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Chemical properties and sensory evaluation of sweetened condensed rice (*Oryza sativa* L.) milk

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Abstract

Food and beverage products that provide beneficial effects on human health and the prevention of diseases have become more popular among consumers who are seeking a healthy lifestyle. Sweetened condensed rice (*Oryza sativa* L.) milk (SCRM) is a plant-based food product and it is suitable for some people who practise vegetarianism and suffer from a food allergy, such as lactose intolerance. The study herein developed SCRM by applying three different sweeteners that comprise refined sugar (SCRMSU), glucose syrup (SCRMGL), and stevia syrup (SCRMST). The aim of the study was to examine the chemical properties (proximate composition and concentrations of sugars), physical properties (colour measurement, pH and moisture content), microbial analysis during the storage period and sensory evaluation. Results showed that SCRMGL exhibited the highest total carbohydrate value (67.93%), while the lowest value was shown in SCRMST (44.07%). All samples have a relatively low amount of protein, fat, and ash compared to carbohydrates. The total sugar concentration of SCRMGL and SCRMSU was 48.36 g/100 g and 45.23 g/100 g, respectively; but not detected in SCRMST. Sucrose constituted the highest concentration of total sugar in all samples, with SCRMSU (44.93 g/100 g) having the highest. Based on the aerobic plate count, SCRMST showed the highest microbial reduction after being stored for 7 (3.68 log CFU/g) and 15 (6.99 log CFU/g) days, followed by SCRMSU (7 days, 2.53 log CFU/g; 15 days, 5.81 log CFU/g). In contrast, there was no appreciable amount of mould detected in all samples after seven days of storage. The study also included the sensory evaluation involving thirty panellists by using a 9-point hedonic scale and a majority of panellists accepted SCRMST given that it had the highest score on several sensory characteristics, e.g., appearance (8.00±1.00), colour (8.10±0.91), taste (8.10±0.91), flavour (7.65±0.88), and texture (7.95±0.85), with the overall acceptability of 8.25±0.64. In summary, SCRMST is expected to respond well in the health market and be one of the alternative products for some people who face food allergy problems.

1. Introduction

Rice is a staple food that is regularly consumed in Asia almost daily. The rice plant has been accounted as the third ranking of the world's cereal crop, behind corn and wheat (Van Soest, 2006). Nevertheless, the rice cultivation procedure in Thailand is severely challenged by inconsistent climate change, flooding, and other environmental/pollution issues, which substantially decreased the amount of rice production (Changsri *et al*., 2016). One of the initiatives undertaken by the Rice Department in the Thai government was attempting to develop a variety of rice by crossbreeding Sangyod Phatthalung Rice and Thai Jasmin Rice, and the product, namely Tubtim Chumphae Rice (TCR/RD69) demonstrated a higher quality, nutrition value, and yield than its parent derivatives (Changsri *et al*., 2016). One of the signatures of TCR is the ruby-red colour of aril, in which the red pigments consist of a higher anthocyanin and proanthocyanidins content than white rice (Chen *et al*., 2012). In addition, the rice presented a rich amount of antioxidants, i.e., γ-aminobutyric acid (GABA) and phenolic compounds that are beneficial to human health (Changsri *et al*., 2016). Moreover, TCR is suitable to be consumed by diabetic people due to its low glycemic index. Despite all these characteristics, the attention towards TCR is still low and only being purchased by the minority customer. Nevertheless, more approaches should be taken to promote the benefit of consuming

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TCR.

Aside from food, plant-based beverage products (e.g., soy milk, almond milk, and rice milk) have gained high popularity among consumers who are embracing a healthy lifestyle and practising vegetarianism. Additionally, these products are particularly suitable for some people who face food allergy problems, such as lactose intolerance. Oak and Jha (2018) reported that about 90% of the population in Asia, South America, and Africa have an abnormal immune response to lactose; whereby these people cannot digest and absorb lactose in cow's milk, resulting in diarrhoea and vomiting. Nevertheless, some of these people might not be appeased by consuming plant-based milk products as they have the typical stereotype that these products lack taste compared to cow's milk. Hence, more research should be carried out to develop highly nutritive plant-based beverage products that cater to consumers' needs and tastes.

