Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan
ISSN 2303-2227 eISSN 2615-594X
Accredited by National Journal Accreditation No. 105/E/KPT/2022

Vol. 11 No. 3 October 2023, Page: 141-152
DOI: https://doi.org/10.29244/jipthp.11.3.141-152
Available online at https://journal.ipb.ac.id/index.php/ipthp/index

Physicochemical Properties, Antioxidant Activity and Organoleptic of Yogurt with The Addition of Red Dragon Fruit Juice (*Hylocereus polyrhizus*)

S. F. Siregar, A. Apriantini*, & M. S. Soenarno
Department of Animal Production and Technology, Faculty of Animal Science, IPB University
Jl. Agatis, Kampus IPB Darmaga, 16680 Bogor, Indonesia
*Corresponding author: astariapriantini@yahoo.com
(Received 07-08-2023; Revised 07-09-2023; Accepted 16-10-2023)

ABSTRACT

Yogurt is dairy product with high nutritional content, is obtained by fermentation process on fresh milk or milk solution with lactic acid bacteria. Yoghurt has a sour taste, to increase the sourness, natural flavourings from fruit juice are added. Red dragon fruit (*Hylocereus polyrhizus*) is one of the fruits that can be added to yogurt. Red dragon fruit (*Hylocereus polyrhizus*) is a fruit that contains antioxidants. The aim of this study was to determine the physicochemical characteristic, antioxidant activity and sensory properties of red dragon yogurt. The results showed that physical properties (pH, A_w, Viscosity and Total Titratable Acid) and chemical properties of ash content in red dragon yogurt has been accordance with SNI. The addition of red dragon fruit juice (*Hylocereus polyrhizus*) had significant affects (P<0.05) on the pH value, protein content, sensory properties of aroma, color, and taste. However, The addition of red dragon fruit juice (*Hylocereus polyrhizus*) did not give significant affect (P>0.05) to the Aw value, viscosity, total acid titration, ash content, color hedonic characteristics, texture, taste, texture hedonic quality characteristics. Yogurt with the concentration 10% of red dragon fruit juice had the best formulation compared to other concentration.

Keywords: antioxidant, red dragon fruit, yogurt

ABSTRAK

Yogurt, merupakan produk susu dengan kandungan gizi yang tinggi diperoleh dengan memfermentasi susu segar atau larutan susu dengan bakteri asam laktat. Yoghurt memiliki rasa asam, untuk meningkatkan rasa asam ditambahkan perasa alami dari sari buah. Salah satu buah yang dapat ditambahkan ke dalam yogurt adalah buah naga merah (*Hylocereus polyrhizus*). Buah naga merah (*Hylocereus polyrhizus*) merupakan buah yang mengandung antioksidan. Penelitian ini bertujuan untuk memanfaatkan yogurt dengan penambahan sari buah naga merah sebagai antioksidan alami dan mengetahui sifat fisikokimia yogurt yang dihasilkan dari penambahan berbagai kadar sari buah naga merah meliputi ph, aw, viskositas dan titrasi total asam. Rancangan yang digunakan dalam analisis data penelitian ini adalah Rancangan Acak Lengkap (RAL) yang kemudian juga dilakukan pengujian Tukey Test. Data Organoleptik diuji menggunakan uji statistik non parametrik Kruskal-Wallis. Hasil yang diperoleh Sifat fisik (pH, A_w, Viskositas dan Total Asam Tertitrasi) dan sifat kimia kadar abu pada yogurt dengan penambahan sari buah naga merah (*Hylocereus polyrhizus*) sudah sesuai dengan SNI. Penambahan sari buah naga merah (*Hylocereus polyrhizus*) memberikan pengaruh yang nyata (P<0.05) terhadap nilai pH, kadar protein, karakteristik hedonik aroma, karakteristik mutu hedonik warna, aroma dan rasa. Namun, Penambahan sari buah naga merah (*Hylocereus polyrhizus*) tidak berpengaruh nyata (P>0.05) terhadap nilai Aw, viskositas, total asam titrasi, kadar abu, karakteristik hedonik warna, tekstur, rasa, karakteristik mutu hedonik tekstur. Yogurt dengan penambahan sari buah naga merah (*Hylocereus polyrhizus*) pada perlakuan 10% memiliki formulasi terbaik dibandingkan perlakuan penambahan sari buah naga merah (*Hylocereus polyrhizus*) lainnya.

Kata kunci: antioksidan, buah naga merah, yogurt

INTRODUCTION

Dairy products are currently experiencing many developments, product diversification begins with an increase in milk production which continues to increase from year to year, namely 135000.02 liters in 2018 to 165775000.02 liters in 2019 (BPS 2020). The increase in milk production was followed by an increase in milk consumption in Indonesia, namely 14.184 liters per capita per year in 2018 to 18.56 liters per capita per year in 2019 (BPS 2020). The most common dairy product we know is yogurt. Yogurt consumption in Indonesia in 2020 according to statistics.com is 9.4 kg. Dairy products are a form of modification through the process of adding or reducing the composition of the nutritional value of fresh milk and through the process of adding aroma or flavor into a product that is more preferred by consumers. Dairy products such as yogurt, milk pudding, pancakes, fried milk and ice cream (Chairunnisa *et al*. 2019). Fermented dairy products such as yogurt have many benefits for the health of the body.

The nutritional content in yogurt is quite high. Yogurt is also good for people who suffer lactose intolerance due to the lack of lactase enzyme in the digestive tract in breaking down lactose thus they cannot consume milk contain lactose. Patients with lactose intolerance are able to consume yogurt because the lactose in yogurt has been broken down into lactic acid so that it does not cause indigestion (Wardana 2012). Yogurt is a health-beneficial functional drink that is rich in dairy nutrients (Hekmat *et al*. 2009). Yogurt is a nutrient-rich dairy product obtained by fermentation of fresh milk or milk solution with lactic acid bacteria, favored by consumers because of its impact on improving the intestinal environment and enhancing immunity (Michael *et al*. 2010). The taste of yogurt is sour, thus the addition of fruit juice with sweet taste are needed to improve the sour taste of yogurt (Mahmood *et al*. 2008). One of the sweet fruits that can be added to yogurt is red dragon fruit (*Hylocereus polyrhizus*).

Red dragon fruit contains flavonoids and phenolic compounds that have the ability as antioxidants (Wu *et al*. 2006). Antioxidants are compounds that can prevent the oxidation of a molecule into free radicals. Antioxidant compounds work by inhibiting oxidative reactions by binding free radical molecules and maintaining the genetic structure of a cell to maintain normal conditions (Lingga 2012). The human body naturally has the ability to produce antioxidants and becomes more optimal if assisted by consuming foods rich in antioxidants (Siagian 2013). Based on Putri *et al*. (2019), red dragon fruit was used in the form of juice in the manufacture of cow's milk yogurt to achieve a thicker concentration and the absence of pulp carried over.

Making yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) needs to be done research on this yogurt so that it can be a source of nutritious food and can increase antioxidant activity in food so that the antioxidant content in red dragon fruit remains stable or even increases so that it is good for consumption and also to determine the physicochemical properties, antioxidants and determine the level of public preference for red dragon fruit juice (*Hylocereus polyrhizus*). The difference between the author's research and the previous researchers is that this study did not influence the length of storage and only tested the chemical content of ash and protein in red dragon fruit juice yogurt. The aim of this study was to determine and analyze the physicochemical properties and organoleptic properties of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) as a source of antioxidants.

