Original Research Article

Physicochemical Characteristics of Set Yogurt Fortified with *Dracaena angustifolia*Leaves Extract

Comment [n1]: Many studies have proven the effect of the leaf extract of the *Dracaena angustifolia*plant.
This manuscript did not mention any effect of adding the extract on the beneficial bacteria present in yoghurt.

ABSTRACT

Aims: This study aims to analyze syneresis, pH, total acid, viscosity, color (L, a*, b*) and sensory analysis (taste, aroma, and color) and antioxidant activity of yogurt set added with *Dracaena angustifolia* leaves (DAL) extract.
Study design: The research used a factorial experimental method with a Completely Randomized Design (CRD), four treatments, and four replications. The research used a percentage treatment of DAL extract (0%, 2%, 4%, 6% from milk total).
Place and Duration of Study: Was carried out at the Animal Products Technology Laboratory, Faculty of Animal Husbandry, Brawijaya University to make suji leaf extract, make yogurt set, testing syneresis, pH, total acid, viscosity, color (L, a*, b*) and sensory analysis (taste, aroma, and color) and antioxidant activity. The Research was conducted on 5 October - 5 December 2023.

Comment [n2]: Please test the half-life of the lethal dose of the yoghurt substance before and after adding the extract and pure extract

Methodology: The yogurt-making process begins with pasteurizing milk to a temperature of 65-70°C, followed by the addition of DAL extract according to the treatment: P0 (control), P1 (2%), P2 (4%), P3 (6%). During pasteurization, the milk is occasionally stirred and maintained at this temperature for 15 minutes. After pasteurization, the milk is filtered, and a starter inoculation is added at a temperature of 43-45°C, constituting 2% of the milk volume. The milk-starter mixture is thoroughly stirred to ensure even distribution. The inoculated milk is then poured into sterilized glass containers, incubated in an incubator at a temperature of 43-45°C for 6 hours, and analyzed physicochemical characteristics (syneresis, pH, total acid, viscosity, color (L, a*, b*) and sensory analysis (taste, aroma, and color) and antioxidant activity).
Results: The yogurt set fortified DAL with different concentrations showed a significantly different effect ($P<0.05$) on pH, color (L, a*, b*), and sensory (taste, aroma, and color) and did not have a different effect ($P>0.05$) on syneresis, total acid, and viscosity.
Conclusion: Based on the research results, it can be concluded that the addition of DAL extract to the yogurt set provides an increase in viscosity, color brightness (L), yellowish color (b*), organoleptic quality (taste, aroma, and color), total acid, antioxidant activity, and reduces syneresis, reddish color intensity (a*), and pH.

Keywords:Keywords: fermented milk, syneresis, pH, total acid, antioxidant, color, sensoryanalysis

1. INTRODUCTION

Yogurt is a dairy product produced through fermentation processes. It contains beneficial bacteria, such as *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, and *Streptococcus thermophilus*. These bacteria can convert lactose into lactic acid, which imparts a sour taste to yogurt. Yogurt has higher nutritional content than fresh milk, attributed to the fermentation process that occurs during processing, thereby breaking down complex compounds into simpler forms. Yogurt is believed to have numerous health benefits [1].

The benefits of yogurt include its consumption by individuals with lactose intolerance, its ability to lower blood cholesterol levels, its preventive effects on digestive tract diseases, and its antioxidant activity, which inhibits and prevents oxidative stress in the body, a leading cause of various diseases [1]. According to [2], yogurt exhibits antioxidant activity of 19.25%, which increases with the addition of ingredients containing antioxidants. Furthermore, the use of colorants in yogurt serves as an important indicator for creating consumer appeal. Innovations that can enhance consumer appeal and increase antioxidant activity in yogurt include the addition of natural ingredients such as pandan leaves, moringa leaves, and *Dracaena angustifolia* leaves (DAL).

DAL are plants that share characteristics similar to pandan leaves. DAL has a pH value of 5.76, indicating acidity [3]. They are commonly used as natural colorants in food due to their chlorophyll content, which produces a natural green color. Chlorophyll content in DAL is greater compared to other leaf types [4]. According to [5], DAL has a higher total chlorophyll content compared to pandan leaves, with a total of 30.221 mg/L, while pandan leaves contain 18.573 mg/L of chlorophyll. The chlorophyll content in DAL has also been proven to possess antioxidant properties [6]. DAL exhibits antioxidant benefits due to the presence of secondary metabolites capable of inhibiting oxidative reactions by binding to free radicals and active molecules [7]. The antioxidant value of DAL is higher than that of pandan leaves, at 48.96 ppm.