Normally, sweet condensed milk (SCM) is a part of the dairy products that are produced from cow's milk. The definition of this product is milk that has been evaporated from any water (60%) and increased 45-50% of sugar in order to extend the self-life and it is a crucial ingredient in coffee, tea and desserts (Park and Drake, 2016; Maurício *et al*., 2021; Stone, 2021). Although sweetened condensed milk has a high sugar concentration, it could be spoiled by microorganisms, especially mould. The previous study tried to extend an SCM's self-life such as Maurício *et al*. (2021) compared the process of dried-sweet condensed milk but they mentioned that the challenge was how to reconstitute dried-sweet condensed milk to SCM. Therefore, SCM in a recent commercial market still has only one appearance which is semi-liquid. In addition, the majority of plant-based products also appeared in terms of beverages such as non-dairy milk (oat milk, soy milk, peanut milk, almond milk, coconut milk and sesame milk) to serve people who face cow milk allergy, lactose intolerance including calorie (Sethi *et al*., 2016). Thus, the product development of SCM from plant-based milk products could be a rising trend because the product may be inexpensive, and the market is still an extensive chance.

In this regard, the main purpose of the study was to examine the chemical properties (proximate composition and concentrations of sugars), physical properties (colour measurement, pH and moisture content), microbial analysis during the storage period and sensory evaluation. Besides, this study aimed to develop three different sweetened condensed rice (*Oryza sativa* L.) milk (SCRM) products by using three different sweeteners, i.e., refined sugar (SCRMSU), glucose syrup (SCRMGL), and stevia syrup (SCRMST). While refined sugar and glucose syrup are commercial sugars with high carbohydrates (high calories), those people who are on a diet or diabetic prefer stevia syrup as it provides lower calories (Goyal *et al*., 2010; Tanaviyutpakdee and Srianujata, 2018). Nonetheless, the relatively high price of stevia syrup compared to other sugars could increase the product cost and therefore, make different reactions in different customer markets. The study also examined the chemical properties of three different SCRM products, including proximate composition, concentrations of sugars (fructose, glucose, lactose, maltose, and sucrose), and microbial analysis after the designated storage period. New product development is essential to optimise product properties and sensory characteristics (appearance, colour, taste, flavour, texture and overall acceptability). Therefore, the study provided the sensory evaluation to present thirty panellists' perspectives on these products. This research provided meaningful insight for manufacturers of SCRM by showing information about panellists' sensory evaluation of these products and their related purchase likelihood.

2. Materials and methods

2.1 Preparation of sweetened condensed rice milk

The non-glutinous rice (*Oryza sativa L.*) in Thailand, TCR was obtained from Ban Fang Community Enterprise, Khon Keang Province, Thailand. The sample was kept at −18 °C until further analysis. The other ingredients of SCRM were bought from a local market in Udon Thani Province, Thailand and are as follows: TCR (13.89%), oat (2.95%), water (1) (22.89%), water (2) (15.20%) and sweeteners (45%). The three sweeteners include refined sugar, glucose syrup, and stevia syrup. The appearance and detail of three sweeteners in this study were as follows: refined sugar was a white crystallised sugar product obtained from the sugarcane and this sugar would call commercial sugar or sucrose ($C6H12O6$), glucose syrup was a liquid sugar made from the sugarcane, stevia syrup (INS number 860) was a liquid sugar made from the leaves of the stevia plant. These were bought from a local market in Udon Thani Province, Thailand.

Briefly, TCR was soaked with water (1) for at least three hours and did not remove water (1). In addition, the moisture content of TCR before soaking was 4.36%. Then, blended with oat and water (2). After that, different sweeteners were added to the mixture and boiled for 1.5 hrs at 75°C. After that, the SCRM was cooled immediately, packed in plastic bags (100 mL per pack), and then stored in the refrigerator (4°C) until further analysis.