MATERIAL AND METHODS

Material

The tools used were stove, pot, spatula, knife, spoon, cutting board, basin, sieve, and glass jar. The equipment used in testing physical, antioxidant and organoleptic properties are pH meter PH02, *viscotester Rion* VT-O4F, A_w meter (Novasina ms 1 set-aw), TB-Changxie digital scales, erlenmeyer flask, 100 ml measuring cup, glass funnel, spray bottle, dark glass bottle, cuvette, burette, autoclave HVE-50 (Hirayama), incubator (NuAire), Uv-Vis spectrophotometer, Universal 320 R *centrifuge*, memmert *waterbath*, test tubes, *laminar air flow cabinet* (Esco), micropipette (Gilson), vortex VM-300 (Gemmy), bunsen, goblet glass, hot plate, sudip, blue tip, *refrigerator*, labels and organoleptic properties questionnaire.

The raw materials in making yogurt were pure cow's milk, bacterial cultures of *Streptococcus thermophilus* FNCC-0040 and *Lactobacillus bulgaricus* FNC0041, sugar, and red dragon fruit (*Hylocereus polyrhizus*). The testing materials used were pH 4 and 7 buffer solutions, alcohol, 0.1 N NaOH solution, H2SO4, NaCl, HCl, boric acid (H_3BO_3), *bromcherosol green methyl red* indicator drops, DPPH (*2,2-diphenyl-1-picrylhydrazyl*), Vitamin C and distilled water, methanol.

Methods

Yogurt Starter Rejuvenation (Darmawati 2023)

Bacterial culture refreshment was carried out by inoculating 3% bacterial culture consisting of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* bacteria starting with pasteurizing cow's milk, filling a glass jar as much as 250 ml then autoclaved at 60 °C for 30 minutes. Next, milk that has been inoculated with LAB as much as 3% of the total volume of milk used is incubated at 37 °C for 18 hours until coagulation is formed.

Prepararation of Red Dragon Fruit Juice (Putri *et al.* 2019 with research modifications)

Ripe red dragon fruits with dark red skin and soft texture were peeled off the skin and cut into small pieces, then crushed with a spoon. The crushed red dragon fruit was then filtered using a sieve. The filter was then pasteurized at 60 °C for 30 minutes and then cooled.

Yogurt with the addition of Red Dragon Fruit Juice (Pre-laboratory)

Cow's milk was pasteurized using an autoclave at 60 °C for 30 minutes and then cooled. Next, *Streptococcus thermophilus* and *Lactobacillus bulgaricus* starters were added to the cow's milk. Starter culture was added as much as 3%. Milk that has been inoculated with bacterial culture

is then incubated for 18 hours to form coagulation. Milk that has become yogurt is added with 5% sugar. Yogurt that has added sugar and red dragon fruit juice is stirred until homogeneous.

The percentage of red dragon fruit (*Hylocereus polyrhizus*) were 5%, 10% and 15% based on the pre-laboratory that has been done.

pH value measurement (Mamani-Linares and Gallo 2014)

The pH value was measured with a pH meter. The pH meter was calibrated first on a standard *buffer* solution of pH 4 and 7. About 10 ml yogurt sample was prepared then inserted the pH meter *probe* into the yogurt and then read the result on the pH meter screen.

Water Activity (A_w) measurement (Meilanie *et al.* 2018)

This measurement used the A_w meter brand Novasina (*Switzerland*). The sample was inserted into the chamber and read the result.

Viscosity measurement (Permadi *et al.* 2018)

Viscosity testing was done using a viscometer. The sample was put into the glass vessel of the viscometer. The spindle was dipped into the sample then the spindle rotated, then the pointer scale needle stopped at a certain number scale. Then read the viscosity value.

Total Acid Titration (TAT) measurement (AOAC 2005)

A sample of 25 ml was titrated with 0.1 N NaOH solution until a pink color appeared. The amount of acid produced during fermentation was calculated by the following formula:

$$\text{TAT (\% Lactic Acid)} = \frac{\text{N} \times \text{V1} \times \text{Eq.Wt}}{\text{V}_2 \times 10}$$

Description:
N = Normality of titrant (mol L^{-1})
V1 = Titrant volume (mL)
V2 = Sample volume (mL)
Eq.Wt = weight *equivalent* acid (lactic acid = 90.8)

Analysis of ash content (Handayani 2015)

The crucible was burned in the furnace and then cooled for 3-5 minutes. After that, the sample was weighed 5 g and then the sample that had been weighed was homogenized. Then the sample was inserted into the petri dish, then put it in the furnace and the sample was burned until it becomes ash. After that the sample was cooled and then weighed. Calculated the ash content with the formula:

$$\text{\% ash content} = \frac{\text{ash weight } (g) - \text{cup weight}}{\text{sample weight}} \text{ x } 100\%$$

Analysis of protein content (AOAC 2005)

Protein analysis consists of three stages, deconstruction, distillation, and titration. Measurement of protein content was carried out using the micro Kjeldahl method. Samples were measured as much as 0.25 g, then put into a 100 mL Kjeldahl flask and added one grain of kjeltab and 3 mL of concentrated H_2SO_4. The sample was deconstructed at 410 °C for approximately 1 hour until the solution was clear and then cooled and put into the Kjeldahl flask added 50 mL of distilled water and 20 mL of 40% NaOH, then the distillation process was carried out with a distillator temperature of 100 °C. The distillation results were collected in a flask and then added to the Kjeldahl flask. The distillation results were collected in a 125 mL Erlenmeyer flask containing a mixture of 10 mL of 2% boric acid (H_3BO_3) and drops of pink *bromcherosol green methyl red* indicator. After the distillate volume reached 40 mL and was bluish green in color, the distillation process was stopped. Then the distillate was titrated with 0.1 N HCl until a pink color change occurred. Calculation of protein content can be obtained by :

$$\text{\% Nitrogen} = \frac{ml\ HCL\ (Sample - Blank)\ x\ n\ HCL\ x\ 14}{Sample\ weight\ (g)}\ x\ 100\%$$

Protein content = % Nitrogen × conversion factor (6.38)

Analysis of antioxidant test (Molyneux 2004)

The sample was refrigerated at 3-5 °C for 24 hours and then 5 ml was taken. Centrifuged at 1000 rpm for 4 minutes and separated the supernatant. The supernatant obtained was used as a sample solution for testing. Preparation of DPPH solution weighed as much as 0.339 g of DPPH and dissolved with methanol in a flask up to 100 mL and then obtained a solution concentration of 50 µM. Then enter the sample solution in a pipette as much as 1 mL into a test tube and then add DPPH solution as much as 4 mL little by little and observe the color change. The presence of antioxidants is indicated by the color formed from each sample tested was purple. The solution was placed in a *waterbath* at 37 °C for 30 minutes, then the absorbance was measured using a UV-VIS 2453 *spectrophotometer* (Agilent, USA) and a wavelength of 517 nm. Then the test was done in duplicate. DPPH free radical scavenging activity was expressed as % *scavenging activity* (%SA) with the following formula:

$$\text{DPPH} = \frac{Blank\ absorbance - sample\ absorbance}{Blank\ absorbance}\ x\ 100\%$$

Antioxidant capacity (Tangkanakul *et al*. 2009). The %SA values were converted based on the standard curve. The reaction results of vitamin C (*ascorbic acid*) were obtained from the standard curve with concentrations of 0; 5; 10; 15; 20; and 25 mg 100 mL^{-1} distilled water with DPPH. A total of 0.025 mL of vitamin C standard solution was reacted with 0.0039 mL of 0.1 mM DPPH (*methanol* solvent). Then the mixture was incubated in a waterbath at 37 °C for 30 minutes and analyzed using a UV-VIS 2453 *spectrophotometer* (Agilent, USA) at a wavelength of 517 nm. Antioxidant capacity was expressed as mg vitamin C equivalent/100g yogurt.

