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The Physicochemical Properties and Consumer Acceptance of Ricegrass Beverage Ready for Consumption

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Abstract

Juice extracted from riceberry ricegrass has exhibited higher phenol and antioxidant activity. The objectives of this research was to enhance the value of ricegrass and to develop a product that small community enterprises can follow through the entire production process. This study was designed to examine the physicochemical, microbiological properties and sensory evaluation of ricegrass juice and ricegrass juice mixed with soybeans and navy beans (SN) milk. Rice leaves were extracted with room temperature water at ratios of 10:1, 2:1, 1:1, 1:5 and 1:10 (w/v) and with hot water at ratios of 2:1 and 1:1 (w/v). The results revealed that ricegrass leaves extracted with room temperature water at a ratio of 1:5 (w/v) had a higher yield, total phenol and antioxidant activity. The sensory evaluation found that 30% of ricegrass juice that was mixed with 10% SN milk had the highest acceptance score on all attributes. Pasteurized products stored at 4°C for 8 days were closed near to the Thai community product standard (TCPS 529/2547), but total phenol and antioxidant activity decreased during storage ($p \leq 0.05$). Furthermore, ricegrass juice mixed with SN milk product is a functional drink which has plenty of phenol, antioxidant and nutrition.

Introduction

Riceberry rice (*Oryza sativa* L.) is a native rice of Thailand with high nutrient values. In the same manner, rice is one of the cereal plants in the grass family (Poaceae) which is the same as wheat, rye and barley. Chomchan et al. (2016) found that plants at a younger stage produce higher levels of phytochemicals substances which can protect themselves away from risks, while these compounds exert various biological benefits for human health, especially 6 to 20 days young ricegrass has a higher level of antioxidant compounds (Akcan Kardas & Durucasu, 2014). Moreover, young leaves of monocotyledon plants are rich in vitamins, minerals, dietary fibre, antioxidants, superoxide dismutase (SOD) enzyme and other bioactive substances, such as tyrosinase and phosphodiesterase inhibitor in wheat, barley, oats, rye and rice (Hattori, 2002; Chen & Hsieh, 2008). Prior

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research reported on discovering in ricegrass juice phenolic compounds and several biological properties, which are antioxidant properties and DNA protective properties (Khanthapoka et al., 2015). Kapkum et al. (2011) claimed that the total phenolic content (TPC) of ricegrass juice from white rice cultivars varied in the range of 1.50 to 2.14 mg gallic acid equivalent (GAE)/g dry extract. Additionally, ricegrass juice from the Khao Dawk Mali 105 cultivar prevented lipid oxidation to a similar extent as wheatgrass juice. According to previous literature, ricegrass juice has been extracted from fresh leaves with room temperature water (Chomchan et al., 2016), dried rice leaves extracted in boiling water (80-98°C) (Phimphilai et al., 2021).

The introduction of young ricegrass juice as an innovative functional drink is fascinating. A previous study demonstrated that the extracts of Thai purple ricegrass at the jointing stage contained significantly higher levels of phytochemicals and antioxidant ability than those of white ricegrass (Khanthapok et al., 2015). Furthermore, black glutinous rice grain sprouts (cv. BGR) were more effective in suppressing the proliferation of human T-lymphocyte (Jurkat), human liver (HepG2) and human colon (HCT116) cancerous cells than white rice sprouts (cv. RD6), which is due to their antioxidant ability and greater polyphenol and anthocyanin contents (So et al., 2020).

It is well known that beans are an excellent source of phytochemicals, particularly polyphenols, as well as protein and dietary fibers (Chen et al., 2019). A number of health benefits have been reported from their consumption, including a reduction in obesity, diabetes and cardiovascular risks (Tharanathan & Mahadevamma, 2003). As a health beverage with potential nutraceutical properties, bean milk has gained popularity in recent years. In particular, it is suitable for children who are allergic to cow's milk and for adults who are not able to tolerate lactose in their systems (Meng et al., 2023). De et al. (2022) found that soymilk and soymilk products were not only effective nutraceutical adjuncts to treating hyperglycemia but also improved nutritional values. Ricegrass drinks have been produced to improve certain nutritional qualities and health benefits. The functional drink products have a global market value of US $ 125.36 billion in 2020 and are expected to raise to US $216.7 billion by 2028 (Department of International Trade Promotion, 2023). However, there are limited investigatory research studies that have been conducted (Phimphilai et al., 2021). In this study, total phenolic and antioxidant activities were determined by using Folin-Ciocalteu method and 2,2-diphenyl-1-picryl hydrazyl (DPPH), respectively. Additionally, microbiological properties, sensory evaluation and nutritional values of riceberry rice juice were evaluated.