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2.2 Proximate composition analysis

The proximate composition of the samples was determined based on the method proposed by Association of Official Analytical Chemists (AOAC) (2019), which estimates the content of protein, fat, ash, and moisture. The results were presented in percentage (%) on a wet basis and the protein factor calculation was 6.25. The protein analysis was conducted using three tools, *viz*., protein digestion unit (Gerhardt, KB/KBL with TZ Control), distillation unit (Gerhardt, Vapodest 45S), and auto titration unit. Soxtec 8000 extraction unit (FOSS) and Hydrotec 8000 (FOSS) were used for fat analysis. Samples were burned by using a muffle furnace (Cabolite, ELE 11/14/201) at 550°C for one hour to determine the ash content. Using these obtained values, the total carbohydrate (1), total energy (2), and energy from fat (3) were calculated following the Methods of Analysis for Nutrition Labeling (Sullivan and Carpenter, 1993) as shown below:

$$\text{Total carbohydrate (\%)} = [100 - (\%\text{ moisture} + \%\text{ ash} + \%\text{ protein} + \%\text{ total fat})] \quad (1)$$

$$\text{Total energy (kcal/100 g)} = [(\%\text{ total fat} \times 9) + (\%\text{ protein} \times 4) + (\%\text{ carbohydrate} \times 4)] \quad (2)$$

$$\text{Energy from fat (kcal/100 g)} = \%\text{ fat} \times 9 \quad (3)$$

2.3 Physical measurement

The study considered colour measurement, pH measurement and % of moisture content as the physical measurement of the samples. Regarding the sample colour, a Miniscan EZ (Hunter Associates Laboratory Inc., USA) was used and this device is based on CIELAB (1976) L* (lightness/darkness), a* (greenness (-a*)/redness (+a*)), b* (blueness (-b*)/yellowness (+b*)) colour scale. Besides, pH measurement (MW150-E Milwaukee pH meter) and percentage moisture content (M45, Moisture Analyzer, Switzerland) were determined based on the method proposed by AOAC (2019).

2.4 Sugars concentration determination

The concentration (g/100 g) of five types of sugars, i.e., fructose, glucose, lactose, maltose, and sucrose were determined according to AOAC (2019), Akamatsu *et al*. (2022), and Jia *et al*. (2020). A total of 5 g sample was dissolved in 50 mL of hot water, followed by extraction using an ultrasonic bath for 20 mins. Then, 1 mL of 15% potassium ferrocyanide ($K_4[Fe(CN_6)]•3H_2O$) and 1 mL of hydrated zinc sulfate ($ZnSO_4•7H_2O$) were added into the mixture and made up to 100 mL with deionised (DI) water. The sample was then filtered through a Whatman filter paper no. 42. The sugar concentration was determined by using high-performance liquid chromatography (HPLC, HP 1260 Infinity, Agilent Technologies, Germany). Samples were injected onto a Prevail^{TM} Carbohydrate Column (particle size 5 µM, 250 × 4.6 mm, internal diameter 4.6 mm) equipped with a 1290 Infinity II ELSD detector, using acetonitrile: DI water as mobile phase. Gradient Elution Analysis was set up for a condition analysis program following the in-house method WI-TMC-07 (AOAC, 2019).

2.5 Microbial analysis

The aerobic plate count (APC), yeast count, and mould count were determined according to the protocol outlined by U. S. Food and Drug Administration Bacteriological Analytical Manual (FDA BAM), Chapter 18 (2001) and Wongkhalaung and Boonyaratanakornkit (2000). Briefly, the samples were contained in plastic bags (2 × 5 in) and stored at room temperature for 7, 15, 30, and 45 days. The analysis was conducted by incubating the samples at 35°C for 48 hrs to obtain APC and then further incubated for seven days at 25°C to calculate the number of yeasts and moulds. According to the APC procedure, 1 mL. of the sample was pipetted into a petri dish and added with PCA agar. After that, the sample was incubated, counted and calculated the number of the microbial colony. Besides, the procedure of yeast and mould began with pipet 1 mL. of sample onto DG 18 agar and spread over the surface. Then, the sample was incubated following the reference temperature and calculated. The microbial counts were recorded and presented as the logarithms of colony-forming per g ($\log_{10}$ CFU/g) based on the previous study outlined by Zhou *et al*. (2022).