Sensory analysis (Saputra 2011)

Sensory analysis was carried out by hedonic and hedonic quality testing. Both sensory tests were carried out using a scale of preference. Sensory tests were conducted for all yogurt treatments with the addition of red dragon fruit juice. Testing using a descriptive hedonic scale with a value range of 1-4 is very disliked to very like.

Hedonic quality testing assesses four sensory characteristics consisting of color, aroma, texture and taste.

About 30 panelists were presented with samples to be assessed and completed a questionnaire, then panelists were asked to assess each sample. Panelists were asked to taste each sample and between each sample tasting were required to consume mineral water as a neutralizer.

Data Analysis

This study used a completely randomized design (CRD) with the treatment of the addition of red dragon fruit juice at different concentrations, namely without the addition of red dragon fruit juice (P0), the addition of 5% red dragon fruit juice (P1), the addition of 10% red dragon fruit juice (P2) and the addition of 15% red dragon fruit juice (P3). The treatment of the addition of red dragon fruit juice was carried out as many as 3 times repetition. The statistical model used according to Steel and Torrie (1997) as follows.

$$Yij = \mu + \alpha i + \varepsilon ij$$

Description:
Yij = Response at the level of the addition of the i-th red dragon fruit juice)
μ = General average of research response
αi = Effect of the level of addition of the i-th red dragon fruit juice (0%, 5%, 10%, 15%)
εij = The effect of the error of the addition of the i-th red dragon fruit juice (0%, 5%, 10% and 15%) in the jth replication (1, 2 and 3).

Data were analyzed by analysis of variance (ANOVA) to determine the effect of the treatment and if the treatment had a real or very real effect, the *Tukey* test was conducted (*Steel and Torrie* 1997). Data were analyzed by analysis of variance (ANOVA) to determine the effect of each treatment with a 95% confidence interval, if the treatment had a real or very real effect, a *tukey* test was conducted (*Steel and Torrie* 1997). Sensory test data were analyzed using the Kruskal-Wallis non-parametric equation as follows.

$$H = \frac{12}{N\,(n+1)} - [\sum_{i=1} \frac{Ri^2}{ni} - 3\,(N+1)]$$

Ri = Number of ranks in treatment i
Ni = Number of observations in treatment-i
N = Total number of observations

RESULTS AND DISCUSSION

Physical Properties of Red Dragon Fruit Juice Yogurt

The analysis of physical properties of yogurt with the addition of red dragon fruit juice consisting of pH analysis, water activity (A_w), viscosity and Total Titratable Acid (TAT). About 12 samples were tested with 4 treatments and 3 replicates. Treatment without the addition of red dragon fruit juice (P0), treatment with the addition of 5% red dragon fruit juice (P1), treatment with the addition of 10% red dragon fruit juice (P2) and treatment with the addition of 15% red dragon fruit juice (P3). The analysis results of the physical properties of yogurt are presented in Table 1.

Figure 1. Red dragon fruit juice yogurt product

pH Value

pH is a physical characteristic of the presentation of yogurt products. pH is a measure of the acidity and basicity of a liquid system. The pH of a liquid is determined by the concentration of H+ and OH- ions in it. The use of lactic acid bacteria in yogurt production produces lactic acid from the fermentation of lactose contained in milk (Isengrad 2009).

The results of analysis of variance in Table 1 show that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) to yogurt had a significant effect (P<0.05) on the pH value. The pH value of yogurt ranged from 4.12 to 4.41. The highest pH value was obtained in treatment P0 (0%) with a value of 4.41 while for treatment P1 (5%) was obtained with a value of 4.29; P2 (10%) with a value of 4.18 and P3 (15%) with a value of 4.12. This shows that the pH of yogurt drink with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) meets the SNI (2009) standard, which is the quality requirement of good yogurt that has a pH value ranging from 3.80-4.50.

The addition of red dragon fruit juice (*Hylocereus polyrhizus*) concentration affects the pH value of the yogurt produced. The lowest pH value obtained in the P3 treatment (15%) was 4.12. The difference in pH indicates that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) can affect the pH of the yogurt produced. The higher the concentration of red dragon fruit juice added, the lower the value of yogurt produced. This is because red dragon fruit (*Hylocereus polyrhizus*) has an acidic pH in the range of 4-5. The presence of ascorbic acid in red dragon fruit flesh gives a sour taste to red dragon fruit (*Hylocereus polyrhizus*). So, when added to yogurt, the pH of yogurt will decrease (Risnayanti *et al*. 2015).

A_w value

Water activity (A_w) is the amount of free water in food products that can be used by microbes to grow. The higher the a_w value, the greater the possibility of damage to food products caused by unwanted microorganism activity. Water activity is one of the factors that can affect food damage because water activity can describe the water requirements of bacteria (Belitz *et al*. 2009).

Table 1 showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) to yogurt drink had no significant effect (P>0.05) on A_w yogurt. The A_w value of yogurt ranged from 0.86 to 0.87. The Aw value is generally

Table 1. Physical of yogurt with added red dragon fruit juice

Variable	Treatment				SNI
	P0	P1	P2	P3	
pH value	4.41±0.05a	4.29±0.12ab	4.18±0.03b	4.12±0.02b	3.80-4.50*
A_w Value	0.87±0.006	0.87±0.001	0.86±0.006	0.86±0.009	0.6-0.9*
Viscosity (dPa.s)	1.61±0.56	2.01±0.48	1.56±0.35	1.78±0.66	-
Total acid titration (%)	0.61±0.09	0.68±0.09	0.64±0.02	0.60±0.04	0.5-2.0*

Notes: *) different lowercase letters on the same line indicate significant differences

*Indonesian National Standard (2009) (Standard for pH and TAT of yogurt) *Indonesian National Standard (2000) (Standard for A_w of yogurt) P0: Without the addition of red dragon fruit juice, P1: Addition of 5% red dragon fruit juice, P2: Addition of red dragon fruit juice 10%, P3: Addition of red dragon fruit juice 15%

acceptable according to SNI 01-6366-2000 that microbes can normally grow in foodstuffs with A_w 0.6-0.9. A_w yogurt in the range of 0.86 to 0.87 indicates that microbes can grow.

Water activity affects the quality of food because it allows microbes to grow (Winarno *et al*. 1980). According to Rahayu (2012) yogurt can be damaged by two types of microorganisms, namely yeast and yeast. Each microorganism has a minimum amount of A_w needed to grow well. Mold grows well with Aw 0.6-0.7, yeast with A_w 0.8-0.9 (Leviana and Paramita 2017).

Viscosity

The high total solids content of milk as yogurt raw material can produce high viscosity (Triyono 2010). Viscosity is the viscosity of food products. According to Manab (2007) in Oktavia *et al*. (2014) yogurt viscosity represents the properties of liquids that resist flow and increase the strength that can withstand relative movement. According to Purbasari *et al*. (2014) yogurt viscosity is influenced by pH, protein content, strain culture type, incubation time and total milk solids.

The results of viscosity showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on yogurt viscosity. The yogurt viscosity values ranged from 1.56 dPa.s to 2.01 dPa.s. Yogurt with treatment P0 (0%) obtained a value of 1.61 dPa.s. and yogurt with treatment P3 (15%) obtained a value of 1.78 dPa.s.

