Research Article

Effects of Salak Sidimpuan Extract and *Chlorella vulgaris* on the Nutritional and Functional Properties of Goat Kefir Milk

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Abstract | This study investigates the effects of Salak Sidimpuan extract and *Chlorella vulgaris* on the fat, protein, viscosity, antioxidant properties, and organoleptic qualities of goat kefir milk. The type of research used is experimental research with goat kefir milk. This study uses a Completely Randomized Design (CRD) with 4 treatments and 5 replications. Statistical analysis was performed using the Duncan's multiple range test using SPSS software. The parameters in this study are nutritional composition, viscosity, antioxidant, total phenol and organoleptic qualities. The results of the study showed that effect of Salak Sidimpuan extract supplemented *Chlorella vulgaris* was significantly different (P<0.05) on the nutritional and functional properties of goat kefir milk. In the results of statistical analysis, it can be seen in the average best fat content taken from the addition of Salak Sidimpuan extract supplemented with *Chlorella vulgaris*, namely treatment E (15% Salak Sidimpuan extract+20% *Chlorella vulgaris*+65% goat kefir milk) of 4.35% from treatment A (control) which is 6.68%. In protein content from the best average protein content in treatment E, namely 10.88% compared to Treatment A (control) which is 5.39%. The water content of the milk was 51.79%, viscosity of 4760 ± 70.71, phenol test of 13.48 mg GEA/ml, antioxidants properties of 45.08%, and organoleptic qualities the value that appears most often (mode) and the middle value (median) obtained is 5. The conclusion is the addition of Salak Sidimpuan extract and *Chlorella vulgaris* supplementation significantly increased the protein content of goat kefir milk, while also affecting fat content, viscosity, total phenol, antioxidant properties, and organoleptic qualities.

Keywords | Chlorella, Kefir, Goat, Salak, Milk

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INTRODUCTION

The demand for animal protein among the Indonesian population continues to increase along with population growth, increasing income, and increasing public awareness in meeting the nutritional needs of each person's body, including milk. In addition to cow's milk, goat's milk with a protein content of 5.46% is now increasingly popular among the public as a source of animal protein (Rizqan *et al*., 2023). Goat milk is nutritionally complete, but its distinct 'goaty' flavor, caused by short and medium-chain fatty acids, often makes it less palatable. To

reduce the prengus taste, additional ingredients commonly found in the South Tapanuli area are added, namely local Salak Sidimpuan. The production of Salak Sidimpuan has reached 1,626,426 tons in Padangsidimpuan city (BPS, 2023). Salak Sidimpuan, rich in vitamin C, is commonly used in the region and is thought to have potential benefits in masking the undesirable flavor of goat's milk which vitamin C contains 68.89%. To overcome the mass production of Salak Sidimpuan fruit (many Salak Sidimpuan fruit cannot be sold and can rot and cause losses), it is necessary to carry out alternative processing in the form of salak sidimpuan extract. In addition to salak sidimpuan fruit, *Chlorella vulgaris* has also been found as a precursor for probiotics in goat kefir milk, a natural marine product and a type of unicellular green microalgae that has secondary metabolite activity that has an antioxidant content of less than 50 ppm. Therefore, it is now widely used as a raw material for probiotics. Based on the above problems, the researcher sees that the combination of Salak Sidimpuan extract and the addition of *Chlorella vulgaris* is the best research to study the nutritional content of Ettawa Peranakan goat milk kefir based on the nutritional composition, antioxidant activity, viscosity, total phenol and organoleptics such as taste and texture, colour, and aroma.

This study aims to investigate the effect of combining Salak Sidimpuan extract and *Chlorella vulgaris* on the quality of low-fat goat milk kefir as a functional animal food product. Results study the can give useful information for health in increase commodity food cattle ruminants and can help government in mitigate stunting disaster in Indonesia.

MATERIALS AND METHODS

Materials

The materials used in the study consisted of Salak Sidimpuan, *Chlorella vulgaris* (Chlorella flour), fresh goat milk, kefir grains, and distilled water. The tools used include pans, stoves, incubators, laminar, petri dishes, test tubes, test tube racks, measuring cups, electric scales, stirrers, beakers, micropipettes, bunsen burners, plastic containers (jars), aluminum foil, matches, plastic wrap and questionnaire sheets. 100 ml measuring cup, 500 ml beaker, 500 ml Erlenmeyer flask, petri dish, 10-100 ul micropipette, Duran brand burette, plastic jar, filter cloth, analytical balance, hotplate, 5 cm magnetic stairer, spectrophotometer, refrigerator. stove, pan, container, stirrer, beaker glass, Brookfield Viscometer measuring cup, and centrifuge.