Pandan leaves are known to exhibit characteristics similar to DAL. Research by Fitriana[8] found that the addition of pandan leaf extract (*Pandanus amaryllifoliousRoxb.)* can decrease the pH value of yogurt. The pH value of yogurt ranges from 3.82 to 3.90. Furthermore, findings from [9] indicate that the addition of pandan leaf extract to yogurt can enhance antioxidant activity, correlating with the increase in concentration added. The inhibition value against DPPH obtained ranges from 73.50% to 90.24%. The IC50 value of yogurt with 9% added pandan leaf extract is 32.09 ppm. This value is considered very strong as it has an IC50 value of less than 50 ppm. It is anticipated that the addition of DAL extract as a natural colorant and antioxidant content will result in yogurt with even higher antioxidant activity. Based on the advantages of DAL as outlined, further research is needed regarding the physicochemical characteristics of yogurt, including syneresis, viscosity, color (L, a*, b*), organoleptic properties (taste, aroma, color), pH, total acidity, and antioxidant activity.

2. MATERIALS AND METHODS

2.1 Material

The materials used in the research include fresh cow's milk (from dairy cooperatives in Dau, Malang, East Java, Indonesia), DAL extract, yogurt starter culture (*Lactobacillus bulgaricus*, *Lactobacillus acidophilus*, *Streptococcus thermophilus*, and *Bifidobacterium sp*. in a 1:1:1:1 ratio), 70% alcohol, and tissue. The ingredients used in the preparation of DAL extract are DAL, water, and distilled water. The materials used in the analysis include buffer 4, buffer 7, distilled water, 1% phenolphthalein solution, 0.1 N NaOH solution, and 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution.

The equipment used in the preparation of yogurt sets is categorized into three groups: equipment for DAL extract preparation, equipment for yogurt set preparation, and analysis equipment. The equipment used for DAL extract preparation includes knives, bowls, a blender (Philips), a scale, a sieve, gauze (Onemed brand), and a refrigerator (LG). Equipment used in yogurt set preparation includes stirrers, sieves, measuring cups, spoons, mercury thermometers, gauze (Onemed brand), pots, stoves, label paper, and glass containers. Equipment used for analysis includes centrifuge tubes, a centrifuge operating at 5000 rpm, an analytical balance (electronic scale), an NDJ-10 viscometer, a CS-10 colorimeter, a pH meter, pipettes, syringes, Erlenmeyer flasks, burettes, measuring cylinders, meniscus, and a UV-Vis 721 spectrophotometer.

2.2 Research Method

The research used the Completely Randomized Design (CRD) experimental method, consisting of 4 treatments of DAL extract addition: P0 (control, without addition), T1 (2%), T2 (4%), and T3 (6%) from milk, with 4 replications. Subsequently, the best treatment was determined using 5 respondents and assessed using the De Garmo Effectiveness Index method, where each observed variable was given its respective weighting in all treatments [10].

2.3 The extraction of *Dracaena angustifolia* leaves

The procedure for making DAL extract is referred to by [11] with a slight modification: DAL is washed with running water to remove dirt, followed by blanching. Blanching is carried out by immersing DAL in distilled water at a temperature of 98-100ºC for 1 minute with a ratio of 50 grams of DAL to 100 ml of distilled water. The DAL is drained and cut into pieces with sizes of 5-10 mm, then blended at varying speeds for 1 minute with a ratio of 1:2. The mixture is then filtered using a sieve lined with gauze, resulting in DAL extract.

2.4 The procedure for making set yogurt

The yogurt-making process begins with pasteurizing milk to a temperature of 65-70°C, followed by the addition of DAL extract according to the treatment: P0 (control), P1 (2%), P2 (4%), and P3 (6%) from milk total. During pasteurization, the milk is occasionally stirred and maintained at this temperature for 15 minutes. After pasteurization, the milk is filtered, and a starter inoculation is added at a temperature of 43-45°C, constituting 2% of the milk volume. The milk-starter mixture is thoroughly stirred to ensure even distribution. The inoculated milk is then poured into sterilized glass containers and incubated in an incubator at a temperature of 43-45°C for 6 hours [12,13].