2.6 Sensory evaluation

Thirty untrained panellists were selected among the students and staff at Udon Thani Rajabhat University, Thailand. Each sample was served to the panellists in a plastic cup with a plastic cover. Six dimensions, including the appearance, colour, taste, flavour, texture, and overall acceptability of the sample were scored by the panellists using a 9-point hedonic scale (9 = like extremely; 5 = neither like nor like; 1 = dislike extremely) (Lawless and Heymann, 2010; Kunyanee and Luangsakul, 2022).

2.7 Statistical analysis

All data were presented in the mean ± SD of at least three replicates. Analysis of variance (ANOVA) and Duncan's new multiple range test were conducted using Statistical Package for the Social Sciences (SPSS) for Mac (SPSS Institute Inc., Chicago, IL, U.S.). The difference between the means is considered significant when $p < 0.05$.

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3. Results and discussion

3.1 Proximate composition

As shown in Table 1, the protein, fat, ash, moisture, total carbohydrate, total energy, and energy from the fat of all three SCRMs varied significantly from each other ($p < 0.05$). The protein content of the samples ranged from 0.39–0.48%, with that of SCRMSU and SCRMST being higher than SCRMGL. The fat content of the samples ranged from 0.64–0.81%, while that of SCRMSU and SCRMGL were not significantly different ($p > 0.05$) and SCRMST showed the highest fat content (0.81%). These results were in agreement with those reported by Wijaya and Romulo (2021), in which the red rice (*Oryza sativa L.*) milk had low protein (0.13%, wet bases) and fat (0.71%, wet bases) content; as the major component of rice is carbohydrate instead of protein and fat, unlike other milk (e.g., cow's milk) which shows otherwise. Nevertheless, the same study also reported that other commercial plant-based milk (e.g., almond milk) has high protein and fat content because it could have been fortified with food additives to enhance its nutritional values and quality (Wijaya and Romulo, 2021). A similar hypothesis was also made by Fernandesa *et al*. (2021), whereby the authors suggested that cereal-based beverages would have fat-based ingredients added to increase the fat content and mouthfeel of the beverage. On the contrary, the ash value ranged from 0.20–0.23% and it did not show a significant difference ($p > 0.05$) among the three samples. The highest moisture content was SCRMST (54.49%), followed by SCRMSU (37.01%) and SCRMGL (30.77%). Moreover, SCRMGL and SCRMST showed the highest (67.93%) and lowest (44.07%) total carbohydrate content, respectively. On the other hand, another product produced from red rice (*Oryza sativa L.*), such as kefir (a fermented milk drink similar to a thin yoghurt), consisting of 16.06–16.98% of carbohydrates (Sulistyaningtyas *et al*., 2019). Total energy content ranged from 185.29–279.49 kcal/100 g, with SCRMGL showing the highest total energy content (279.49 kcal/100 g), followed by SCRMSU (254.16 kcal/100 g), and SCRMST (185.29 kcal/100 g). Lastly, SCRMST demonstrated the highest energy from fat (7.29 kcal/100 g), while SCRMSU was the lowest (5.76 kcal/100 g).

3.2 Physical properties

The colour measurement, pH, and moisture content were presented in Table 2. The study determined the colour of samples by using CIELAB (L*, a* and b* colour scale). The highest L* value was reported for SCRMSU (39.75±0.10) and this sample did not differ from SCRMGL (39.87±0.11). In contrast, SCRMST was the lowest lightness value (28.93±0.09). Besides, the study recorded a* value that SCRMST was the highest redness (13.18±0.10) followed by SCRMGL (10.09±0.10) and SCRMSU (9.24±0.12). SCRMSU was the highest b* value (23.38±0.09). However, SCRMGL (17.49±0.10) and SCRMST (17.87±0.08) were not significantly different (P>0.05) on b* value. Regarding pH measurement, there was no significantly different (P>0.05) among the three samples (4.13±0.10 - 4.85±0.08). Maurício *at el*. (2021) reported pH values of non-sweetened milk and sweetened milk were not different (6.75±0.02 and 6.74±0.02, respectively). Therefore, the study would say that a sweetener amount would not affect pH values of the samples. In addition, one of the key factors to show the physical properties of SCRM was moisture content and the results presented in %. SCRMST had the highest moisture content (12.53±0.98) and was followed by SCRMSU (10.50±0.10) and SCRMGL (7.73±0.15), respectively.