Research gap	Approach	Strategy solution problem
There has been no discovery of goat milk kefir interacting with two additional materials	Salak Sidimpuan fruit own vitamin C content 0.058% and carbohydrate by 12.8%	Interaction vitamin C content of addition of Salak Sidimpuan extract on goat milk kefir Peranakan Ettawa can lower level fat milk and mitigate level smell from milk kefir
There is *Chlorella vulgaris* as probiotics without mixture other to quality milk goat Peranakan Ettawa	Chlorella as probiotics own content antioxidant And anti-inflammatory tall	The combination *Chlorella vulgaris* against goat milk kefir can lower cholesterol and radical free
Not yet the discovery of milk kefir goat interact with two material addition	Interactions Salak sidimpuan extract with *Chorella vulgaris* can fulfil standard milk low fat	Optimization addition of salak sidimpuan extract with *Chorella vulgaris* on goat milk kefir Peranakan Ettawa own content nutrition and high protein

Researcher previous	Salak Sidimpuan extract and *Chorella vulgaris*	Variables	Results	Newness proposer
Ismalinda *et al.* (2019)	Study Characteristics Physico-chemistry And Organoleptic Flour Snakefruit Sidimpuan (Salacca Sumatra)	Design Random Complete Factorial consisting of from two treatment that is thickness slice And type immersion	Flour salak which has highest vitamin C content 0.0585%	Method increase level up to 15% and supplementation flour *Chlorella vulgaris* as high protein source
Sulmiyati *et al.* (2019)	Characteristics Physicochemistry, Microbiology, and Sensory Milk Goat Kefir with Different Kefir Grain Contents with levels 2%, 4%, and 6%	Design the experiment used is design random complete (RAL) with three treatment and five repetitions	Milk Kefir goat best ca produced with addition of 2% kefir grains based on characteristic physicochemistry, microbiology, and sensory	Method optimization from fruit snakefruit And *Chlorella vulgaris* with level award above 2%
Sholeh *et al.* (2021)	Quality Milk Goat Peranakan Etawa On Various Period Lactation Reviewed From Nature Physique	Studies Case	Quality physique milk goat Already fulfil SNI standard No. 01-3141-1998	Method addition of fruit juice snakefruit with flour *Chlorella vulgaris* as source antioxidant and high protein

Preliminary research

Salak *Sidimpuan fruit* (*Salacca zalacca*)

The Salak Sidimpuan fruit is peeled, washed, cut into medium sizes and blended as much as 100 grams of the blended Salak Sidimpuan fruit. Covered with aluminum foil and shaken with a shaker for 30 minutes. After 30 minutes, the snake fruit is filtered with the help of a vacuum pump to obtain clear Salak Sidimpuan fruit juice and extract. Salak Sidimpuan extract liquid is then stored in a dark bottle at a cold temperature.

Making kefir

The process of making kefir follows the method of Otles and Cagindi (2003) with some modifications. Fresh goat milk was pasteurized at 70°C for 15 seconds and the temperature was lowered to room temperature (± 27°C). Pasteurization could be a treatment given to new drain so that it does not ruin rapidly. Warming at pasteurization temperature is expecting to murder a few pathogenic germs in drain, with negligible misfortune of sustenance and keeping up the physical properties and taste of new drain as much as conceivable (Abubakar *et al*., 2012), then inoculated with 5% kefir grains and stirred until smooth, then poured into a sterile plastic container (jar) and incubated at room temperature (±27°C) according to the fermentation time treatment, namely for 48 hours, so that the milk thickens into kefir. This kefir was then filtered to separate the kefir grains from the kefir substrate and then tested.

Method

A completely randomized design (CRD) with two factors was used. The first factor was Salak Sidimpuan extract (0%, 7%, 10%, 12%, and 15%) and the second factor was *Chlorella vulgaris* (0%, 5%, 10%, 15%, and 20%). The study included 5 treatments, with 4 replications, totaling 40 samples. All data were subjected to analyses of variance of completely randomized design using SPSS software version 25.0 (IBM, 2017). IBM SPSS Statistics for Windows, version 21.0. Armonk, NY: IBM Corp. The results were presented as the mean values and standard error of the means. Differences between treatment mean were determined by Duncan's multiple range test. The significance level was at $P<0.05$ (Harsojuwono *et al*., 2021).

