase intent, sixty-five percent of consumers would buy the soy yogurt drink fortified psyllium husk and quinoa if it is commercially available in the market.

Table 7 Sensory evaluation results of developed soy yogurt drink fortified with psyllium husk and quinoa by using 9-point hedonic scale (n=100)

Sensory Attributes	Score
Appearance	5.6±1.6
Taste	6.0±1.6
Texture	5.8±1.8
Overall Liking	6.1±1.4

It was interesting that more than 80% of the consumers accepted this new product and around 70% would like to buy the product even the mean scores of all sensory attributes were not quite high. Many consumers mentioned that the product was very new and they did not familiar with the smell and taste of the product whereas some of them thought that this product was very interesting and it should be a good choice of food that can provide many health benefits. However, further development is needed to increase% consumer acceptant, purchase intent, and all sensory scores.

Results from logistic regression analysis are present in Table 8. This type of regression was used to identify the influential sensory attributes (numerical data: 9 point hedonic scale) toward the overall acceptance and purchase intent (categorical data: yes/no). Texture was only sensory attributes that had significant effect on overall acceptance as the Wald χ^2 value was 0.02 ($p < 0.05$). while appearance and texture were factors influencing consumers' purchase intent as the Wald χ^2 value was 0.05 and 0.1 respectively ($p < 0.05$). The texture of product was important factor for overall acceptance and purchase intent. The appearance affected mainly on purchase intent.

Table 8 Parameter estimates and probability for predicting overall acceptance and purchase decision of developed product

Variables	Overall Acceptance		Purchase Intent	
	Estimate	Pr > x^2	Estimate	Pr > x^2
Appearance	2.36	0.12	3.84	0.05
Taste	0.01	0.93	1.43	0.23
Texture	5.72	0.02	7.69	0.01
Overall liking	4.11	0.04	3.56	0.06

Based on the logistic regression analysis, full model with sensory attributes was used. The analysis of maximum likelihood estimates were used to obtain parameter estimates. Significance of parameter estimates were based on the Wald χ^2 value at $p < 0.05$.

3.5 Physical, chemical, and microbiological properties of final product

Comparison of chemical, physical and micro biological properties between soy yogurt drink with psyllium husk and quinoa and soy yogurt drink without psyllium husk and quinoa are presented

in Table 9. Total Soluble Solid (TSS) was only one chemical property that was not significant difference between soy yogurt drink with and without psyllium husk and quinoa. Adding psyllium husk and quinoa made a significant effect on chemical properties. Soy yogurt drink with psyllium husk and quinoa had significantly higher on protein, fiber, ash, acidity and pH value compared with soy yogurt drink without psyllium husk and quinoa.

Table 9 Physical, chemical and biological analysis results of the final product

Properties	Final product without quinoa and psyllium husk	Final product with quinoa and psyllium husk
Chemical properties		
Protein (%)	1.41 ± 0.09^{b}	5.88 ± 0.07^{a}
Fiber (%)	0.59 ± 0.16^{b}	5.60 ± 0.13^{a}
Ash (%)	0.09 ± 0.01b	0.19 ± 0.01^{a}
Acidity (g/L)	0.12 ± 0.10^{b}	0.22 ± 0.10^{a}
pH	4.20 ± 0.06^{b}	4.57 ± 0.06^{a}
TSS (°Brix)	10.10 ± 0.12^{a}	10.01 ± 0.12^{a}
Physical properties		
Color L*	74.01 ± 0.14^{a}	71.67 ± 0.23^{b}
a*	-2.57 ± 0.05^{a}	-2.45 ± 0.16^{a}
b*	6.72 ± 0.43^{a}	4.82 ± 0.15^{b}
Viscosity (cP)	11.86 ± 0.39^{b}	76.98 ± 0.39^{a}
Micro biological properties		
Lactic acid bacteria (CFU/mL)	4.4×10^{7}	4.6×10^{7}
Total place count (CFU/mL)	<10	<10
Yeast and Mold (CFU/mL)	<10	<10

*Mean of the same column with different superscripts indicating significantly differences ($p \leq 0.05$)
Mean values ± standard deviation (n=3)

For physical properties, L* and b* value decreased significantly when add psyllium husk and quinoa. No significant difference was found on a* value. The soy yogurt drink fortified with with psyllium husk and quinoa had lower intensity of white and yellow colors than the sample without psyllium husk and quinoa. Viscosity was increased significantly when adding psyllium husk and quinoa.

Microbiological properties were determined for the developed product. According to the notification of the Ministry of Public Health, Thailand (No. 353/2013), standard of microorganism in yogurt drink was reported that no less than 1.0×10^{7} CFU/mL of lactic acid bacteria would be found in the product. Yeast and mold should not be found more than 100 CFU/mL and total plate count should not be more than 1.0×10^{4} CFU/mL The results of microbiological properties of soy yogurt drink fortified with psyllium husk and quinoa followed with all standards.

4. Conclusions

The significance of this study was to develop soy yogurt drink fortified with quinoa and psyllium husk. The suitable ratio between soybean and water for making soy yogurt drink was 1 : 4. Adding 8% of liquid sucrose was the most preferred formula. The ratio of 1 : 5 was the suitable ratio for adding psyllium husk and quinoa, respectively. Fortification of soy yogurt drink with quinoa and psyllium husk provided significant results by increasing both protein and fiber content. The averaged overall liking score was 6.1, which was classified as 'light slightly' on 9 point hedonic scale. Eighty three percent of a hundred consumers accepted this product. Sixty five of 100 consumers decided to buy this product of it was commercially available. The developed product can be an alternative healthy food for health-conscious consumers and consumers who

have problems caused by consumption of milk and milk products.

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