Table 1. Proximate composition of sweet condensed rice milk with three different sweeteners.

Sample	Proximate Composition						
	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Total Carbohydrate (%)	Total Energy (kcal/100g)	Energy from fat (kcal/100g)
SCRMSU	0.48 ± 0.10^{a}	0.64 ± 0.12^{b}	0.23 ± 0.09^{a}	37.03 ± 0.07^{b}	61.62 ± 0.10^{b}	254.16 ± 0.10^{b}	5.76 ± 0.10^{c}
SCRMGL	0.39 ± 0.11^{b}	0.69 ± 0.10^{b}	0.22 ± 0.10^{a}	30.77 ± 0.08^{c}	67.93 ± 0.10^{a}	279.49 ± 0.11^{a}	6.21 ± 0.10^{b}
SCRMST	0.43 ± 0.09^{a}	0.81 ± 0.10^{a}	0.20 ± 0.08^{a}	54.49 ± 0.10^{a}	44.07 ± 0.10^{c}	185.29 ± 0.14^{c}	7.29 ± 0.10^{a}

Values are presented as mean±SD, n = 5. Values with different superscripts within the same column are statistically significantly different (P<0.05). SCRMSU: sweet condensed rice milk with sugar, SCRMGL: sweet condensed rice milk with glucose syrup, SCRMST: sweet condensed rice milk with stevia syrup

Table 2. Physical properties of sweet condensed rice milk with three different sweeteners.

Sample	L*	a*	b*	pH	Moisture content (%)
SCRMSU	39.75 ± 0.10^{a}	9.24 ± 0.12^{c}	23.38 ± 0.09^{a}	4.14 ± 0.07^{a}	10.50 ± 0.10^{b}
SCRMGL	39.87 ± 0.11^{a}	10.09 ± 0.10^{b}	17.49 ± 0.10^{b}	4.85 ± 0.08^{a}	7.73 ± 0.15^{c}
SCRMST	28.93 ± 0.09^{b}	13.18 ± 0.10^{a}	17.87 ± 0.08^{b}	4.13 ± 0.10^{a}	12.53 ± 0.98^{a}

Values are presented as mean±SD, n = 5. Values with different superscripts within the same column are statistically significantly different (P<0.05). SCRMSU: sweet condensed rice milk with sugar, SCRMGL: sweet condensed rice milk with glucose syrup, SCRMST: sweet condensed rice milk with stevia syrup

3.3 Concentration of sugars

The concentration of five different sugars (*viz*., fructose, glucose, lactose, maltose, and sucrose) was estimated and the results are illustrated in Figure 1. The total amount of sugar in SCRMGL, SCRMSU, and SCRMST was 48.36, 45.23 g/100 g, and not detected, respectively. Particularly, SCRMSU presented the highest amount of sucrose (44.93 g/100 g) with a small quantity of fructose (0.10 g/100 g) and glucose (0.20 g/100 g). In contrast, SCRMGL had a lower sucrose amount (19.40 g/100 g) than SCRMSU, but a higher amount of fructose (13.89 g/100 g) and glucose (15.07 g/100 g). Since lactose is a disaccharide or specific sugar in cow's milk (Oak and Jha, 2018), it was not detected in all SCRM samples. However, the study would like to confirm that this product did not contain any lactose, hence, it was included to identify the sugar concentration. Likewise, maltose (enzymatic hydrolysis product of starch) was not found in all samples. A part of the disaccharide type that has to be produced by using the enzymatic hydrolysis reaction with starch was explained as the meaning of maltose (Woźniaka *et al*., 2020). In addition, Shintani *et al*. (2021) studied the maltose formation of wheat dough, and the result was ~0.25 g maltose/g flour of the maltose produced at 60°C. Lastly, all five aforementioned sugars were not detected in SCRMST as stevia is not a natural sugar but a bio-sweetener derived from the leaves of the plant species *Stevia rebaudiana* (Goyal *et al*., 2010). Nonetheless, stevia syrup is still organised into food additive groups in Thailand.