According to Ozturk and Oner (1999), increasing the concentration of fruit juice in yogurt can weaken the consistency of the product so that the viscosity of yogurt tends to decrease. This may be due to acidic pH conditions. pH can reduce the solubility of casein so that hydrophobic interactions occur between the structure of yogurt drink with casein micelles that make up the composition, causing yogurt drink to become thicker, resulting in an increase in viscosity.

Total Titratable Acid

Measurement of Total Titrated Acid (TAT) is the determination of the total concentration of acid contained in a food ingredient (Kamaluddin and Handayani 2018). Sadler and Murphy (2003) stated that the total titratable acid in food ingredients is determined by acid-base titration to estimate total acidity. Most of these acids are organic acids that affect taste, color, microbial stability and nutritional quality.

The results of Total Titrated Acid analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on yogurt. Total titrated acid of yogurt ranged from 0.60 to 0.68. This result was in accordance with SNI (2009) which states that the acidity of yogurt ranges from 0.5-2.0%.

The higher the percentage of red dragon fruit juice (*Hylocereus polyrhizus*) added to yogurt, the lower the total titrated acid value. The total acid titration value obtained from the four yogurt samples is inversely proportional to the pH of the yogurt. The higher the pH, the lower the total acid titration of red dragon fruit juice (*Hylocereus polyrhizus*) yogurt. This result in line with the research of Oktaviana *et al*. (2018), that the total acid titration of yogurt is an indicator of acidity which is usually inversely proportional to pH.

Chemical Properties of Red Dragon Fruit Juice Yogurt

Test the chemical properties of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) which consists of testing ash content and protein content. The test results of the chemical properties of yogurt are shown in Table 2.

Ash Content

Ash content can describe the mineral content of a food ingredient (Harini *et al*. 2019). Ash content is a component that is not volatile in the process of burning and emitting organic compounds (Susanti *et al*. 2017). The mineral content of yogurt can affect the ash content value (Ichwansyah 2014). According to Fadila (2022) the mineral content in dragon fruit contains magnesium, calcium and phosphorus.

The results of ash content analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on yogurt. Ash content of yogurt ranged from 0.67 to 0.71. These results were in accordance with the quality standards of SNI 2981: 2009 with a maximum value of 1%. This may be due to the addition of red dragon fruit juice to the yogurt. In addition to lactic acid, milk fermentation to make yogurt products also produces minerals such as magnesium, calcium, phosphorus, sodium and potassium.

The more additives in yogurt, the more minerals as by-product ingredients and increase the ash content value of the ingredients (Harjiyanti *et al*. 2012). The addition of red dragon fruit does not affect the mineral content in yogurt

Table 2. Chemical properties of yogurt with added red dragon fruit juice

Variables	Treatment				SNI
	P0	P1	P2	P3	
Ash content (%)	0.71±0.01	0.69±0.01	0.68±0.01	0.67±0.01	Max 1.00
Protein content (%)	2.09±0.21a	2.44±0.09ab	2.58±0.00ab	2.68±0.04b	Min 2.70 *

Type: *) different lowercase letters on the same line indicate significant differences. *Indonesian National Standard (2009) P0: Without the addition of red dragon fruit juice, P1: Addition of red dragon fruit juice 5%, P2: Addition of red dragon fruit juice 10%, P3: Addition of red dragon fruit juice 15%

but is still in accordance with SNI 2981:2009. This result may be due to the soaking and heating process making a decrease in ash content during soaking can be caused by the dissolution of mineral molecules in the soaking medium and accelerated by heating (Jasmine *et al*. 2020). According to Maya *et al*. (2015) ash content is influenced by the type of material, method of drying, time and temperature.

Protein Content

Protein content is the percentage of product protein content, the calculated protein content is the remaining protein that is not used by the initial bacteria during storage (Wahyuni 2009). The protein content of yogurt is determined by the amount of ingredients added, the higher the protein content of the ingredients, the higher the protein content of yogurt. The higher the level of protein produced (Askar and Sugiarto 2005). Protein content aims to determine the total amount of protein content contained in red dragon fruit yogurt (Phisita 2022). The results of the analysis of variance showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had a significant effect (P <0.05) on yogurt. The results of the highest protein content in the P3 (15%) treatment with a value of 2.68 while the lowest protein content in the P0 (0%) treatment with a value of 2.09.

Other treatments were P1 (5%) treatment with a value of 2.44 and P2 (10%) treatment with a value of 2.58. The results of the study are slightly below the SNI where the quality requirements (SNI 2981: 2009) yogurt protein content of at least 2.7 while the results showed the highest value of 2.68 in the P3 treatment (15%), so it is less than the SNI yogurt quality requirements. The yogurt product in the study had a low protein content value when red dragon fruit (*Hylocereus polyrhizus*) was added, the protein content should have increased even though it was not much. This is thought to be due to the raw materials used have low protein content values (Jonathan *et al*. 2022), namely the protein content of red dragon fruit 0.16-0.23 (Panjuantiningrum 2009). Wahyuni and Nugroho (2014) stated that this is because red dragon fruit juice (*Hylocereus polyrhizus*) contains little protein. The decreasing in protein content can also be caused by heating during the yogurt making process during the study.

Antioxidant Activity of Red Dragon Fruit Yogurt

Red dragon fruit contains antioxidant sources (Widianingsih 2017) so in this study, red dragon fruit was added to yogurt. The results of DPPH inhibitory activity and antioxidant capacity of yogurt are presented in Table 3.

Antioxidants are compounds that can prevent oxidation. Antioxidant activity testing is done using the DPPH method or *2,2- diphenyl-1-picrylhydrazyl*. DPPH is a synthetic radical that is soluble in polar solvents such as methanol and ethanol (Rohman *et al*. 2005). The results of analysis of variance showed the antioxidant activity of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on yogurt. The antioxidant activity value ranged from 64.552 to 71.044%.

Red dragon fruit (*Hylocereus polyrhizus*) contains high antioxidant activity. The higher the concentration of red dragon fruit (*Hylocereus polyrhizus*) added, the higher the antioxidant activity of red dragon fruit juice yogurt (*Hylocereus polyrhizus*). In this case, the high vitamin C content in red dragon fruit (*Hylocereus polyrhizus*) act as antioxidant, which is 8-9 mg per 100 g. Vitamin C (C6H8O6) has high antioxidant activity of 134.1 µg GA/g puree.

The addition of red dragon fruit juice (*Hylocereus polyrhizus*) at any concentration did not affect the antioxidant activity. The antioxidant compounds in red dragon fruit may decrease due to the heating process. In the research of Suharyani *et al*. (2022) used 95% ethanol solvent to extract dragon fruit because it contains anthocyanin compounds which are included in the flavonoid group. Flavonoid compounds include polar compounds and can be extracted with polar solvents such as ethanol and water.

Antioxidant capacity ananlysis is a parameter that describes the ability of a compound contained in yogurt products added with red dragon fruit as an inhibitor of free radical activity. The antioxidant capacity of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on yogurt. Table 3 shows that the antioxidant capacity value of yogurt before adding red dragon fruit juice (*Hylocereus polyrhizus*) was 259.44 mgEVC/100 g after adding several additions of red dragon fruit juice (*Hylocereus polyrhizus*) treatment ranged from 228.74-260.89 mg EVC/100 g. Where mgEVC/100 g is the

Table 3. Activity (%) and antioxidant capacity of yogurt with the addition of red dragon fruit juice

Treatment	Antioxidant Activity (%)	Antioxidant Capacity (mg/EVC/100g)
P0	71.04±11.562	259.44±54.694
P1	68.09±15.506	245.47±73.35
P2	71.35±10.681	260.89±50.52
P3	64.55±9.113	228.74±43.11

P0 : No addition of red dragon fruit juice, P1: Addition of 5% red dragon fruit juice, P2 : Addition of red dragon fruit juice 10%, P3: Addition of red dragon fruit juice 15%

ability of antioxidant capacity of yogurt before adding red dragon fruit juice (Hylocereus polyrhizus).