Research parameters

Milk pasteurization method

Goat milk samples were put into sterile bottles measuring 500 ml then pasteurized using the High Temperature Short Time (HTST) method at a temperature of 72°C for 15 seconds. Pasteurized goat milk was cooled by soaking in ice water for 15 minutes to a temperature of 40 °C. Goat milk samples were then put into unsterilized plastic bottles measuring 250 ml. Pasteurized goat milk samples were then stored in a refrigerator at a temperature of 4-10 °C until testing time.

Fat content

Pasteurizer for pasteurization equipment and using the Gerber method to calculate the milk fat content. Next, 10 ml of concentrated H_2S0_4 is inserted into the butyrometer, 10 ml of milk sample is inserted through the tube wall using a pipette and 1 ml of alcohol is added. Then the tube is plugged with a rubber stopper and homogenized for about 3-5 minutes, the tube is soaked in a 57-65 °C water bath for 3-5 minutes and then centrifuged for 3-5 minutes at 1200 revolutions per minute. After that, it is put back into the water bath for 3-5 minutes, then dried and read the fat content (Gupta *et al*., 2022).

Protein content

The determination of protein content using the semi-micro Kjeldahl method is as follows. (a) A test comparable to 0.03 - 0.04 grams of Nitrogen is weighed carefully and put into a Kjedhal carafe, (b) 10 grams of selenium and 20 mL of concentrated sulfuric corrosive are included, (c) The blend is processed at tall temperature until the fluid is evident and after that cooled, (d) The blend is exchanged into a refining jar and flushed with a certain sum of water, (e) An overabundance of 50% b/v NaOH arrangement is included to the blend and instantly refined, (f) 200 ml of distillate is collected in an Erlenmeyer jar containing 50 mL of 4% b/v boric corrosive arrangement and 4 drops of blended pointer, (g) The arrangement is titrated with 0.1 N sulfuric corrosive until the green color changes to blue-violet, (h) The titration comes about are recorded on the LCP (what is recorded is the volume of titrant utilized).

Antioxidant activity test

Each concentration was tested for antioxidant activity, using the Asif (2015) method. A 1 ml sample was added with 1 ml of DPPH dissolved in 4 ml of ethanol until a purple color appeared on the sample. DPPH was used as a blank which was treated the same as the sample. Furthermore, the sample was homogenized using a vortex, incubated in a dark room for 30 minutes and then with a spectrophotometer at wave 517 its absorbance could be read. Determination of the inhibition value to determine the value of antioxidant activity in the sample was determined using the following formula (Yusriah and Agustini, 2014).

$$\% AA = (\text{Control absorbance} - \text{Sample absorbance}) / (\text{Control absorbance}) \times 100\%$$

Description: Sample absorbance: DPPH absorbance after being reacted with the sample, Control absorbance: DPPH absorbance without sample, DPPH: 1,1-diphenyl-2-picrylhydra-zyl

Furthermore, the IC50 value was calculated using the regression equation formula. IC50 is the concentration needed to reduce DPPH by 50%. This aims to obtain a more optimal concentration as an antioxidant in suppressing free radicals. IC50 is calculated using the linear regression method, sample concentration as the x-axis and % inhibition as the y-axis (Mukherjee, 2014).

From the equation y = a + bx, IC50 can be calculated using the formula:

$$y = a + bx$$
$$50 = a + bx$$
$$(x)\ IC50 = ((50-a)/b)$$

Viscosity test

The viscosity value of milk is measured using a viscosity measuring tool, namely the Brookfield viscometer.

Sensory test

The sensory test is carried out with a hedonic test (level of preference) for texture, color, taste, and aroma. The panelists used were 30 untrained panelists.

Organoleptic test

The organoleptic tes a color, aroma, and acceptability tests of PE goat kefir milk.

RESULT AND DISCUSSION

Water content, protein content, and fat content of goat milk kefir

The results of the water, protein, and fat content tests of goat kefir milk with the addition of Salak Sidimpuan extract and *Chlorella vulgaris* supplementation which have been further tested using Anova can be seen in Table 1.