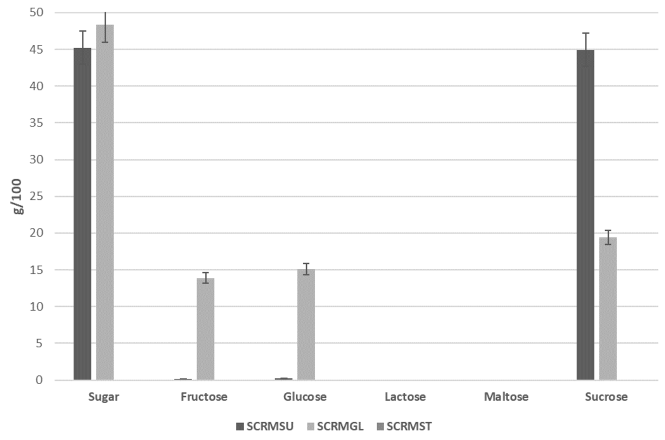

Figure 1. The sugar concentration of sweet condensed rice milk with three different sweeteners. Values are presented as mean±SD, n = 5. SCRMSU: sweet condensed rice milk with sugar, SCRMGL: sweet condensed rice milk with glucose syrup, SCRMST: sweet condensed rice milk with stevia syrup.

3.4 Microbial analysis

The aerobic plate count (APC), yeast count, and mould count of the SCRM at room temperature after the designated storage period (7, 15, 30, and 45 days) were determined and the results were presented as log CFU/g in Figure 2. Based on the results of APC (Figure 2A), SCRMST showed the highest microbial reduction after being stored for seven (3.68 log CFU/g) and 15 (6.99 log CFU/g) days, followed by SCRMSU (7 days, 2.53 log CFU/g; 15 days, 5.81 log CFU/g). In contrast, SCRMGL had less than 10 colonies (< 10 log CFU/g) at both storage periods but slightly increased to 1.32 log CFU/g and 2.00 log CFU/g after 30 and 45 days of storage, respectively. Similar to other samples, the APC of SCRMST and SCRMSU had been continually increasing for 30 days. Nevertheless, the microbial formation in SCRMSU and SCRMST reduced steadily after 45 days of storage as the microorganisms achieved a dead phase of growth (Van Impe *et al*., 2004; Bzura *et al*., 2022). When comparing the three samples, SCRMGL showed the lowest amount of APC during the storage period. The study would mention that the key ingredient of SCRMGL was glucose syrup, and the syrup contains 0.05% of food preservatives. Besides, this sample also had the lowest moisture content (7.73±0.15). These possible factors, food preservative and moisture content, could affect the lower number of APC than other samples.

After seven days of storage, SCRMSU had a significantly ($p < 0.05$) higher amount of yeast than that of the initial duration time (2.23 log CFU/g), and it had increased to 5.93 log CFU/g after 45 days of storage (Figure 2B). Likewise, the yeast count in SCRMST was 1.00 log CFU/g after seven days of storage and it continually increased to 5.83 log CFU/g after 45 days. On the contrary, there were less than 10 colony-forming (< 10 log CFU/g) in SCRMGL throughout 45 days of storage.

In addition to yeast, mould is one of the largest groups of food microorganisms that is normally found on perishable food or semi-perishable food, but it has a slower growth rate than aerobic bacteria (Pahariya *et al*., 2022; Zhou *et al*., 2022). In the current study, the population of mould has no significant difference ($p >$ 0.05) among three samples after seven days of storage (Figure 2C). The initial colony-forming was 1.08 log CFU/g (SCRMSU), 1.04 log CFU/g (SCRMGL), and 1.08 log CFU/g (SCRMST). The mould population increased uninterruptedly during the experimental period. The highest mould population was recorded in SCRMSU (5.54 log CFU/g), followed by SCRMST (5.04 log CFU/g), and SCRMGL (4.15 log CFU/g) after 45 days of storage. Raybaudi-Massilia *et al*. (2009) reported that food which contains higher sugar content and lower pH could have a higher rate of decay process initiated by aerobic bacteria, whereby the decomposition process would be later dominated by yeast and mould. In addition, food and food products have to indicate food safety with the quality standard of food microorganisms (Department of Medical Science, Thailand, 2017). For example, the total aerobic plate count of dessert must be less than 1×10^6 CFU/g and yeast and mould must be less than 1×10^3 CFU/g.