Materials and methods

1. Plant materials

Riceberry rice seed (*Oryza Sativa* L.) was obtained from the community enterprise of organic agriculture for Life, Darn Chang, Suphun Buri Province, Thailand. The seeds were washed and soaked overnight in tap water. After washing with distilled water, seeds were planted in a soil bed under natural light for further growth. After 11 days of seed germination, fresh grasses were rapidly cut above ground, weighed and washed three times with tap water followed by juice extraction.

2. Extraction procedure

Rice leaves were extracted with room temperature water at ratios of 10:1, 2:1, 1:1, 1:5 and 1:10 (w/v) and hot water (80°C) at ratios of 2:1 and 1:1 (w/v). The samples were extracted by using a juice extracter (EM-11, Sharp, Japan) at level 2 speed for 3 min. Ricegrass extract were tested for % yield, color by using a colorimeter (Minolta chroma meter (CR-300), Konica Minolta, Inc., Tokyo, Japan). The pH value was measured using the digital pH meter (L855, Xylem, Germany). Total phenolic content was measured by using a Folin–Ciocalteu method from Waterman & Mole, 1994. Antioxidant activity was determined in using 2,2-diphenyl-1-picryl hydrazyl (DPPH). In the presence of an antioxidant, DPPH solution turns from purple to yellow, corresponding to the color of the hydrazine in the solution. The reducing ability of antioxidants toward DPPH can be determined by measuring the decrease of its absorbance at 517 nm. All results are expressed as % DPPH for a fixed antioxidant concentration (Brand-Williams et al., 1995). The % DPPH was calculated using the following equation:

$$\% \text{ DPPH} = \frac{(A\ control - A\ sample)}{A\ control}\ x\ 100$$

3. Development of ricegrass juice

3.1 Optimum concentration of ricegrass extract

The ricegrass juice (ricegrass extract mixed with sugar and water) was prepared by mixing 100 g of sugar with 1.5 L of water and the added 10, 20, 30 and 40% (v/v) ricegrass extract. All samples were assessed for color, odor, taste and acceptance based on sensory attributes. The test panel consisted of 50 untrained panellists who participated in 9-Points Hedonic Scale as used in this experiment.

3.2 Optimum concentration of ricegrass juice mixed with SN milk

SN milk was prepared by mixing commercial soybeans with navy beans at ratio of 3:1 (w/w) and prepared by using soymilk production protocols (Yu et al., 2021). Ricegrass extract with the highest sensory score was selected and mixed with 0, 10, 20 and 30% (v/v) SN milk. The samples were evaluated by following section 3.1.

4. Pasteurization condition

Samples were boiled at 100°C for 2-3 min, followed by storage at 4±2°C for 8 days and sampling every 2 days (Day 0, 2, 4, 6 and 8). To assess the color of pasteurized products, a colorimeter was used (Minolta chroma meter (CR-300), Konica Minolta, Inc., Tokyo, Japan). The pH value of the samples was measured with a digital pH meter (L855, Xylem, Germany); the total phenolic content was determined using the Folin–Ciocalteu method (Waterman & Mole, 1994); and the antioxidant activity was determined using 2,2-diphenyl-1-picryl hydrazyl (DPPH) (Brand-Williams et al., 1995). An analysis of the microbiological properties was conducted by using the total plate count to identify the presence of *Staphylococcus aureus* and *Escherichia coli* (AOAC, 2000). Sensory evaluations were estimated for color, odor, taste and acceptance based on sensory attributes. This experiment consisted of 50 untrained participants and 9-Points Hedonic Scale was used to analyse the results.

5. Physicochemical properties, antioxidant activity and nutritional value of ricegrass juice and ricegrass juice mixed with SN milk products

Pasteurized products were measured for nutritional value, total phenolic content by using a Folin–Ciocalteu method (Waterman & Mole, 1994) and antioxidant activity using 2,2-diphenyl-1-picryl hydrazyl (DPPH) (Brand-Williams et al., 1995).