Milk water content

Table 1 shows that the water content of PE goat milk kefir with the addition of Salak Sidimpuan extract with *Chlorella vulgaris* ranges from (51.79-82.86%). The results of the diversity analysis showed that the addition of Salak Sidimpuan extract with *Chlorella vulgaris* flour was significantly different (P <0,05) on the water content of PE goat milk. This is because the increase in milk solids is closely related to the green fodder given. The water content of goat kefir milk is greatly influenced in treatment E of 51.79% produced, this is due to the isotonic properties it has. In expansion, Salak Sidimpuan extract has phytochemical substance in Salak Sidimpuan fruit natural product is flavonoids which can lower cholesterol levels. Agreeing to Bengoa *et al.* (2019), what is implied by phytochemicals are organically dynamic compounds found in plant simplicia. The dynamic flavonoid compound is valuable as an antioxidant within the body which capacities to extend glucose resistance. In maintaining its osmosis so that it is isotonic with livestock blood, sufficient lactose production is required. If there is a lack of lactose, it will reduce the secretion of water into the milk so that milk production is reduced or low because the water content in the milk passes through the epithelial cells and enters the milk by filtration. Water secretion has a close relationship with the osmotic pressure of milk. Typically in line with the conclusion put forward by Bolla *et al.* (2016) amid the natural product aging prepare there will be physical and chemical changes such as changes in water substance, protein, fat, natural acids, vitamins, minerals and carbohydrates. Changes in starch carbohydrates to glucose or bad habit versa will influence antioxidant action and natural product from Salak Sidimpuan extract.

Table 1: Test results for water content, protein content, and fat content of goat milk kefir (%).

Treatment	Water content (%)	Protein content (%)	Fat content (%)
A	82.86	5.39	6.68
B	75.60	7.67	5.93
C	75.41	7.84	4.88
D	74.05	8.22	4.72
E	51.79	10.88	4.35
Average	71.94	8.6	5.31
SE	0.95	1.38	0.99

The results of the study showed significantly different results (P<0.05).SE: Standard Error. Treatment A (Control), treatment B (7% salak sidimpuan extract+ 5% *Chlorella vulgaris* + 88% goat milk kefir), treatment C (10% salak sidimpuan extract + 10% *Chlorella vulgaris* + 80% goat milk kefir), treatment D (12% salak sidimpuan extract + 15% *Chlorella vulgaris* + 73% goat milk kefir), treatment E (15% salak sidimpuan extract + 20% *Chlorella vulgaris* + 65% goat milk kefir).

Milk protein content

Protein is one of the solid non-fat components (dry matter without fat). The level of milk protein is influenced by the type of feed given to livestock. Good feed quality in livestock tends to increase the content of solid non-fat in milk. Protein is a complex organic compound with high molecular weight which is a polymer of amino acid monomers that are connected to each other by peptide bonds. Protein molecules contain carbon, hydrogen, oxygen, nitrogen and sulfur and phosphorus. Protein plays an important role in the structure and function of all living cells and viruses. Most proteins are enzymes or enzyme subunits. Other types of proteins play a role in structural or mechanical functions, such as proteins that form the cytoskeleton rods and joints. Protein is one of the components that determines the quality of milk, crude protein (CP) has a role in the formation of milk protein.

Milk production is influenced by feed. The feed given is only greens without the addition of concentrate, feed is given in the afternoon.

Based on Table 1, further ANOVA test of protein content showed a significant difference (P<0.05), the average value of the best treatment E of 10.88% had a higher protein content compared to treatment D of 8.22%, treatment C of 7.84%, treatment B of 7.67%, and Treatment A of 5.39% as a control. This is different from the results from Christi *et al.* (2024) the protein content of goat kefir milk has 3,9%, Etawa goat milk protein varied between 4.17-4.56%. Because the higher the protein content in the feed, the higher the protein content in the milk produce. The source of protein in feed usually comes from concentrate. Increasing the availability of amino acids in feed will increase milk protein synthesis. Milk protein is formed from concentrated feed consumed by livestock and then synthesized by rumen microbes into amino acids and these amino acids are absorbed in the small intestine and flowed into the blood and enter the udder secretion cells and later become milk protein. The higher the protein content in milk can affect the selling price of milk. Protein is one of the components of dry matter without fat. This protein content is in accordance with fresh milk standards, with protein content values of at least 2.8% and >3.7% for premium fresh goat milk. However, compared to *Chlorella vulgaris* as a high protein contributor to goat kefir milk, it is likely contributed by protein from salak sidimpuan extract which has a protein content of 0.8 gr.