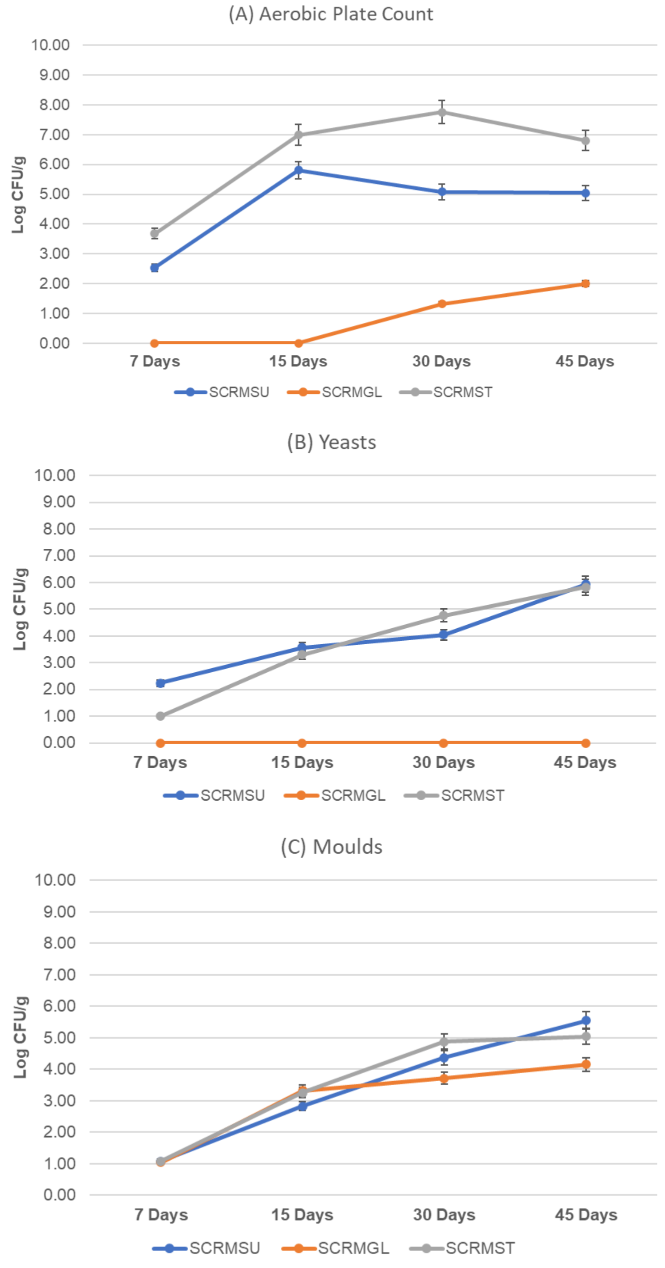

Figure 2. Microbial analysis of different sweeteners of sweet condensed rice milk during storage at 7, 15, 30 and 45 days at room temperature and this figure includes Aerobic plate count (A), Yeasts (B), and Moulds (C) that were presented microbial analysis result. Values are presented as mean±SD, n = 5. SCRMSU: sweet condensed rice milk with sugar, SCRMGL: sweet condensed rice milk with glucose syrup, SCRMST: sweet condensed rice milk with stevia syrup.