6. Statistical analysis

All experiments were conducted in triplicate and data were analyzed using ANOVA and significant differences were determined using Duncan's multiple range test ($p \leq 0.05$). Physicochemical and microbiological properties were assessed using a completely randomized design (CRD), while sensory evaluation was conducted using a randomized complete block design (RCBD). All analysis was performed using SPSS software, version 16 (SPSS Inc.).

Results and discussion

1. Effect of extraction process on qualities and biological properties of ricegrass extraction

Effects of extraction process on the yield and color of ricegrass extract are presented in Table 1. In accordance with the extraction process ratios were modified by Chomchan et al. 2016. The result of a study conducted on fresh leaves with room temperature water (10:1 w/v) showed the lowest yield, while greenness was the highest at 19.67 ($p \leq 0.05$). According to the results, there will be a higher cost for the final product when using fresh leaves as an ingredient compared to the other conditions since the fresh leaves have the lowest %yield. When comparing room temperature water and hot water (80°C) at the same ratio, it was found that using hot water significantly decreased the lightness and total phenol content in ricegrass juice. One of the factors that may affect the decomposition of bioactive substances is the higher water temperature. Tiwari et al. (2011) found that juices were extracted using water, which is a high-polarity solvent and that most compounds dissolved in the juice were hydrophilic. Besides, tannin, saponin and soluble phenolic compounds were presented in the solution using water as solvent in some of earlier reports. Wangcharoen & Phimphilai (2016) published that number and position of hydroxyl groups attached to ring structures of their molecules as the reason in affect to the antioxidant potential of phenolic compounds. It means that high antioxidant activities displayed in ricegrass can be detected by the high level of phenolic compounds. Khanthapoka et al. (2015) showed that riceberry, Kum Doisaket and Kum Noi pigmented rice juices displayed a higher percentage of DPPH radical scavenging activity and FRAP, which was compared with wheatgrass juice. The reason is because of the high anthocyanin content of riceberry. Moreover, compared with white-colored rice (RD6), colored rice had a higher TPC, DPPH scavenging activity and ferric reducing antioxidant power (So et al., 2020). As a result, the high productivity can be attributed to the juice obtained by squeezing fresh rice leaves with room temperature water at a ratio of 1:5. This variety had the highest total phenolic content as well as a high % yield. It had a good appearance as well as a high lightness and a bright green color. A ratio of 1:5 is significantly more potent than those in the other ratios, which will be explored in the next step.

Table 1 Effect of extraction process on the physicochemical properties of ricegrass extract

Methods (w/v)	%Yield (ml)	Color			Total phenol (mg/L)	DPPH (%)
		Lightness (L^*)	Redness-Greenness (a^*)	Yellowness-Blueness (b^*)		
Fresh leaves/room temperature water (10:1)	124.56^{e}±1.00	10.78^{c}±2.56	-19.67^{a}±2.05	15.61^{a}±3.56	261.85^{ab}±68.18	64.14^{b}±1.36
Fresh leaves /room temperature water (2:1)	378.23^{d}±6.04	10.67^{c}±0.61	-17.21^{ab}±1.10	13.42^{ab}±0.52	333.67^{a}±54.43	70.57^{a}±1.15
Fresh leaves /room temperature water (1:1)	598.34^{c}±15.21	7.17^{d}±2.11	-11.16^{c}±1.38	7.85^{c}±1.05	276.56^{ab}±25.46	65.18^{b}±1.21
Fresh leaves /hot water (2:1)	408.67^{d}±9.29	6.83^{de}±0.85	-13.71^{bc}±1.97	9.95^{bc}±1.37	226.15^{b}±4.78	63.52^{b}±1.01
Fresh leaves /hot water (1:1)	589.56^{c}±32.05	5.41^{e}±1.39	-9.75^{c}±4.74	7.32^{c}±3.18	225.56^{b}±16.84	58.36^{c}±1.42
Fresh leaves /room temperature water (1:5)	2,671.17^{b}±46.17	20.67^{b}±2.32	-15.56^{b}±2.62	14.23^{ab}±4.67	311.84^{a}±10.67	54.21^{c}±1.93
Fresh leaves /room temperature water (1:10)	4,982.62^{a}±83.02	29.53^{a}±1.85	-13.43b^{c}±2.75	12.78^{ab}±4.56	149.26^{c}±7.51	45.79^{d}±2.17