In addition, protein in the *Chlorella vulgaris* plant as a precursor and encompasses a decently tall wholesome substance so that it is exceptionally potential to be utilized for beauty care products (Iriani *et al.*, 2023), biodiesel (Widyastuti, 2014) and nourishment items (Iriani *et al.*, 2017). The dietary substance of *Chlorella vulgaris* is 51-58% protein, 28-32% oil, 12-17% carbohydrate, 14-22% fat, 4-5% nucleic acid, and high chlorophyll (Mufidah *et al.*, 2017), as well as antioxidant substance with a solid category (Iriani *et al.*, 2011). Furthermore, the addition of *Chlorella vulgaris* to goat kefir milk as an additional ingredient can increase the protein value and other nutritional values of the milk itself. The incorporation of *Chlorella vulgaris* into food can cause changes in nutritional composition so that the resulting goat kefir milk is more beneficial and nutritious. The addition of *Chlorella vulgaris* does not have a negative impact on the resulting food products, based on toxicity tests that have been carried out on clastogenic, genotoxicity and irritation parameters (Dillon *et al.*, 2020), so that *Chlorella vulgaris* fortification as a functional food product is safe for consumption. According to Mandik *et al.* (2022) *Chlorella vulgaris* bioactive compounds have been shown to have positive effects on health such as antihypertension, antiobesity, antioxidants, anticancer, and cardiovascular protection.

Milk fat content

In general, milk fat content is the most volatile nutritional component, and is highly dependent on dietary fiber. Milk fat becomes low because acetate is a material for forming milk fat. Milk fat is called butter fat. Milk fat plays an important role in determining the aroma of milk and other products derived from milk. The fat content of milk is very important because it is a determining factor in the price of the milk (Myhandi *et al.*, 2023).

Table 1 shows that the fat content of PE goat milk with the addition of Salak Sidimpuan extract and *Chlorella vulgaris* flour ranges from 4.35-6.68%. The results of the diversity analysis showed that the addition of Salak Sidimpuan extract supplemented with *Chlorella vulgaris* mixed with goat milk kefir was significantly different (P<0.05) on the milk fat content. This is because the crude fiber in the feed plays a major role in the formation of fat in milk. The milk fat content is greatly influenced by the consumption of crude fiber in the feed given, the milk fat content is also influenced by factors that affect the production of acetic acid in the rumen, in this case the performance of rumen microbes in fermenting crude fiber into acetic acid. Carbohydrates are precursors of lactose synthesis which in the process of degradation by rumen microbes become pyruvic acid and then broken down into Volatile Fatty Acid (VFA) consisting of propionic, acetic, and butyric acids. Acetic and butyric acids enter the blood which will become precursors in the formation of fatty acids, then will enter the udder secretion cells and become milk fat. Because most milk fat is influenced by feed and the synthesis of milk components in the udder. In the body, fat functions as an efficient source of energy directly and potentially when stored in adipose tissue. Fat is useful as a reserve material and fuel that can be used at any time, fat is also useful for protecting the delicate parts of the body and protecting the ends of the bones, which is why in the joints. Fat content is very important in determining the nutritional value of milk. Food ingredients processed from raw milk such as butter, cheese, cream, condensed milk and powdered milk contain a lot of fat. Milk fat consisting of fatty acids is a source of energy for the body (Sholeh *et al.*, 2021). Usually in the rainy season the milk fat content will increase while in the dry season the milk content is lower. High environmental temperatures will reduce milk production. The fat content in milk is the most important component besides protein that affects the selling price of milk. Based on the average value, it can be seen that the average in Table 1, treatment A (control) of 6.68% has a higher content compared to treatment B 5.93%, treatment C 4.88%, treatment D 4.72%, and the lowest treatment E of 4.35%. This is because giving Salak Sidimpuan extract has 0.4 gr/100 gr lipid with *Chorella*

vulgaris in goat milk kefir with the level other percentage in each treatment resulted in acetic acid different, so that it can still maintain the level of milk fat produced. The lipid content in several *Chorella vulgaris* is also rich in essential fatty acids such as C18 linoleic acid and derivatives of C20 such as eicosapentanoic acid and arachidoneic acid. The types of fatty acids included in the essential components can be used to help lower cholesterol in goat milk kefir (Fradique *et al*., 2010). According to Sukhikh *et al*. (2022), *Chlorella vulgaris* biomass is rich in nutrients, including omega 3 and 6 fatty acids, essential amino acids (cysteine, isoleucine, and valine), carotene, chlorophyl, and vitamins Milk fat levels are greatly influenced by crude fiber from feed and its metabolic results in the form of acetic acid. Nevertheless in general, milk fat content is one of the most considered components in assessing ruminant milk. Milk fat content is highly dependent on the crude fiber content of the feed and acetic acid production. Low crude fiber in feed will result in low acetate content in the rumen, so that milk fat becomes low because acetate is a material for forming milk fat. Goat milk fat content is influenced by green fodder, the higher the green fodder given, the higher the milk fat content. Livestock fed with additional concentrate will decrease the milk fat content and feed consisting only of greens has a higher fat content. The amount of acetate production will affect the amount of fatty acid synthesis which will then result in an increase in milk fat content.