Where mgEVC/100g is the ability of the compound to reduce free radicals (DPPH) which is equivalent to the antioxidant vitamin C in the same amount. The results showed that 228.74 mgEVC/g equivalent to 100 g of red dragon fruit yogurt (*Hylocereus polyrhizus*) was able to inhibit free radicals. Tangkanakul (2009) levels the antioxidant capacity of ingredients divided into four groups: very high (>500 mgVCE/g), high (200 - 500 mgVCE/g), medium (100 - 200 mgVCE/g) and low (<100 mgVCE/g). Based on the level of antioxidant capacity by Tangkanakul (2009), the results of the study were in the high level.

Sensory Properties of Red Dragon Fruit Yogurt

Organoleptic or Sensory analysis is a test of acceptance of the product using the human senses as the main tool of measurement. Organoleptic properties carried out in this study including hedonic test and hedonic quality test. The test was conducted by 40 semi trained panelists. The organoleptic results of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) were presented in Table 4.

Table 4. Hedonic test of yogurt with added red dragon fruit juice

Variables	Treatment			
	P0	P1	P2	P3
Color	3.20±0.64	3.2±0.72	3.3±0.64	3.27±0.71
Scent	3.27±0.50	2.97±0.47	3±0.55	3.25±0.54
Texture	3.25±0.49	3.05±0.50	3.1±0.54	3.02±0.65
Taste	3.42±0.63	3.2±0.51	3.42±0.54	3.2±0.68

Notes: P0: without addition of red dragon fruit juice, P1: addition of red dragon fruit juice (5%), P2: addition of red dragon fruit juice (10%), P3: addition of red dragon fruit juice (15%). Hedonic test score scale 1 = very dislike, 2 = dislike, 3 = like, 4 = very like.

Hedonic test is a test in organoleptic or sensory analysis that is used to determine the size of the difference in quality between several similar products by giving a rating or score to certain product characteristics and to determine the level of recommendation of the product. This level of preference is called a hedonic scale, for example, very like, like, dislike, very dislike and others (Stone and Joel 2004).

Color

Color is one of the important physical parameters of food. Color is one of the basic criteria for determining food quality. Color can determine the quality of food ingredients, used as an indicator of the freshness of food ingredients, whether there is mixing or processing or not. The analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on the color of yogurt. The color analysis results obtained ranged from 3.2 to 3.3 which means all panelists liked the color of the sample. The most preferred color by panelists is yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) in the P2 treatment (15%) has an average of 3.3 while the least preferred color by panelists is yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) in the P1 treatment (5%) has an average of 3.2. The addition of red dragon fruit juice in treatment P0 (0%) has an average of 3.20 and treatment P3 (15) has an average of 3.27.

The reason P2 treatment with the addition of 10% was more liked by panelists because the color of red dragon fruit juice (*Hylocereus polyrhizus*) is good is pink while the P0 treatment without the addition of the lowest average was liked by panelists because of its pale white color. Consumers like food that has an attractive color even though it does not necessarily taste good. This is in accordance with the opinion of Harun *et al*. (2013) state that color is one of the quality criteria for assessing a food product and can support its quality.

Aroma

Aroma is one of the parameters in testing sensory properties (organoleptic) using the sense of smell. Scent can be accepted when the material produced has a specific scent (Kusmawati et al. 2000). The analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had a significant effect (P < 0.05) on the scent of yogurt. The scent analysis results obtained ranged from 2.97 to 3.27, which means that all panelists somewhat liked the scent of the sample.

The aroma most favored by panelists was yogurt with no addition of red dragon fruit juice (*Hylocereus polyrhizus*) in treatment P0 (0%) had an average of 3.27 while the scent least favored by panelists in treatment P1 (5%) had an average of 2.97. The P2 (10%) treatment had an average of 3 and the P3 (15) treatment had an average of 3.25. The scent in the 5% concentration yogurt was less favored by panelists. This is because the combination of scents between the scent of yogurt and red dragon fruit may not be balanced so that the resulting scent is not liked by panelists. According to Hartatie (2011) that the scent of the product is strongly influenced by the ingredients used in making the product.

Texture

The texture of yogurt will affect the quality of yogurt and consumer preference. The results of the analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05), it can be interpreted that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) did not affect the level of liking of panelists on the texture of yogurt. The results of the texture analysis obtained ranged from 3.02 to 3.25, which means that all panelists liked the texture of the sample. The texture most favored by panelists was P0 (0%) which had an average of 3.25 while the least favored by panelists was P3 (15%) which had an average of 3.02.

Yogurt with the highest concentration in the 15% treatment was the least preferred yogurt by panelists. This is because the results of the texture test in accordance with the results of the viscosity physical test have no effect when added red dragon fruit (*Hylocereus polyrhizus*).

Taste

Yogurt has a distinctive flavor that is sour. Taste is one of the factors that can determine whether a product is acceptable or not by consumers. The analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on the taste of yogurt. The results of the flavor analysis ranged from 3.2 to 3.42.

The most preferred flavor by all panelists were P0 (0%) and P2 (10%) which had the same average of 3.42 while the least preferred flavor by all panelists were P1 (5%) and P3 (15%) which had the same average of 3.2. Yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) did not affect the taste level of the panelists.

Hedonic quality testing is a method used to measure the extent to which consumers like or dislike a product based on certain characteristics such as color, aroma, texture and taste. Testing these variables in the context of hedonic quality testing has several main reasons:

1. The importance of sensory experience: color, aroma, texture and taste are key components in the sensory experience of consuming food and measuring consumer preference for these variables.
2. Influence on product acceptance: characteristics such as color, aroma, texture and taste can have a significant impact on product acceptance by consumers.

Color

The addition of red dragon fruit juice (*Hylocereus polyrhizus*) had a significant effect (P<0.05) on the color of yogurt. The analysis results obtained ranged from 1 to 3.9 which means all yogurt samples were white to purplish red in color. Yogurt without the addition of red dragon fruit juice (*Hylocereus polyrhizus*) (P0) has an average of 1 which means it has a white color. Yogurt with the addition of 5% red dragon fruit juice (P1) has an average of 2.8, which means that sample P1 has a reddish white color. Yogurt with the addition of 10% red dragon fruit juice (P2) has an average of 3.67 which means sample P2 has a pink color. Yogurt with the addition of 15% red dragon fruit juice (P3) has an average of 3.9, which means that the P3 sample has an almost pink to purplish red color.

The color change of yogurt is influenced by red dragon fruit juice which has a red color. The addition of red dragon fruit juice (*Hylocereus polyrhizus*) P3 (15%) received attractive criteria for panelists compared to P1 (0%). This is because the higher the dragon fruit added, it will give a more vibrant pink color so that panelists are more interested. As the opinion of Sudarmi and Subagyo (2015) in (Ningsih *et al*. 2019) states that the addition of dragon fruit can improve the color of the yogurt produced because it contains anthocyanins of 8.8 mg/100 g in the fruit pulp.