Remark: Mean ± S.D. with different superscripts in the same column indicated significant different ($p \leq 0.05$)

2. Product development of drinking from ricegrass extract

2.1 Sensory evaluation of ricegrass juice

The ricegrass juice preparation was made from 10-40% of the ricegrass extract. Sensory attributes of ricegrass juice on color, odor, taste and overall acceptance are illustrated in Table 2. Ricegrass juice received the highest odor score (7.58). As observed from the sensory score, 40% of ricegrass extraction received the lowest score in terms of odor, taste and overall acceptance due to the unique smell of the product hence affecting the liking score. However, the 30 % of ricegrass juice reached the highest score for color, taste and overall acceptance. This concentration of ricegrass juice was used for further studies.

Table 2 Sensory evaluation scores of ricegrass juice derived from different extraction % of ricegrass mixed with sugar and water

Attributes	Ricegrass extraction (%)			
	10	20	30	40
Color	5.31^{d}±1.08	6.25^{c}±1.35	7.45^{a}±0.28	7.25^{b}±1.05
Odor	7.58^{a}±0.56	7.42^{ab}±1.26	7.21^{b}±0.31	5.76^{c}±1.26
Taste	7.21^{b}±0.47	7.57^{a}±1.09	7.32^{a}±0.48	5.96^{c}±1.21
Overall acceptance	7.19^{b}±0.65	7.25^{b}±1.05	7.35^{a}±0.53	6.95^{c}±1.16

Remark: Mean ± S.D. with different superscripts in the same row indicated significant different ($p \leq 0.05$)

2.2 Sensory evaluation of 30% ricegrass extract mixed with SN milk

The sensory evaluation of 30% ricegrass extract mixed with 10-30% SN milk and the effects on color, odor, taste and overall acceptance are presented in Table 3. The result showed that 30% ricegrass extraction mixed with 10% of SN milk achieved the highest score for all attributes. A prior report found that increased quantities of SN milk are a significant contributing factor to a decrease in overall acceptance of the product due to the characteristic smell of soybean milk, which is unappealing to consumers.

Table 3 Sensory evaluation scores of 30% ricegrass extract mixed with different % of SN milk

Attributes	30% ricegrass extract mixed with SN milk (%)			
	0	10	20	30
Color	7.45^{a}±0.32	7.73^{a}±0.73	6.78^{b}±1.32	6.11^{b}±1.12
Odor	7.03^{a}±0.15	7.43^{a}±0.67	6.58^{b}±1.16	5.78^{b}±1.24
Taste	7.23^{b}±0.58	7.67^{a}±0.82	6.32^{c}±1.05	6.28^{c}±1.07
Overall acceptance	7.21^{b}±0.16	7.69^{a}±0.54	6.25^{c}±1.01	6.21^{c}±1.03

Remark: Mean ± S.D. with different superscripts in the same row indicated significant different ($p \leq 0.05$)

3. Physicochemical, microbiological and sensory evaluation of pasteurized products

3.1 Physicochemical and microbiological properties of pasteurized products

The physicochemical properties of pasteurized products stored at 4±2°C for 8 days are exhibited in Table 4 and 5. It was found that color, total phenol and antioxidant activity were significantly reduced with storage time, similar to what had been observed in previous studies by Wojdyło et al., 2014; Mäkilä et al., 2017; Aaby & Amundsen, 2023. Whereas pH was not significant during the storage time. However, important changes in the color during the storage ($p<0.05$) and the values of L^* and b^* decreased indicating that the yellowness reduced and then the products became darker. Besides, the rise in a^* values signified an increase in a reddish tone which supports the color had considerably changed. Koca et al. (2003) reported those trends and the results are consistent with their report. It was observed in this study that the color gradually turned to brown during prolonged storage. Wibowo et al. (2015) described the pasteurized orange juice color changes during storage. The value of *L**, *a**, pH and total phenol of ricegrass juice mixed with SN milk was higher than ricegrass juice due to be mixed with SN milk. However, the value of *b** and DPPH of ricegrass juice mixed with SN milk was higher.