2.5 Syneresis analysis

The syneresistest is determined using centrifugation method according to [14]. The testing begins by preparing the centrifuge tubes. A sample weighing 5 grams is prepared in the centrifuge tube. The sample is then centrifuged at a speed of 2000 rpm for 20 minutes. The liquid part of the yogurt sediment is separated, and then the sediment is weighed in the tube. Syneresis is calculated using the following formula:

Syneresis (%) = $\frac{(A-B)}{A}$ x 100%

Note :

A = Initial weight of the sample before centrifugation (in grams)

B = Final weight of the sample after centrifugation (in grams)

2.6 Viscosity analysis

The viscosity test is conducted using the NDJ-8S viscometer. The viscometer is turned on. Spindle number 3 is attached to the viscometer arm, and the speed is set to 60 rpm for 30 seconds. A sample of 30 ml of yogurt is prepared in a plastic bottle. The sample is immersed until the spindle line boundary is submerged in the yogurt. The spindle is immersed into the yogurt without touching the bottom of the container. The "OK" button on the viscometer motor is pressed to start spinning the spindle. Once the dial needle stabilizes, indicating a stable reading, the spinning is stopped. The reading on the viscometer scale is noted. Each sample is measured three times, and the average value is recorded [15].

2.7 Color (L, a*, b*) analysis

The color (L, a*, b*) test begins by preparing the yogurt set samples to be tested in plastic clips. The Colorimeter CS-10 device is turned on by pressing the start button, which will generate the L, a*, and b* values. Measurements can be taken three times per sample using the triplicate method for each treatment to ensure more accurate values. The color values taken are L, a*, and b*. The L value (lightness) indicates the brightness level ranging from 0 (black) to 100 (white). The a* value indicates the level of redness from 0 to +80 for the red color and 0 to -80 for the green color. Additionally, the b* notation represents the yellowness level, where 0 to +70 is yellow and 0 to -70 is blue. Finally, the color intensity of L, a*, b* is calculated [16].

2.8 Sensory analysis

The sample undergoes sensory quality analysis, including taste, aroma, and color, with the participation of 25 panelists comprised of students from the Faculty of Animal Husbandry, Brawijaya University. A 5-point hedonic scale is employed, ranging from "very like" (score = 5) to "very dislike" (score = 1) [17].

2.9 pH analysis

The pH test begins by preparing a 20 ml sample and a pH meter. The pH meter is turned on and calibrated using pH 4 and pH 7 buffers within the pH range of the yogurt set. Measurement is conducted by dipping the pH meter electrode into the 20 ml sample. The measured result is read from the pH meter [18].

2.10 Total acid analysis

The Total Acidity is determined using the titration method. The testing begins by preparing a sample of 5 mg and adding 10 ml of distilled water to an Erlenmeyer flask. Then, 3 drops of 1% phenolphthalein solution are added as an indicator using a 1 ml syringe. The burette is filled with 0.1 N NaOH solution using a measuring glass and an initial reading is taken from the burette using a meniscus. The yogurt is titrated with 0.1 N NaOHsolution until the yogurt color changes to pink for at least 30 seconds. After titration, the reading on the burette's meniscus is taken again [14]. Total acidity can be calculated using the following formula:

$$\text{Total acid (\%)} = \frac{ml\ NaOH\ x\ 0{,}009\ x\ 100\%}{weight\ of\ sample\ \ (in\ gram)}$$

2.11 Antioxidant activity

The antioxidant activity testing begins by preparing a 1 ml sample of yogurt set in a centrifuge tube using a 1 ml syringe. The yogurt sample is dissolved in PA-grade methanol with a ratio of 1:9. The sample is centrifuged at a speed of 4000 rpm for 10 minutes. 2 ml of the supernatant is collected. A 0.1 mM concentration of DPPH is prepared by dissolving 3.9432 mg of DPPH in 100 ml of PA-grade methanol, and then 2 ml is taken. The supernatant is mixed with the DPPH solution in a 1:1 ratio and homogenized. The mixture is left to stand for 30 minutes at room temperature in a closed condition. A blank is prepared with 2 ml of DPPH added to 2 ml of methanol. The absorbance value of the supernatant is measured using a UV-Vis spectrophotometer at a wavelength of 517 nm. Antioxidant activity can be calculated using the following equation:

$$\text{Antioxidant activity (\%)} = \frac{absorbance\ \ of\ kontrol - absorbance\ \ of\ sample}{absorbance\ \ of\ kontrol} \times 100\%$$

The IC50 value is measured using the linear regression equation y = ax + b, where y represents the % inhibition equal to 50, and x represents the concentration of yogurt extract for which the IC50 value will be determined [19].