Aroma

The analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had a significant effect (P < 0.05) on the aroma of yogurt. The analysis results obtained ranged from 1.02 to 2.27 which means that all yogurt samples were flavored with red dragon fruit (*Hylocereus polyrhizus*). Based on the results of scent analysis by panelists, the three yogurt treatments still smelled like yogurt, but the treatment with 15% red dragon fruit juice (P3) had an average of 2.27. Red dragon fruit juice (*Hylocereus polyrhizus*) has strongless aroma, so when added to yogurt, panelists cannot smell the scent.

According to Krisnaningsih *et al*. (2020) the sour aroma in yogurt because the decreasing of pH. Lactic acid bacteria will break down lactose into lactic acid and other acids such as *acetaldehyde* and *diacetyl*. These two acids play a role in forming the distinctive aroma of yogurt. The aroma produced by lactic acid bacteria *Lactobacillus bulgaricus* while *Streptococcus thermophilus* plays an important role in the formation of yogurt flavor (Hidayat *et al*. 2006).

Texture

The analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had no significant effect (P>0.05) on the texture of yogurt. The analysis results obtained ranged from 2.3 to 2.55 which means all yogurt samples had a slightly liquid or slightly runny texture. The average of the product texture test results increased as the red dragon fruit (*Hylocereus polyrhizus*) treatment was added. The test results are in accordance with the results of the physical viscosity test where yogurt products whose texture is watery change the impression that the texture is slightly preferred.

In all four treatments, the product has a liquid or watery texture in addition to the addition of red dragon fruit juice (*Hylocereus polyrhizus*) with a high concentration, stirring during the fermentation process which results in the

Table 5. Hedonic quality test of yogurt with the addition of red deagon fruit juice

Variables	Treatment			
	P0	P1	P2	P3
Color	1±0d	2.8±0.51c	3.67±0.47b	3.9±0.30a
Scent	1.02±0.15c	1.57±0.54b	2.12±0.79a	2.27±1.01a
Texture	2.55±0.67	2.37±0.62	2.41±0.74	2.3±0.79
Taste	1.02±0.15d	1.65±0.53c	2.37±0.83b	2.82±0.78a

Ket: *) different lowercase letters on the same line indicate significant differences P0: without the addition of red dragon fruit juice, P1: addition of red dragon fruit juice (5%), P2: addition of red dragon fruit juice (10%), P3: addition of red dragon fruit juice (15%). Color scale hedonic quality test scores include (1)= white, (2)= reddish white, (3)= pink, (4)= purplish red. The scent organoleptic score includes (1)= no red dragon fruit scent, (2)= slightly red dragon fruit scent, (3)= red dragon fruit scent, (4)= very red dragon fruit scent. Texture scores include (1)= liquid, (2)= slightly liquid, (3)= thick, (4)= slightly thick. Taste characteristics score includes (1)= no red dragon fruit flavor, (2) somewhat red dragon fruit flavor, (3)= red dragon fruit flavor, (4)= very red dragon fruit flavor.

texture of the yogurt changing (breaking) not clumping. The liquid texture is because the red dragon fruit juice added is liquid and adding too much liquid will make the yogurt liquid or runny.

Taste

The analysis showed that the addition of red dragon fruit juice (*Hylocereus polyrhizus*) had a significant effect (P<0.05) on the flavor of yogurt. The results of the flavor analysis obtained ranged from 1.02 to 2.82 which means that all yogurt samples contained a little red dragon fruit (*Hylocereus polyrhizus*) flavor. Based on the analysis of yogurt without the addition of red dragon fruit juice (P0) has a flavor of 1.02. Yogurt with the addition of 5% red dragon fruit juice (P1) has a taste of 1.65 which means it starts to taste a little red dragon fruit juice. Yogurt with the addition of 10% red dragon fruit juice (P2) had a taste of 2.37, which means it was slightly flavored with red dragon fruit juice. Yogurt with the addition of 15% red dragon fruit juice (P3) has a taste of 2.82 which means it almost tastes red dragon fruit juice.

Based on the analysis, the yogurt had a slight red dragon fruit flavor. This is because red dragon fruit juice (*Hylocereus polyrhizus*) has natural sugar content in it so that it disguises the sour taste of the sample. The taste of yogurt comes from the metabolites of lactic acid bacteria which produce a distinctive sour taste (Rahmawati and Kusnadi 2018). This is also in accordance with the statement (Al-Baari 2014) that LAB in making yogurt produces lactic acid that tastes sour with a distinctive flavor.

Determination of the Best Formulation of Yogurt with the Addition of Red Dragon Fruit Red Dragon Fruit

Scoring on the analysis of physical characteristics are pH, A_w, viscosity, total acid titration, analysis of chemical characteristics are ash content, protein content, and analysis of organoleptic characteristics in the form of color, scent, texture and taste. The pH standard of yogurt based on SNI 2981:2009 is in the range of 3.80-4.50. The results showed that the pH of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) was in that range. A_w standard of yogurt based on SNI 01-6366-2000 is 0.6-0.9. The results showed Aw in yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) was in that range. The standard of Total Titratable Acid (TAT) of yogurt based on SNI (2009) is 0.5-2.0%. The results showed that the TAT value of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) was within the range. The results of the analysis and scoring of yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) can be seen in Table 6.

Based on Table 6, it can be concluded that the best treatment in the process of making yogurt with the addition of red dragon fruit juice is the formulation with the addition of red dragon fruit juice (10%). The selection of the best formulation is because the P2 treatment produces a higher total scoring value than P0, P1 and P3.

Table 6. Recapitulation of analysis results and scoring values

Variables observed	Treatment			
	P0 (0%)	P1 (5%)	P2 (10%)	P3 (15%)
Physical Properties				
Ph	4.41 (2)	4.29 (1)	4.18 (1)	4.12 (1)
A_w	0.87 (1)	0.87 (1)	0.86 (1)	0.86 (1)
Viscosity (dPa.S)	1.61 (1)	2.01 (1)	1.56 (1)	1.78 (1)
Total Acid Titration (%)	0.61 (1)	0.68 (1)	0.64 (1)	0.60 (1)
Chemical Properties				
Ash	0.71 (1)	0.69 (1)	0.68 (1)	0.67 (1)
Protein	2.09 (2)	2.44 (2)	2.58 (3)	2.68 (3)
Antioxidant				
Antioxidant Activity	71.04 (1)	68.08 (1)	71.35 (1)	64.55 (1)
Antioxidant Capacity	259.44 (3)	245.47 (2)	260.89 (3)	228.74 (1)
Organoleptic Assesment				
Color	3.20 (1)	3.2 (1)	3.3 (2)	3.27 (1)
Aroma	3.27 (2)	2.97 (1)	3 (3)	3.25 (2)
Texture	3.25 (2)	3.05 (1)	3.1 (1)	3.02 (1)
Taste	3.42 (2)	3.2 (1)	3.42 (2)	3.2 (1)
Total Scoring Score	19	14	20	15

Description: 1= Assessment based on set standards, 2= assessment based on the largest data. Total Scoring Value = based on the largest total number

CONCLUSION

Physical properties (pH, A_w, Viscosity and Total Titratable Acid) and chemical properties of ash content in yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) in accordance with SNI. The addition of red dragon fruit juice (*Hylocereus polyrhizus*) affects the pH value, protein content, hedonic characteristics of aroma, hedonic quality characteristics of color, aroma and taste. The addition of red dragon fruit juice (*Hylocereus polyrhizus*) did not affect Aw, viscosity, total acid titration, ash content, color hedonic characteristics, texture, taste, texture hedonic quality characteristics. Yogurt with the addition of red dragon fruit juice (*Hylocereus polyrhizus*) in the 10% treatment had the best formulation compared to other red dragon fruit juice (*Hylocereus polyrhizus*) addition treatments.