Researchers have previously observed that the phytochemicals exhibited similar behavior in extracts of rice plants. A study by Kapkum et al., 2011, indicated that dried rice plants dried by vacuum-microwave at 2880 W and water extracted for 3 min had a total polyphenol content of 0.04 GAE/mL, antioxidant activity of 0.26 mg TEAC/mL and FRAP of 0.09 mg $FeSo_4$/ml, respectively. Khanthapok et al., 2015 also examined the antioxidant activity of juice squeezed from rice grasses prepared from grass juice and processed at a low temperature, demonstrating that the total phenolic content ranged from 1.9-4.3 mg GAE/g DE in colored rice cultivars, while the Kum Doisaket cultivar demonstrated the greatest radical scavenging activity with an EC_{50} of 0.11 mg DE/mL. Additionally, Wangcharoen & Phimphilai (2016) studied three rice varieties (Jusmine, Sukhothai 1 and Sukhothai 2) under sterilization conditions and stored ricegrass juices at room temperature for a period of one month. Researchers found that TPC varied between 10.50 and 23.04 mg gallic acid equivalent/200 mL, antioxidant activities such as ABTS varied between 25.44 and 35.18 mg vitamin C equivalent/200 mL, and FRAP varied between 16.00 and 23.70 mg $FeSo_4$ equivalent/200 mL. However, no studies have examined the physicochemical characteristics and consumer acceptance of ricegrass beverages at the ready-to-drink stage. The decrease of phenolic and antioxidant can be explained by the pasteurized process and storage time. The reason is that phenolics and antioxidants are sensitive to heating and the prolonged thermal treatment would lead to a loss of natural antioxidants due to most of these compounds are unstable (Kapkum et al., 2011; Aydar et al., 2023). Moreover, the total phenolic compound decreased, an effect that is inversely proportional to the storage time due to the fact that total phenolic compounds are highly sensitive to light, oxygen and temperature and as a result, the total phenolic content will decrease over time due to oxidative stress caused by pairing reactive oxygen free electrons with each other (Silva et al., 2023).

Table 6 demonstrates the microbiological analyses of pasteurized products, including total plate count, *Staphylococcus aureus* and *Escherichia coli.* The results show that in 8 days of storage, the total plate count was recorded at less than 3 CFU/mL. For the pathogenic bacteria, including *Staphylococcus aureus* and *Escherichia coli,* there was no detection in the pasteurized samples. The results were closed near to the Thai community product standard (TCPS 529/2547).

Table 4 Physicochemical properties of pasteurized ricegrass juice with different storage times

Day	color (CIE-Lab)			pH^{ns}	Total phenol (mg/L)	DPPH (%)
	*L**	*a**	*b**			
0	$50.86^{a}\pm0.65$	$-24.31^{a}\pm0.62$	$34.87^{a}\pm1.02$	6.45 ± 0.35	$86.09^{a}\pm13.01$	$61.05^{a}\pm2.21$
2	$50.41^{ab}\pm0.41$	$-24.08^{a}\pm0.46$	$33.67^{ab}\pm1.13$	6.43 ± 0.78	$87.18^{a}\pm2.16$	$62.56^{a}\pm3.03$
4	$48.68^{bc}\pm1.32$	$-23.57^{ab}\pm0.21$	$32.53^{c}\pm1.23$	6.51 ± 0.11	$84.59^{b}\pm6.03$	$52.35^{b}\pm1.21$
6	$47.62^{c}\pm1.27$	$-21.67^{c}\pm0.02$	$31.12^{c}\pm1.18$	6.48 ± 0.56	$68.42^{c}\pm1.04$	$43.21^{c}\pm1.25$
8	$44.32^{d}\pm1.28$	$-20.89^{d}\pm0.05$	$29.28^{d}\pm0.67$	6.44 ± 0.47	$65.71^{c}\pm3.19$	$31.67^{d}\pm1.19$

Remark: Mean ± S.D. with different superscripts in the same column indicated significant different ($p \leq 0.05$)
Mean ± S.D. with ns in the same column indicated not significantly different ($p > 0.05$)

Table 5 Physicochemical properties of pasteurized ricegrass juice mixed with SN milk with different storage times