Goat milk kefir viscosity test

The results of the viscosity test of goat milk kefir with the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* which have been further tested using Anova can be seen in Table 2.

Viscosity is one of the quality requirements to see the quality of yogurt. The viscosity of yogurt can be influenced by several factors including the type of milk, type of lactic acid bacteria, protein content, fat content and total milk solids. This is in accordance with the opinion of Purbasari *et al*. (2014) which states that the viscosity of yogurt is influenced by protein content, type of strain culture, pH, yogurt incubation time and total milk solids. Based on Table 2, the average viscosity value of goat milk with the addition Salak Sidimpuan extract supplemented with *Chorella vulgaris* of different protein sources, ranges from 27.05 ± 021 cP to 4760 ± 70.71 cP. Based on the results of the viscosity analysis of goat milk kefir with the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* supplemented gave a very significant effect (P<0.05) on the treatment given. Based on the results of further tests, the significant difference in viscosity values with the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* had the highest viscosity value compared to treatments with lower levels of addition, while the lowest viscosity value was obtained from goat's milk kefir without the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris*.

Table 2: Goat milk kefir viscosity test.

Treatment	Viscosity (cps)	Average	Spindle	RPM
A	27.2	27.05 +0.21	1	60
	26.9		1	60
B	525	524 1.41	2	30
	523		2	30
C	520	515 +7.07	3	60
	510		3	60
D	3450	3405 ±63.64	3	12
	3360		3	12
E	4810	4760 ±70.71	3	12
	4710		3	12

The results of the study showed significantly different results (P<0.05). SE: Standard Error. Treatment A (Control), treatment B (7% salak sidimpuan extract+ 5% *Chlorella vulgaris* + 88% goat milk kefir), treatment C (10% salak sidimpuan extract + 10% *Chlorella vulgaris* + 80% goat milk kefir), treatment D (12% salak sidimpuan extract + 15% *Chlorella vulgaris* + 73% goat milk kefir), treatment E (15% salak sidimpuan extract + 20% *Chlorella vulgaris* + 65% goat milk kefir).

The addition of Salak Sidimpuan extract with *Chorella vulgaris* to goat milk kefir can increase viscosity because the protein content of milk kefir with a level of 20% chorella vulgaris flour is 10% higher when compared to the protein content. This is in accordance with the opinion of Triana *et al*. (2019) which states that the higher the protein content, the higher the thickness or viscosity of yogurt. The higher the viscosity is due to the binding of water by the protein. Mirza *et al*. (2017) added that protein will be coagulated by acid and form a gel, the higher the protein, the more protein will be coagulated so that the gel formed is higher so that the viscosity is higher. This shows that the addition of 15% Salak Sidimpuan extract and 20% *Chorella vulgaris* can increase viscosity due to the formation of a stronger protein network.

Antioxidant test and total phenol level test

Results of antioxidant test analysis and total phenol content test from the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* in goat milk kefir. In food terms, antioxidants are substances that can prevent the oxidation process that can cause damage to pagan materials (Pratama *et al*., 2021). Fermented goat milk samples using Lactobacillus rhamnosus and the addition of beetroot juice reacted with DPPH (2,2-diphenyl-1-picrylhydrazyl) solution experienced a color change from purple to yellow, then absorbed at a wavelength of 517 nm. The presence of compounds that can donate hydrogen atoms causes a color

change in the DPPH solution from purple to pale yellow (Sarwat *et al*., 2002).

Table 3: Goat milk kefir antioxidant test.