REFERENCES

Al-Baari, A. N. 2014. Total bakteri asam laktat, pH, keasamaan, cita rasa dan kesukaan yogurt drink dengan penambahan ekstrak buah belimbing. Jurnal Aplikasi Teknologi dan Manajemen Agroindustri. 5(2): 54-60.

AOAC (Association of Official Analytical Chemistry). 2005. Official Methods of Analysis of AOAC Internasional. Ed ke-18. Maryland (US): Association of Analytical Chemistry.

Askar, Sugiarto. 2005. Uji kimiawi dan organoleptik sebagai uji mutu yogurt. Balai Besar penelitian Pasca Panen Pertanian. Bogor.

Belitzh, H. D., W. Grosch, & P. Schieberle. 2009. Food Chemistry 4th Revised and Extended Edition. Springer Verlag: Berlin, Germany. ISBN: 978-3540699330.

BPS (Badan Pusat Statistik). 2020. Produksi susu di Indonesia. https://www.bps.go.id/dynamictable/2015/12/23/1095/produksi-susu-perusahaan-sapi-perah-2000---2019.html

BPS (Badan Pusat Statistik). 2020. Badan Pusat Statistik (Susenas 2014-2018)/BPS-Statistics Indonesia (National Social Economic Survey 2014-2018).

Chairunnisa, H., L. Nurlina, H. Arief, E. Wulandari, W. S. Putranto, & Nanah. 2019. Upaya Peningkatan kesadaran masyarakat dalam konsumis susu dan olahannya di Desa Cileles Kecamatan Jatinangor. Media Kontak Tani Ternak. 1(1):26-30.

Choo, W. S., & W. K. Yong. 2011. Antioxidant properties of two species of hylocereus fruits. Adv. Appl. Sci. Res. 2(3):418-425.

Darmawati, M. P. 2023. Karakteristik fisik dan sifat organoleptik yogurt dengan penambahan gula buah Monk (Siraitia grosvenorii) sebagai pemanis alami. [skripsi]. Bogor: Institut Pertanian Bogor.

Fadila, I. 2012. 15 Manfaat buah naga yang mungkin belum Anda ketahui. Diakses dari https://hellosehat.com/nutrisi/fakta-gizi-/manfaat-buah-naga.

Frilanda, A., W. S. Putranto, & J. Gumilar. 2022. Pengaruh berbagai konsentrasi pulp buah naga merah pada pembuatan set yogurt terhadap total bakteri asam laktat, nilai pH dan total asam. Jurnal Teknologi Hasil Peternakan. 3(1):32-41.

Gianti, I. 2011. Pengaruh pemberian gula dan lama penyimpanan terhadap kualitas fisik susu fermentasi. [skripsi]. Malang: Universitas Brawijaya.

Handayani. 2015. Analisis kualitas kimia susu pasteurisasi dengan penambahan sari buah sirsak. [skripsi]. Makassar: Universitas Hasanuddin.

Harini, N., R. Marianty, & V. A. Wahyudi. 2019. Analisa Pangan. Sidoarjo: Laksana

Harjiyanti, M. D., Y. B. Pramono, & S. Mulyani. 2012. Total asam, viskositas dan kesukaan pada yogurt drink dengan sari buah mangga (Mangifera indica) sebagai perisa alami. Jurnal Aplikasi Teknologi Pangan. 4:40-43.

Hartatie, E. S. 2011. Kajian formulasi (bahan baku, bahan pemantap) dan metode pembuatan terhadap kualitas es krim. Gamma. 7(1):20-26.

Harun, N., Rahmayuni, & Y. E. Sitepu. 2013. Penambahan gula kelapa dan lama fermentasi terhadap kualitas susu fermentasi kacang merah (Phasolus vulgaris L.). Ejournal. 12(2):9-14.

Hekmat, S., H. Soltani, & G. Reid. 2009. Growth and survival of Lactobacillus reuteri RC-14 and Lactobacillus rhamnosus GR-1 in yoghurt for use as a functional food. Innov Food Sci and Emerging Technol. 10:293-296.

Hidayat, N., M. C. Padaga, & S. Suhartini. 2006. Mikrobiologi Industri. Yogyakarta: Andi. https://doi.org/10.21776/ub.jitek.2019.014.01.7

Ichwansyah, R. 2014. Pengembangan yogurt sinbiotik plus berbasis puree pisang ambon (Musa paradisiaca L) dengan penambahan inulin sebagai alternatif pangan fungsional [skripsi]. Bogor: Institut Pertanian Bogor.

Isengard, H. D., & D. Breithaupt. 2009. Food Analysis. Di dalam: Campbell-plaat G, editor. Food Science and technology. Oxford : J wiley.

Jasmine, R. O., R. Fadhilla, V. Melani, P. Ronitawati, & D. Angkasa. 2020. Stirred yogurt berbasis sari kacang merah (Phaseolus vulgaris L) dan sari buah naga merah (Hylocereus polyrhizus) berpotensi sebagai sumber serat dan antioksidan. Darussalam Nutritional Journal. 4(2):82-93.

Jonathan, H. A., I. N. Fitriawati, I. I. Arief, M. S. Soenarno, & R. H. Mulyono. 2022. Fisikokimia, mikrobiologi dan organoleptik yogurt probiotik dengan penambahan buah merah (Pandanus conodeous L.). Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan. 10(1):34-41.

Kamaluddin, M. J. N., & M. N. Handayani. 2018. Pengaruh perbedaan jenis hidrokoloid terhadap karakteristik fruit leather papaya. Jurnal Edufortech. 3(1):25-32.

Krisnaningsih, A. T. N., T. I. W. Kustyorini, & M. Meo. 2020. Pengaruh penambahan pati talas (Colocasia esculenta) sebagai stabilizer terhadap viskositas dan uji organoleptik yogurt. Jurnal Sains Peternakan. 8(1):66-76.

Kusmawati, Aan, H. Ujang, & E. Evi. 2000. Dasar-Dasar Pengolahan Hasil Pertanian I. Jakarta: Central Grafika.

Leviana, W, & V. Paramita. 2017. Pengaruh suhu terhadap kadar air dan aktivitas air dalam bahan pada kunyit

(Curcuma longa) dengan alat pengering electrical oven. Ejournal. 13(2):37-44.

Lingga, L. 2012. The Healing Power of Antioxidant. Jakarta: PT Elex Media Komputindo.

Lisa, M., M. Lutfi, & B. Susilo. 2015. Pengaruh suhu dan lama pengeringan terhadapmutu tepung jamur tiram putih (Plaerotus ostreatus). Jurnal Keteknikan Pertanian Tropis dan Biosiste. 3(3):270-279.

Mahmood, A. M., J. H. Doughari, & F. J. Chanji. 2008. In vitro antibacterial activities of crude extracts of Nauclea latifolia and Daniella oliveri. Scientific Research and Essay. 3(3):102-105.

Mamani, L. W., & C. B. Gallo. 2014. Meat quality, proximate composition and muscle fatty acid profile of young llamas (Lama glama) supplemented with hay or concentrate during the dry season. Meat Sci. 96:394-399.

Meilanie, R. T., I. I. Arief, & E. Taufik. 2018. Karakteristik yogurt probiotik dengan penambahan ekstrak bunga rosella (Hibiscus sabdariffa L) selama penyimpanan suhu dingin. Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan. 6(1):36-44.

Michael, M., R. K. Phebus, & K. A. Schmidt. 2010. Impact of a plant extract on the viability of Lactobacillus delbrueckii ssp. bulgaricus and Streptococcus thermophilus in nonfat yogurt. Int Dairy J. 20(10):665-672.