Day	Color (CIE-Lab)			pH^{ns}	Total phenol (mg/L)	DPPH (%)
	*L**	*a**	*b**			
0	$92.05^{a}\pm0.11$	$-5.85^{a}\pm0.21$	$10.81^{a}\pm0.31$	6.65 ± 0.48	$129.51^{a}\pm2.21$	$36.67^{a}\pm1.21$
2	$91.32^{b}\pm0.03$	$-5.69^{ab}\pm0.03$	$10.53^{ab}\pm0.59$	6.68 ± 0.75	$121.61^{b}\pm1.26$	$28.31^{b}\pm1.32$
4	$91.31^{b}\pm0.11$	$-5.33^{cd}\pm0.04$	$10.04^{c}\pm0.11$	6.66 ± 0.51	$93.94^{c}\pm1.25$	$21.04^{c}\pm1.05$
6	$91.25^{b}\pm0.14$	$-5.21^{d}\pm0.18$	$9.54^{d}\pm0.15$	6.70 ± 0.84	$81.21^{d}\pm1.13$	$11.05^{d}\pm1.01$
8	$90.58^{c}\pm0.02$	$-4.67^{e}\pm0.12$	$9.49^{d}\pm0.12$	6.67 ± 0.65	$80.42^{e}\pm1.17$	$12.71^{d}\pm1.05$

Remark: Mean ± S.D. with different superscripts in the same column indicated significant different ($p \leq 0.05$)
Mean ± S.D. with ns in the same column indicated not significantly different ($p > 0.05$)

Table 6 Microbiological properties of pasteurized ricegrass juice and ricegrass juice mixed with SN milk with different storage times

Day	Ricegrass juice			Ricegrass juice mixed with SN milk		
	Total plate count (CFU/mL)	*S. aureus* (CFU/mL)	*E.coli* (Per 100 mL)	Total plate count (CFU/mL)	*S. aureus* (CFU/mL)	*E.coli* (Per 100 mL)
0	< 3	Not detected	Not detected	< 3	Not detected	Not detected
2	< 3	Not detected	Not detected	< 3	Not detected	Not detected
4	< 3	Not detected	Not detected	< 3	Not detected	Not detected
6	< 3	Not detected	Not detected	< 3	Not detected	Not detected
8	< 3	Not detected	Not detected	< 3	Not detected	Not detected

3.2 Sensory evaluation of ricegrass juice and ricegrass juice mixed with SN milk after pasteurization

Ricegrass juice and ricegrass juice mixed with SN milk were sensory evaluated by 50 untrained panellists illustrated in Table 7. The ricegrass juice and ricegrass juice mixed with SN milk had no major differences among all attributes. Observing from the sensory score, the overall acceptance score from ricegrass juice mixed with SN milk received a higher score than ricegrass juice due to the unique smell of the product. Kongjaroon (2019) claimed that the aroma of ricegrass powder can be turned into a unique fragrance for green tea. In the most recent studies that compared different types of grass juices, blends of wheatgrass juice with fruit juices, or different treatments, which proved that better acceptability occurred when formulated with other juices (Rexhepi & Renata, 2015; Rodríguez et al., 2022).

Table 7 Sensory evaluation scores of ricegrass juice and ricegrass milk mixed with SN milk

Attributes	ricegrass juice	ricegrass milk mixed with soy and navy milk
Color^{ns}	7.21±0.73	7.73±0.82
Odor^{ns}	7.23±1.02	7.46±0.95
Taste^{ns}	7.11±0.93	7.71±0.91
Overall acceptance^{ns}	7.07±1.75	7.73±0.95

Remark: Mean ± S.D. with ns in the same column indicated not significantly different ($p > 0.05$)

4. Physicochemical properties and Nutritional value of ricegrass juice and ricegrass juice mixed with SN milk

The nutritional values of ricegrass juice and ricegrass juice mixed with SN milk were calculated from 100 mL of consumption and results are displayed in Table 8. The nutritional value of ricegrass juice mixed with SN milk was analysed as follows: Calories 54.5 kilocalories, Calories from fat 12.2 kilocalories, Total fat 1.36 g, Saturated fat 0.25 g, No Cholesterol, Protein 2.91 g, Carbohydrate 7.65 g, Dietary Fiber 0.16 g, Sugar 6.64 g, Sodium 0.91 g, Vitamin B1, 2 Calcium and Iron. The results revealed that the nutritional value of ricegrass juice mixed with SN milk was better than other mixtures of ricegrass juice because SN milk had sources of nutrition, such as protein and vitamins.