Comment [n3]: No result for IC50 was mentioned in the results presentation

2.12 Data analysis

The data on syneresis, viscosity, color (L, a*, b*), organoleptic quality (taste, aroma, and color), pH, and total acidity are analyzed using analysis of variance (ANOVA), followed by the Duncan Multiple Range Test (DMRT) [20].

3. RESULTS AND DISCUSSION

3.1 Syneresis

The determination of syneresis value is one of the critical factors to be considered as it can influence physical appearance and consumer preference. Syneresis in set yogurt with varying concentrations of DAL extract can be observed in Table 1.

Table 1. The Physical Characteristics Value of Set Yogurt Fortified with DAL Extract

Treatment fortified DALExtract (%)	Syneresis (%) ± SD	Viscosity (cP) ± SD	Color ± SD			Sensory analysis ± SD		
			L	a*	b*	Taste	Aroma	Color
0	14.46 ± 0.11	19.10 ± 4.22	83.96 ± 1.48^{b}	-4.03 ± 0.56^{b}	7.97 ± 0.69^{a}	3.14 ± 0.84^{a}	3.26 ± 0.76^{a}	3.29 ± 0.74^{a}
2	14.38 ± 0.22	20.60 ± 1.84	80.89 ± 1.10^{ab}	-6.12 ± 0.33^{ab}	15.68 ± 1.00^{b}	3.41 ± 0.78a	3.52 ± 0.95^{a}	3.54 ± 0.83^{a}
4	14.38 ± 0.32	21.68 ± 1.50	79.03 ± 0.72^{a}	-7.30 ± 0.66^{a}	20.51 ± 0.66^{c}	3.63 ± 0.69^{b}	3.83 ± 0.75^{b}	3.75 ± 0.66^{ab}
6	14.43 ± 0.09	21.95 ± 1.77	77.88 ± 0.82^{a}	-7.88 ± 0.66^{a}	23.79 ± 1.51^{d}	3.94 ± 0.76^{c}	4.01 ± 0.73^{c}	3.94 ± 0.68^{b}

Note: Different superscripts (a, ab, b, c) in the same column indicate significantly different effects among treatments ($P < 0.01$).

The analysis of variance results indicated that the addition of DAL extract did not result in a significant difference ($P > 0.05$) in yogurt syneresis. This is suspected to be due to a weak interaction between the polyphenols in DAL and milk proteins, resulting in suboptimal water binding. According to [21], the interaction between polyphenols and proteins is largely based on several weak interactions. According to [22], a low syneresis value indicates good fermentation product quality, while a high syneresis value indicates weak water-holding capacity, resulting in more nutrients being lost from the solid material due to low gel strength. The low protein-water interaction leads to precipitation, causing protein networks to release water. This results in protein gel contraction, which stimulates curd formation and whey separation.

The average syneresis value of yogurt with the addition of DAL extract ranged from 14.38% to 14.46%. The decrease in syneresis value compared to previous studies indicates an improvement in yogurt quality. According to [23], yogurt produced from cow's milk typically has syneresis values ranging from 26-30%. The reduction in syneresis value is attributed to the polyphenols present in DAL extract interacting with the proteins in milk, thereby altering the protein structure. The formation of bonds between protein and polyphenol below the protein's isoelectric point through hydrogen bonding enhances casein stability and water-holding capacity. This results in reduced syneresis because the casein network's ability to retain water improves [24,25]. According to [21], polyphenols are plant secondary metabolites capable of interacting with proteins, resulting in the formation of complexes between proteins and polyphenols. The interaction between polyphenols in DAL and proteins in yogurt is deemed sufficient to strengthen the yogurt gel structure, thereby causing a decrease in syneresis value.