Treatment	Blank absorbance	Sample absorbance	% (inhibition)
A	0.264	0.152	42.42
B	0.264	0.138	42.73
C	0.264	0.144	45.45
D	0.264	0.139	47.35
E	0.264	0.145	45.08

The results of the study showed significantly different results (P<0.05). SE: Standard Error. Treatment A (Control), treatment B (7% salak sidimpuan extract+ 5% *Chlorella vulgaris* + 88% goat milk kefir), treatment C (10% salak sidimpuan extract + 10% *Chlorella vulgaris* + 80% goat milk kefir), treatment D (12% salak sidimpuan extract + 15% *Chlorella vulgaris* + 73% goat milk kefir), treatment E (15% salak sidimpuan extract + 20% *Chlorella vulgaris* + 65% goat milk kefir).

Table 4: Goat milk kefir total phenol content test.

Treatment	Sample absorption	Value of X	Sample weight	Mg GEA/ml
A	0.176	2,348	1	23.48
B	0.177	2,391	1	23.91
C	0.188	2,870	1	28.70
D	0.190	2,957	1	29.57

The results of the study showed significantly different results (P<0.05). SE: Standard Error. Treatment A (Control), treatment B (7% salak sidimpuan extract+ 5% *Chlorella vulgaris* + 88% goat milk kefir), treatment C (10% salak sidimpuan extract + 10% *Chlorella vulgaris* + 80% goat milk kefir), treatment D (12% salak sidimpuan extract + 15% *Chlorella vulgaris* + 73% goat milk kefir), treatment E (15% salak sidimpuan extract + 20% *Chlorella vulgaris* + 65% goat milk kefir).

The results of the antioxidant activity test showed that goat milk kefir before hydrolysis (control) had lower activity than after hydrolysis with the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* containing high protein into goat milk can increase antioxidant activity. The highest antioxidant activity of kefir milk in treatment D of 47.35% was produced by adding 12% Salak Sidimpuan extract with 15% *Chlorella vulgaris*, however the best result was in treatment E of 45.08% by adding 15% Salak Sidimpuan extract and 20% *Chlorella vulgaris* suplementation to PE goat milk kefir. This is because Salak Sidimpuan extract can act as a natural antioxidant because it has quite high antioxidant compounds. According to research (Ifmalinda *et al*., 2019), the ethanol extract of Salak Sidimpuan fruit has an inhibitory concentration (IC_{50}) of 13.69 mg/L. Salak sidimpuan extract contains alkaloids, polyphenols, flavonoids, quinones, monoterpenes and sesquiterpenes (Wijanarko *et al*., 2006), while according to other research results, Salak Sidimpuan has chemical compounds including polyphenols, flavanols, flavonoids, ascorbic acid and tannins (Elghandour *et al*., 2024). Where glucose is the basic ingredient of secondary metabolite compounds that can act as antioxidants, changes in vitamins during fruit development also affect antioxidant activity and fruit where several vitamins also act as antioxidants.

The total phenol content test, aims to determine the amount of phenol contained in the sample. The total phenol content test is carried out using the Follin-Ciocalteu method. The total phenol content is determined using the visible light spectrophotometry method. This method is based on the formation of a blue complex compound from phosphomolybdate-phosphotungsate which is reduced by phenolic compounds in an alkaline environment. The total phenol content in each extract is expressed as gallic acid equivalent (GAE). The total phenol content in treatment A was 23.48 mg GAE/ml, treatment B 23.91 mg GAE/ml, treatment C 28.70 MG GAE/ml, treatment D 29.57 mg GAE/ml, and treatment E 13.48 mg GAE/ml. This is caused by Salak Sidimpuan extract contains different phytoconstituents, supplements, sources of dietary fiber, and has plenteous mineral and vitamin. Vitamins play a part within the prepare of development, direction, and repair of body capacities, whereas minerals play a part in a few stages of metabolic responses, vitality, development, and body upkeep (Harahap *et al*., 2023). The mineral and vitamin substance that can be found in Salak Sidimpuan fruit is phosphorus, potassium, calcium, magnesium, sodium, press, manganese, ascorbic corrosive, carotene, thiamine, niacin, riboflavin, and folate (Saleh *et al*., 2018). The overall phenolic substance of Salak Sidimpuan extract in treatment E was identified at a critical level 15%. The information gotten show that Salak Sidimpuan extract can possibly be a promising source of bioactive useful nourishment (Setiani *et al*., 2018). Moreover, *Chlorella vulgaris* is a type of microalgae that can grow in fresh, brackish, and salt water and has a very high nutritional content. When dry, it contains 55-60% protein, depending on the source. Microalgae is also rich in γ-linoleic acid (GLA), α-linoleic acid (ALA), linoleic acid (LA), stearidonic acid (SDA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and arachidonic acid (AA) (Suwitaningsih and Wulansari, 2018).