Molyneux, P. 2004. The Use Of The Stable Free Radical Diphenyl Picryhydrazyl (DPPH) For Estimating Antioxidant Activity. New York: UJ. Sci. Technol.

Ningsih, E. L., I. L. Kayaputri, & I. S. Setiasih. 2019. Pengaruh penambahan CMC (Carboxy Methyl Cellulose) terhadap karakteristik fisik yogurt probiotik potongan buah naga merah. Jurnal Ilmu dan Teknologi Hasil Ternak. 19(1):60-69.

Oktavia, H., L. E. Radiati, & D. Rosyidi. 2013. Pengaruh penambahan kultur tunggal dan campuran dengan lama inkubasi pada suhu ruang terhadap kadar pH, keasaman, viskositas dan sineresis pada set yogurt. Artikel Penelitian. Fakultas Peternakan, Universitas Brawijaya, Malang.

Oktaviana, A. Y., I. I. Arief, & I. Batubara. 2018. Potensi yogurt rosella probiotik Lactobacillus plantarum IIA-1A5 atau Lactobacillus fermentum B111K dalam mengasimilasi kolesterol. Jurnal Aplikasi Teknologi Pangan. 7(3):132-141.

Ozturk, B. A., & M. D. Oner. 1999. Production and evaluation of yogurt with concentrated grape juice (CGJ). Journal of Food Science. 64(3):530-532.

Panjuantiningrum, F. 2009. Pengaruh pemberian buah naga merah (Hylocereus polyrhizus) terhadap kadar glikosan darah tikus putih yang diinduksi aloksan. [skripsi]. Surakarta: Universitas Sebelas Maret.

Permadi, M. R., H. Oktafa, & K. Agustianto. 2018. Perancangan sistem uji sensoris makanan dengan pengujian peference test (hedonik dan mutu hedonik), studi kasus roti tawar, menggunakan algoritma radial basis function network. J Mikrotik. 8(1):29-42.

Phisita, I. 2022. Aktivitas antioksidan dan kualitas yoghurt susu sapi penambahan buah naga merah dengan starter dadih. [skripsi]. Jakarta: Universitas Islam Negeri Syarif Hidayatullah.

Purbasari, A., Y. B. Pramono, & S. B. M. Abduh. 2014. Nilai pH, kekentalan, cita rasa dan kesukaan pada susu fermentasi dengan perisa alami jambu ari (Syzygium sp). Jurnal Aplikasi Teknologi Pangan. 3(4):174-177.

Putri, D. C. L. A., I. N. K. Putra, & I. P. Suparthana. 2019. Pengaruh penambahan sari buah naga merah (Hylocereus polyrhizus) terhadap karakteristik yoghurt campuran susu sapi dan kacang merah (Phaseolus vulgaris). Jurnal Ilmu dan Teknologi Pangan. 8(1):8-17.

Rahayu, W. P., & C. C. Nurwitri. 2012. Mikrobiologi Pangan. Bogor: Institut Pertanian Bogor.

Rahmawati, D., & J. Kusnadi. 2018. Penambahan sari buah murbei (Morus alba L.) dan gelatin terhadap karakteristik fisiko kimia dan mikrobiologi yogurt susu kedelai. Jurnal Pangan dan Agroindustri. 5(3):83-94.

Risnayanti, S. M. Sabang, & Ratman. 2015. Analisis perbedaan kadar vitamin C buah naga merah (Hylocereus polyrhizus) dan buah naga putih (Hylocereus undatus) yang tumbuh di Desa Kolono Kabupaten Morowali Provinsi Sulawesi Tengah. Jurnal Akademika Kimia. 4(2):91-96.

Rohman, A., & S. Riyanto. 2005. Daya antioksidan ekstrak etanol daun kemuning (Murryaya paniculata (L) Jack) secara in vitro. Majalah Farmasi Indonesia. 16(3):136-140.

Sadler, G. D., & P. A. Murphy. 2003. pH and titratable acidity. Di dalam: Suzane Nielsen (Ed). Food Analysis Third Edition: Purdue University, West Lafayette, Indiana.

Saputra, L. B. 2011. Kajian pembuatan yoghurt susu kambing dan diversifikasi rasa dengan penambahan sirup rempah-rempah [skripsi]. Bogor: Institut Pertanian Bogor.

Siagian, P. 2013. Keajaiban Antioksidan. Jakarta: Gramedia Pustaka Utama.

SNI (Standarisasi Nasional Indonesia). 2009. SNI 2981:2009. Yogurt. Badan Standardisasi Nasional (BSN), Jakarta.

Steel, R., & J. K. Torrie. 1997. Prinsip dan Prosedur Statistik. Jakarta: PT. Gramedia Pustaka Umum.

Stone, H., & L. Joel. 2004. Sensory Evaluation Practices, Ed ke-3. California (USA): Elsevier Academic, Press.

Suharyani, I., Y. Falya, Rindiyani, N. Nurmaya, & Y. Afidah. 2022. Pengaruh pelarut polar terhadap aktivitas antioksidan daging buah naga merah (Hylocereus polyrhizus) yang diekstrasi dengan metode Microwave Assisted Extraction (MAE). Pharmacoscript. 5(2):237-247.

Susanti, I., E. H. Lubis, & S. Meilidayani. 2017. Flakes sarapan pagi berbasis mocaf dan tepung jagung. Journal of Agro-based Industry. 34(1):44-52.

Tangkanakul, P., P. Auttaviboonkul, B. Niyomwit, N. Lowvitoon, P. Charoenthamawat, & G. Trakoontivakorn. 2009. Antioxidant capacity, total phenolic content and nutritional composition of Asian

foods after thermal processing. Internasional Food Research Journal. 16(4):571-580.

Triyono, A. 2010. Mempelajari Pengaruh Penambahan Beberapa Asam pada Proses Isolasi Protein terhadap Tepung Protein Isolat Kacang Hijau (Phaseolus radiatus). Semarang: Undip Press.

Wahyuni, R., & M. Nugroho. 2014. Pengaruh penambahan ekstrak kulit buah naga super merah terhadap produk mie kering. Jurnal Teknologi Pertanian. 15(2):93-102.

Wardana, A. S. 2012. Teknologi Pengolahan Susu. Surakarta: Universitas Slamet Riyadi.

Widianingsih, M. 2017. Aktivitas antioksidan ekstrak metanol buah naga merah (Hylocereus polyrhizus) (Fac Weber) Britton & Rose) hasil maserasi dan dipekatkan dengan kering angin. Jurnal Wiyata: Penelitian Sains dan Kesehatan. 3(2):146-150.

Winarno, F. G., S. Fardiaz, & D. Fardiaz. 1980. Pengantar Teknologi Pangan. Jakarta: PT. Gramedia

Winarno, F. G., I. E. Fernandez. 2007. Susu dan Produk Fermentasinya. Bogor : M- Brio Press.

Winarsi, H. 2007. Antioksidan Alami dan Radikal Bebas: Potensi dan Aplikasi dalam Kesehatan. Yogyakarta: Kanisius.

Wu, C. L., H. W. Hsu, Y. C. Chen, C. C. Chiu, Y. I. Lin, & J. A. Ho. 2006. Antioxidant and antiproliferative activities of Red Pitaya. Food Chemistry. 95(2):319-327.

Zainoldin, K. H., & A. S. Baba. 2012. The effecy of Hylocereus polyrhizus and Hylocereus undatus on physicochemical, proteoysis and antioxidant activity in yoghurt. International Journal of Biological and Life Science. 8(2):93-98.