Table 1 shows that the addition of DAL to yogurt tends to decrease syneresis values. Treatments P1, P2, and P3 exhibit lower syneresis values, which is attributed to the higher concentration of DAL extract compared to treatment P0 (control). According to [26], phenolic compounds naturally occur in plants as secondary metabolites. Phenols are characterized by their ability to bind and form complexes with proteins, affecting solubility. The addition of DAL extract can decrease syneresis values. Lower syneresis values indicate better yogurt quality, whereas higher syneresis values indicate lower yogurt quality. High syneresis values indicated unstable gel bonds and lower yogurt quality [27].

3.2 Viscosity

The analysis of variance indicated that DAL extract at different percentages of addition did not have a significant effect ($P > 0.05$) on the viscosity of set yogurt. This is suspected to be due to the influence of DAL extract containing polyphenolic compounds that disrupt the interaction of milk proteins, thus not significantly affecting viscosity values. This is supported by [28], who stated that there is an interaction between polyphenols and proteins that disrupts milk stability, resulting in the inability to form stable protein networks during yogurt fermentation, leading to unstable gel formation in yogurt.

The average results in Table 1 show that the viscosity values of set yogurt range from 19.10 cP to 21.95 cP. The lowest viscosity value in set yogurt is observed in treatment P0 (control), yielding a value of 19.10 cP, while the highest viscosity value in set yogurt is observed in P3 with the addition of DAL extract at 6%, resulting in a value of 21.95 cP. The viscosity of set yogurt increases with higher percentages of DAL extract addition. According to [29], increased viscosity values occur due to a decrease in pH during the fermentation process, which can cause casein and proteins to coagulate, thereby forming a gel or semi-solid.

The increase in viscosity observed in set yogurt with the addition of DAL extract (*Dracaena angustifolia*) is suspected to be due to the influence of total acidity in set yogurt, which increases and can enhance the coagulation of milk proteins during the fermentation process. This is supported by the views of [30], who suggest that the formation of lactic acid due to lactic acid bacteria (LAB) leads to an increase in total acidity, causing milk casein to coagulate and form a gel. The formation of this gel results in a semi-solid texture and increased viscosity of yogurt. According to [17], higher viscosity values are attributed to the gel formed during the fermentation process, resulting in a semi-solid texture of yogurt. The fermentation process of yogurt involves the breakdown of milk proteins. Lactose in milk is utilized by bacteria as a carbon and energy source, thereby breaking down lactose into simple sugars, namely glucose and galactose, with the help of the enzyme β-galactosidase. At the end of the fermentation process, glucose is converted into the final product, lactic acid [31].

3.3 The Color parameter L* value (Lightness)

The analysis of variance indicated that DAL extract at different percentages has a highly significant effect ($P < 0.01$) onlightness set yogurt. It is suspected that DAL can impart a green color to the set yogurt, resulting in a decrease in brightness (L*) and a tendency towards darker coloration. This is supported by the opinion of [32] that chlorophyll, a green pigment, tends to produce darker colors, so the brightness level will inversely correlate with the amount of chlorophyll in the color measurement results. An increase in chlorophyll content in DAL extract may decrease the brightness level.

The average results in Table 1 show that the lightness (L*) of set yogurt ranges from 77.88 to 83.96. The lowest lightness value (L*) is observed in treatment P3, which involves the addition of 6% DAL extract, resulting in a lightness value (L*) of 77.88. Conversely, the highest lightness value (L*) is observed in treatment P0 (control), which does not involve the addition of DAL extract, resulting in a lightness value (L*) of 83.96. The decrease in lightness intensity (L*) in the set yogurt in this study is attributed to the addition of DAL extract which influences the yogurt color towards greenish tones. As the percentage of DAL increased, the lightness level (L*) of the set yogurt tended to decrease due to the presence of green pigment from chlorophyll.

Based on the analysis of variance, the addition of DAL extract at higher percentages leads to a decrease in the brightness level (L*) of set yogurt. According to [33,34], the notation L represents the parameter of brightness, with a value ranging from 0 (dark) to 100 (bright/white). A brightness value (L*) defines the light that reflects and can produce achromatic, gray, and black colors. [34] explain that a value of L approaching 100 indicates a sample with high brightness (bright) color, while a value of L approaching 0 indicates a sample with low brightness (dark). The decrease in brightness intensity (L*) in set yogurt with the addition of DAL extract is influenced by the percentage added. The brightness intensity (L*) in the study is affected by the DAL extract containing chlorophyll, resulting in a natural green color. The extraction process of DAL using the blanching method preserves chlorophyll, which contributes to the green color of the set yogurt.