Table 7 Nutritional content of ricegrass juice and ricegrass juice mixed with SN milk

Nutrient	Products	
	Ricegrass juice (per 100 ml)	Ricegrass juice mixed with SN milk (per 100 ml)
Calories (kilocalories)	23.3	54.5
Calories from fat (kilocalories)	0.00	12.2
Total fat (g)	0.00	1.36
Saturated fat (g)	Not Detected	0.25
Cholesterol (mg)	Not Detected	Not Detected
Protein (Nx6.25) (g)	<0.20	2.91
Total carbohydrate (g)	5.82	7.65
Dietary Fiber (g)	0.01	0.16
Sugars (g)	5.69	6.64
Sodium (mg)	2.99	0.91
Vitamin A (ug RE)	12.5	Not Detected
Vitamin B1 (mg)	Not Detected	0.05
Vitamin B2 (mg)	Not Detected	0.1
Calcium (mg)	4.12	15.8
Iron (mg)	0.12	0.44
Ash (g)	0.08	0.38
Moisture (g)	94.1	87.7
Total phenol (mg/L)	85.33±13.61	129.95±2.93
DPPH (%)	61.00±3.61	37.33±2.52

Conclusion

This study demonstrated that 30% ricegrass juice and ricegrass juice mixed with 10% of SN milk could be considered as the best functional drinks with antioxidant potential, due to their total phenol, antioxidant activity and other nutrients. All the pasteurized products had a low number of microbial contents. A high preference of the sensory panellists towards the ricegrass juice mixed with 10% of SN milk created a unique flavor. However, the flavors from the product will be investigated in further studies.

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References

Aaby, K., & Amundsen, M. R. (2023). The stability of phenolic compounds and the colour of lingonberry juice with the addition of different sweeteners during thermal treatment and storage. *Heliyon, 9*(5), e15959.

Akcan Kardas, T., & Durucasu, I. (2014). A new analytical method for the determination of phenolic compounds and their antioxidant activities in different wheat grass varieties. *Ekoloji Dergisi, 23*(90).

AKCAN KARDAS, T., & Durucasu, I. (2014). A new analytical method for the determination of phenolic compounds and their antioxidant activities in different wheat grass varieties. *Ekoloji Dergisi, 23*(90), 73-80.

AOAC. (2000). *Official methods of analysis* (17th ed.). Washington. DC: Association of Official Analytical Chemists.

Aydar, E.F., Mertdinç, Z., Demircan, E., Çetinkaya, S.K., & Özçelik, B. (2023). Kidney bean (*Phaseolus vulgaris* L.) milk substitute as a novel plant-based drink: Fatty acid profile, antioxidant activity, in-vitro phenolic bio-accessibility and sensory characteristics. *Innovative Food Science & Emerging Technologies, 83,* 103254.

Brand-Williams, W., Cuvelier, M.E., & Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT - Food Science and Technology, 28*(1), 25-30.

Chen, S.-T., & Hsieh, J.-F. (2008). Monocotyledon plant indications extract compositions, method of preparation and pharmaceutical compositions containing them. In: Google Patents.

Chen, Y., Zhang, H., Liu, R., Mats, L., Zhu, H., Pauls, K.P., ... Tsao, R. (2019). Antioxidant and anti-inflammatory polyphenols and peptides of common bean (*Phaseolus vulga* L.) milk and yogurt in Caco-2 and HT-29 cell models. *Journal of Functional Foods, 53,* 125-135.

Chomchan, R., Siripongvutikorn, S., Puttarak, P., & Rattanapon, M.R. (2016). Investigation of phytochemical constituents, phenolic profiles and antioxidant activities of ricegrass juice compared to wheatgrass juice. *Functional Foods in Health and Disease, 6*(12), 822-835.

De, B., Shrivastav, A., Das, T., & Goswami, T.K. (2022). Physicochemical and nutritional assessment of soy milk and soymilk products and comparative evaluation of their effects on blood gluco-lipid profile. *Applied Food Research, 2*(2), 100146.

Department of International Trade Promotion, M. O. C., Thailand. (2022). *Functional drink trend after post pandemic.* Retrieved April 2, 2023 from https://www.ditp.go.th/contents_attach/734600/734600.pdf

Hattori, T. (2002). Young leaves of a grass plant. In: Google Patents.