Organoleptic test results of goat milk kefir

Goat milk kefir color

Color is a sensory test that can be seen directly by the panelists. Determination of color in milk generally depends on the color it has. Based on the results of organoleptic tests conducted by 20 panelists on goat milk kefir with the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris*, the value that appears most often (mode)

and the middle value (median) obtained is 5 (yellowish white). The color produced from the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* into goat milk kefir each shows that the milk color is good. The minimum and maximum values for the color of the milk produced vary depending on the fat content produced by each individual livestock. The color of the milk produced after treatment is still the same, namely yellowish white which is caused by the high fat content in the milk, causing color conversion between milk fat and milk water. The yellowish color is caused by the fat content in milk, especially influenced by fat-soluble substances such as carotene from animal feed (Sulmiyati *et al*., 2016). Kinteki *et al*. (2019), added that the color of milk is said to be milk is very easy to absorb aromas from its surroundings, such as the smell of the animal from which the milk was milked. Milk has a distinctive aroma because it easily absorbs odors around it (Evadewi and Tjahjani, 2021).

Goat milk kefir aroma

Based on the results of organoleptic tests conducted by 20 panelists on goat milk kefir with the addition of Salak Sidimpuan extract supplemented with *Chorella vulgaris* the value that often appears (mode) and the middle value (median) obtained is 5 (typical milk odor). The aroma of milk produced in goat milk kefir shows a good value and does not change. The minimum and maximum values of the aroma of goat milk kefir vary because the fat content contained in the milk has different levels. The aroma of milk is influenced by various things, including the presence of fatty acids in milk. The aroma of milk is more specific due to the content of volatile acids and fat in milk (Sulmiyati *et al*., 2019). Fatty acids are one of the main components of milk besides casein and milk lactose. Increasing milk fat content results in an increase in the specific gravity of milk, because fatty acids are one of the components of total solids. Suhendra *et al*. (2015) stated that milk fat is composed of saturated and unsaturated fatty acids. Saturated fatty acids that make up milk fat include palmitic acid and stearic acid. Unsaturated fatty acids that make up milk fat include oleic acid, linoleic acid, and linolenic acid.

Goat milk kefir flavor

The taste of milk is one of the important factors in organoleptic testing. Based on the results of organoleptic tests conducted by 20 panelists on goat milk kefir, the values that appear most often (mode) and the median value obtained are 3-4 (*Chlorella vulgaris* flavor concentration). The taste of goat milk changes or can be stated as normal. The minimum and maximum values for the taste of goat milk vary quite a bit, because milk contains varying levels of lactose, which affects the taste of the milk. The slightly sweet taste of fresh milk is caused by disaccharide carbohydrates, namely lactose (Tanuwiria *et al*., 2005). The formation of lactose is greatly influenced by propionic acid from concentrated feed or feed containing high energy sources. Starch is a nutrient source of energy from concentrate, this starch will later be fermented into propionic acid which will be used to form glucose. Excess energy in the body will be stored in the form of glucose, then stored in the liver so that it can be used as a raw material for the formation of milk lactose (Suhendra *et al*., 2015). Feed consumption affects the amount of milk lactose content, while the rest can be influenced by other factors such as livestock conditions, genetics, and the environment. The lactose content is not only influenced by feed, but can also be caused by the month of lactation of livestock that has entered the end of the lactation period where during that period the lactose content decreases. This reason is in accordance with the opinion of Puspitarini and Susilowati (2020) who stated that the factors that affect the quality and production of milk are the nation, lactation month, lactation period and feed quality.

CONCLUSION

The use of Salak Sidimpuan extract and *Chlorella vulgaris* in the treatment resulted in significantly different outcomes ($P<0.05$). Treatment E (15% Salak Sidimpuan extract + 20% *Chlorella vulgaris*) showed a milk water content of 15.79%, protein content of 10.88%, fat content of 4.35%, viscosity of 4760 ± 70.71 cP, phenol content of 13.48 mg GAE/ml, and antioxidant activity of 45.08%. The conclusion is that goat kefir milk with the addition of Salak Sidimpuan Extract with *Chlorella vulgaris* can mitigate stunting and improve heart health in humans if consumed daily.

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AUTHOR'S CONTRIBUTION

ZN, AUH, TM: Supervised the experiment and wrote

original manuscript.
RS, KW: Conducted the experiment and data analysis.
The final version of the manuscript was read and approved by all authors.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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