3.4 The color parameter a* (redness)

The analysis of variance results indicated that DAL extract at different percentages has a significant effect ($P<0.01$) on set yogurt. This is likely due to the chlorophyll present in DAL imparting green color to the yogurt product, resulting in a decrease in redness (a*) intensity and yielding negative values (-). According to [35], the values of a* represent red-green color. Positive values of a* indicate red color, while negative values of a* indicate green color.

The average results in Table 1 indicated that the redness (a*) of set yogurt ranges from -7.88 to -4.03. The lowest redness (a*) value is observed in treatment P3 with a 6% addition of DAL extract, resulting in a redness (a*) of -7.88, while the highest redness (a*) value is observed in P0 (control), yielding a value of -4.03. Higher redness (a*) values indicate a reddish color of the product. According to [36], positive +a* values result in red color ranging from 0 to +80, while negative -a* values result in green color ranging from 0 to -70.

The increase in DAL extract percentage in set yogurt tends to decrease the redness intensity (a*). This is because DAL extract tend to have a greenish color, which can result in negative redness intensity (a*). According to [11], the intensity of greenish and yellowish colors in the a* value parameter indicates that the sample has colors ranging from green to red. Analysis results showing negative notation in the sample indicate a tendency towards greenish coloration. DAL contain chlorophyll with a high category, thus obtaining a dense green color. The green pigment called chlorophyll in leaves is found in chloroplasts with carotene and xanthophyll, which are present in living organisms used for photosynthesis. Most green-colored plants have two forms of chlorophyll: chlorophyll a, which is less polar and tends to have a blue-green color, and chlorophyll b, which is polar and tends to have a yellowish-green color.

3.5 The color parameter b* (yellowness)

The analysis of variance indicated that DAL extract at different percentages has a highly significant effect (P<0.01) on set yogurt. This is likely due to the presence of chlorophyll pigment in DAL, which imparts a yellowish color, thereby increasing the intensity of the yellow color (b*) in the set yogurt. According to [37], chlorophyll pigments, particularly chlorophyll b, which tends towards a yellowish-green color, are found in DAL.

The average results in Table 1 indicated that the yellowness (b*) of set yogurt ranges from 7.97 to 23.79. The lowest value of yellowness (b*) is observed in treatment P0 (control) with a value of 7.97, while the highest yellowness (b*) is recorded in treatment P3 with a 6% addition of DAL extract, resulting in a value of 23.79. This study demonstrates an increase in the intensity of yellowness (b*) in set yogurt with the addition of DAL extract in treatment P3, which had the highest percentage of extract addition. This is attributed to the presence of chlorophyll pigments in DAL, which can enhance the color value (b*). DAL contained chlorophyll at a concentration of 2053.8 µg/g [38]. According to [39], green leaves have a higher concentration of chlorophyll a compared to chlorophyll b. The formation of chlorophyll a is influenced by light, which reduces protochlorophyllide to chlorophyll a, and then oxidizes it to chlorophyll b. Chlorophyll b is formed in a protected state due to imbalances in the chlorophyll formation process caused by a lack of radiation intensity, and it is not directly affected by light intensity.

3.6 The sensory parameter - Taste

The analysis of variance indicated a highly significant effect (P<0.01) of DAL extract at different percentages on set yogurt. This is likely due to the addition of DAL extract to the yogurt, which enhances its distinctive flavor, thus increasing the level of flavor preference. The average scores presented in Table 1 indicated that the organoleptic taste scores of set yogurt range from 3.14 to 3.94. The lowest organoleptic taste score is observed in treatment P0 (control), yielding a score of 3.14, while the highest organoleptic taste score is observed in treatment P3 with a 6% addition of DAL extract (Dracaena angustifolia), resulting in a score of 3.94.

The results indicated that the taste scores of set yogurt with the addition of DAL extract (Dracaena angustifolia) increase with higher percentage additions while decreasing with lower percentages. The increased taste scores suggest that the yogurt with DAL extract addition produces a less sour taste, thus enhancing likability. According to [40], DAL has a non-bitter taste, pleasant aroma, and cooling properties. [41]also emphasizes that taste is a crucial factor in determining the acceptability of a product by consumers. Taste is perceived by the tongue's taste buds, and categorized into four main sensations: sweet, bitter, sour, and salty, with additional responses to taste modifications.