Kapkum, N., Phimphilai, S., Srichairatanakool, S., & Varith, J. (2011). Reduction in antioxidant properties lost during processing of a powdered beverage from young organic rice plants. *Asian J Food Ag-Ind, 4*(6), 388-398.

Khanthapok, P., Muangpromb, A., & Sukronga, S. (2015). Antioxidant activity and DNA protective properties of rice grass juices. *Sci. Asia, 41,* 119.

Koca, N., Burdurlu, H.S., & Karadeniz, F. (2003). Kinetics of nonenzymatic browning reaction in citrus juice concentrates during storage. *Turkish Journal of Agriculture and Forestry, 27*(6), 353-360.

Kongjaroon, C. (2019). *Green tea substitution: Aroma rice powder.* Proceeding of the 29th Thaksin University National Academic Conference: Research and Innovation for Sustainabitity Development. Songkhla: Thaksin University.

Mäkilä, L., Laaksonen, O., Kallio, H., & Yang, B. (2017). Effect of processing technologies and storage conditions on stability of black currant juices with special focus on phenolic compounds and sensory properties. *Food Chemistry, 221,* 422-430.

Meng, J., Wang, J.-L., Hao, Y.-P., Zhu, M.-X., & Wang, J. (2023). Effects of Lactobacillus fermentum GD01 fermentation on the nutritional components and flavor substances of three kinds of bean milk. *LWT, 184,* 115006.

Phimphilai, S., Koonyosying, P., Hutachok, N., Kampoun, T., Daw, R., Chaiyasut, C., ... Srichairatanakool, S. (2021). Identifying chemical composition, safety and bioactivity of thai rice grass extract drink in cells and animals. *Molecules, 26*(22), 6887.

Rexhepi, A.H., & Renata, K. (2015). Sensory analysis for consumer acceptance and juice extraction yield of wheatgrass, barley grass and oat grass juices. *International Journal of Innovative Research in Science and Engineering, 3*(12), 407-413.

Rodríguez, F.C., Gallagher, E., Rai, D.K., & Burgess, C.M. (2022). Nutritional and physiochemical properties of wheatgrass juice and preservation strategies. *Food Chemistry Advances, 1*(1), 100136.

Silva, E.T.d.V., Queiroz, A.J.M.d., Figueirêdo, R.M.F.d., Moura, H.V., Santos, F.S.d., Silva, A.P.d.F., . . . Gomes, J.P. (2023). Dynamic modelling of degradation kinetics of phenolic compounds, phenolic profiles, mineral content, and overall antioxidant capacity of germinated peanut flours. *LWT, 183,* 114927.

So, V., Pocasap, P., Sutthanut, K., Sethabouppha, B., Thukhammee, W., Wattanathorn, J., & Weerapreeyakul, N. (2020). Effect of harvest age on total phenolic, total anthocyanin content, bioactive antioxidant capacity and antiproliferation of black and white glutinous rice sprouts. *Applied Sciences, 10*(20), 7051.

Tharanathan, R.N., & Mahadevamma, S. (2003). Grain legumes—a boon to human nutrition. *Trends in Food Science & Technology, 14*(12), 507-518.

Tiwari, P., Kumar, B., Kaur, M., Kaur, G., & Kaur, H. (2011). Phytochemical screening and extraction: A review. *Internationale Pharmaceutica Sciencia, 1*(1), 98-106.

Wangcharoen, W., & Phimphilai, S. (2016). Chlorophyll and total phenolic contents, antioxidant activities and consumer acceptance test of processed grass drinks. *Journal of Food Science and Technology, 53*(12), 4135-4140.

Waterman, P.G., & Mole, S. (1994). *Analysis of phenolic plant metabolites.* London: Blackwell Scientific.

Wibowo, S., Vervoort, L., Tomic, J., Santiago, J.S., Lemmens, L., Panozzo, A., . . . Van Loey, A. (2015). Color and carotenoid changes of pasteurised orange juice during storage. *Food Chemistry, 171,* 330-340.

Wojdyło, A., Teleszko, M., & Oszmiański, J. (2014). Antioxidant property and storage stability of quince juice phenolic compounds. *Food Chemistry, 152,* 261-270.

Yu, X., Meenu, M., Xu, B., & Yu, H. (2021). Impact of processing technologies on isoflavones, phenolic acids, and antioxidant capacities of soymilk prepared from 15 soybean varieties. *Food Chemistry, 345,* 128612.