3.5 Sensory evaluation

Taste is one of the most crucial and frequently reported factors in relation to plant-based products, underlining that sensory quality is still key in the development of new food. The sensory characteristics (appearance, colour, taste, flavour, texture, and overall acceptability) of the samples were evaluated by thirty random panellists and the results are shown in Figure 3. Using a 9-point hedonic scale, SCRMST had the highest score on appearance property (8.00±1.00 out of 9), while SCRMGL and SCRMSU had the appearance score of 7.10±0.98 and 7.05±1.10, respectively. In addition, the results also found that both SCRMST and SCRMSU achieved a higher score on colour, taste, and flavour than SCRMGL; whilst their general scores on colour did not have a significant difference between them. For the taste score, the majority of the panellists ranked SCRMST (8.05±0.93) and SCRMSU (7.95±0.88) as the highest score. The panellists also preferred the flavour of both SCRMSU (7.65±0.93) and SCRMST (7.65±0.88). Nonetheless, SCRMGL received the lowest score on colour (7.35±0.81), taste (7.70±0.66), and flavour (7.25±0.81). Regarding texture characteristics, the highest score was SCRMST (7.95±0.85), followed by SCRMSU (7.80±1.01) and SCRMGL (7.55±1.15). In summary, most panellists preferred SCRMST (8.25±0.64) based on the overall acceptability results along with the other sensory characteristics, including appearance, colour, taste, flavour, and texture. The results were also in accordance with other sensory evaluations. For instance, previous studies reported that rice milk scored 7.95±0.11 out of 9 on the overall acceptability by thirty semi-trained panellists (Padma *et al*., 2019). In addition, Wongkhalaung and Boonyaratanakornkit (2000) compared the sensory evaluation comprising colour, odour, flavour, texture, and acceptability between commercial daily yoghurt and rice-based yoghurt, and the overall scores were not significantly different between both products.

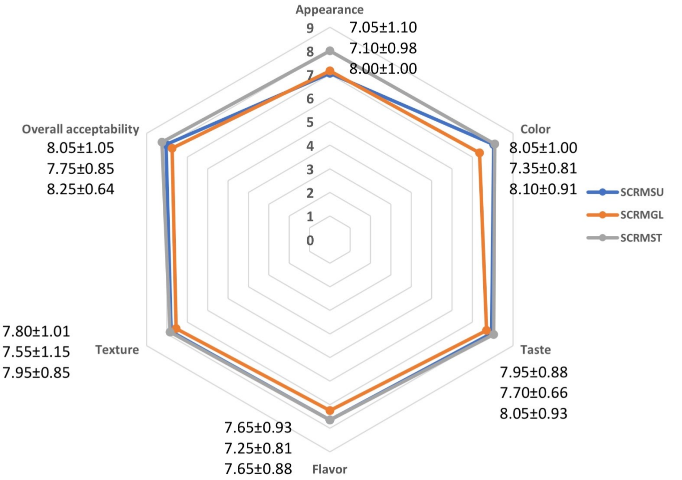

Figure 3. Sensory evaluation of sweet condensed rice milk. Values are presented as mean±SD, n = 30. SCRMSU: sweet condensed rice milk with sugar, SCRMGL: sweet condensed rice milk with glucose syrup, SCRMST: sweet condensed rice milk with stevia syrup.

4. Conclusion

The study herein developed three different SCRM products and all exhibited different proximate compositions, sugar concentration, microbial activity, as well as customers' responses. The samples with refined sugar (SCRMSU) and glucose syrup (SCRMGL) had a high percentage of total carbohydrate (61.62–67.93%) but the sample with stevia syrup (SCRMST) had only 44.07%. Nevertheless, all samples had a low amount of protein, fat, and ash. For the determination of sugar concentration, only SCRMST did not have all five sugars (fructose, glucose, lactose, maltose, and sucrose) detected. However, the study found a small crystallization of sugar in SCRMSU during the storage time and the sugar crystal tends to be larger in size and higher amount than at the beginning of storage. Therefore, refined sugar would not suit as the sweetener for SCRM products, or the ingredient needs to have a crystallization inhibitor and stabilizer to maintain the quality of SCRM. According to microbial analysis, SCRMGL had the lowest microbial action even after 45 days of storage at room temperature. Besides, the TCR colour would affect a* value because this rice was red colour. Lastly, results are overall positive towards SCRMST, in terms of satisfactory texture properties and thirty panellist acceptance which contributed to its potential to meet the desirability of the consumer market.

Conflict of interest

The authors declare no conflict of interest.

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