3.7 The sensory parameter - Aroma

The analysis of variance reveals a highly significant effect (P<0.01) of DAL extract at different percentages on set yogurt. This is attributed to the increased addition of DAL extract, which enhances the distinctive aroma of the set yogurt, resulting in a unique scent. This is supported by [40], who state that DAL has a non-bitter taste, pleasant aroma, and cooling properties, which can enhance the likability of the yogurt aroma. The average results in Table 1 indicate that the aroma scores in the organoleptic test of set yogurt range from 3.26 to 4.01. The lowest aroma score is observed in treatment P0 (control), with a score of 3.26, while the highest aroma score is recorded in treatment P3, with a 6% addition of DAL extract, resulting in a score of 4.01. Increasing the percentage of DAL extract enhances the aroma of the set yogurt.

The aroma scores in the organoleptic test of set yogurt with the addition of DAL extract (Dracaena angustifolia) increase as the percentage of addition increases, while decreasing the addition leads to lower aroma scores. This indicates that lower additions of DAL extract result in a slightly acidic to sour aroma in the set yogurt. According to [42], the composition of compounds related to aroma in food involves both taste and smell. A food item produces aroma as a strong attraction to entice consumers, as it stimulates the sense of smell, thereby arousing appetite. Aroma in food arises due to the formation of volatile compounds, either through enzymatic reactions or without enzymatic involvement [43].

3.8 The sensory parameter - Color

The analysis of variance indicated a highly significant effect (P<0.01) of different percentages of DAL extract on set yogurt. This is likely due to the increasing percentage of DAL extract leading to higher color scores, attributed to the influence of the extract containing chlorophyll, which serves as a natural green colorant. The average results in Table 1 indicated that the color score of the sensory evaluation for set yogurt ranges from 3.29 to 3.94. The lowest color score is observed in treatment P0 (control), yielding a score of 3.29, while the highest color score is seen in treatment P3, with a 6% addition of DAL extract, resulting in a score of 3.94.

The sensory color score of set yogurt with the addition of DAL extract increased with higher percentages of the extract. This is attributed to the green color imparted by the increased presence of DAL extract, making the yogurt visually appealing. Conversely, lower percentages of DAL extract result in a more faded or whitish color. [44]state that DAL extract contains high levels of chlorophyll pigment, thus producing a natural green color that enhances its attractiveness. Color plays a vital role in consumers' visual assessment of a product and can be used to identify its quality.

3.9 pH

Determining pH is a crucial indicator in assessing the quality of yogurt. The pH values of set yogurt with varying concentrations of DAL extract can be observed in Table 2. The analysis of variance reveals that the addition of DAL extract significantly affects (P<0.05) the pH values of yogurt. This is likely due to the presence of polyphenols in DAL, which can enhance the metabolism of lactic acid bacteria (LAB) and lead to a decrease in pH values. According to [45], polyphenolic compounds contribute to increasing the metabolic activity of LAB and the production of lactic acid in larger quantities. Generally, LAB exhibits much higher resistance to polyphenols. Polyphenols stimulate the growth of LAB depending on the concentration of the added substance, resulting in a decrease in pH in yogurt.

The average pH values of yogurt fortified with DAL extract range from 3.7 to 3.83. These pH values deviate from the standards outlined in the Indonesian National Standard [46] for good-quality yogurt, which specifies a pH range of 3.80 to 4.50. The lowest pH value observed in this study resulted from the addition of 2% DAL extract, yielding a pH of 3.70. The decrease in pH can be attributed to the presence of polyphenolic compounds in DAL. These compounds serve as substrates for fermentation bacteria, acting as a source of energy for their survival [47].

DAL have a pH value of 5.76, indicating their acidic nature, which contributes to the decrease in yogurt pH. According to [48], the pH reduction is attributed to the addition of acidic substances, which consequently affect the decrease in yogurt pH. During fermentation, lactic acid bacteria (LAB) produce lactic acid, acetic acid, and citric acid, leading to a decrease in yogurt pH. The organic acids formed dissociate into H+ ions. The greater the amount of acid produced, the more H+ ions are formed, resulting in a decrease in pH value.

Table 2. The Chemical Characteristics Value of Set Yogurt Fortified with DAL Extract

Treatment fortified DALExtract (%)	pH ± SD	Total acid (%) ± SD
0	3,73 ± 0,05^{ab}	0,79 ± 0,12
2	3,70 ± 0,00^{a}	0,82 ± 0,08
4	3,70 ± 0,08^{a}	0,88 ± 0,14
6	3,83 ± 0,05^{b}	0,84 ± 0,08

Note :Different superscripts$^{(a,ab,b)}$in the same column indicate significantly different effect on each treatments(P<0,05)

3.10 Total Acid

The determination of total acidity is a crucial characteristic in the fermentation process of set yogurt. Total acidity in set yogurt with different concentrations of DAL extract can be observed in Table 2. The analysis of variance indicated that the addition of DAL extract does not significantly affect (P>0.05) the total acidity of yogurt. This is presumably due to the interaction of polyphenols present in DAL extract with proteins, resulting in the production of lactic acid, thus leading to a decrease in pH value and an increase in total acidity. As noted by [45], polyphenolic compounds aid in enhancing the capability of lactic acid bacteria (LAB) to generate larger quantities of lactic acid. The formation of lactic acid by LAB elevates the total acidity of yogurt, consequently inducing the coagulation of casein and the formation of gel [49].

The average total acidity values of yogurt with the addition of DAL extract ranged from 0.79% to 0.88%. These values comply with the quality standards outlined in the Indonesian National Standard [46], where the minimum requirement for total acidity in yogurt ranges from 0.5% to 2.0%. The lowest total acidity value was obtained from the control group (P0), while the highest mean value was achieved from the addition of 4% DAL extract, at 0.88%. The increase in total acidity values can be attributed to the presence of polyphenolic compounds in DAL. Polyphenols serve as substrates utilized by lactic acid bacteria (LAB) during the fermentation process. Total acidity values exhibit an inverse relationship with pH values. As total acidity values increase, pH values tend to decrease [50].

The increase in total acidity values occurs due to the interaction between the addition of DAL extract during the fermentation process, thereby affecting the total acidity of yogurt. According to [51], the lactic acid formed is secreted out of the cell and accumulates in the fermentation medium, leading to an increase in the total accumulated acid content and a decrease in pH value. The addition of DAL, which have a pH of 5.76 and are acidic, can be metabolized by *Lactobacillus bulgaricus* bacteria into lactic acid, thereby increasing the amount of lactic acid in the yogurt.

3.11 Antioxidant activity

Set yogurt with the addition of DAL extract exhibits high antioxidant activity, making it suitable as a beverage rich in antioxidants. The results of antioxidant activity testing of yogurt set with the addition of DAL extract are presented in Figure 1.

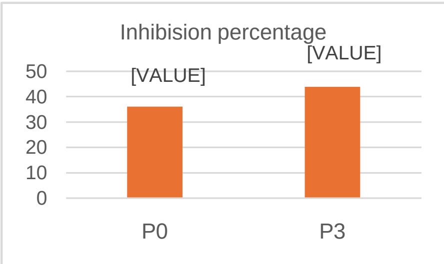

Figure 1. Percentage Inhibition of Samples Against DPPH

The antioxidant activity test results on set yogurt with added DAL extract showed an increase in antioxidant activity. In treatment P3, the inhibition percentage reached 43.826%, which is higher compared to treatment P0 (control) with only 36.087%. According to [2], yogurt initially possesses an antioxidant activity of 19.25%, which increases with the addition of antioxidant-containing substances. DAL extract contains compounds such as flavonoids, tannins, saponins, and polyphenols [52]. [53]noted that polyphenolic compounds can enhance milk stability during heating processes and form stable antioxidant activities. The antioxidant activity of polyphenolic compounds is generated through the neutralization of free radicals or the termination of chain reactions caused by free radicals. Polyphenols are compounds capable of reducing and inhibiting various oxidative reactions [54].

4. CONCLUSIONS

The addition of 6% DAL extract gave the best results with an average value of syneresis of 14.38%, viscosity of 21.95 cP, color brightness (L) 77.88, reddish color (a*) -7.88, yellowish color (b*) 23.79, taste organoleptic test 3.94, aroma organoleptic test 4.01, color organoleptic test 3.94, pH 3.83, and total acid 0.88%.

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