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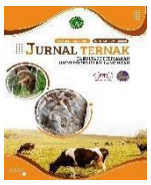

Effect Of Red Dragon Fruit Peel Extract On The Physicochemical Quality Of Greek Yogurt

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ABSTRACT

Greek yogurt is a fermented milk product characterized by a thick texture, high protein content, and physiological benefits for digestive health. Product development efforts focus on enhancing its functional value and sensory attributes. Red dragon fruit peel extract (RDFP) contains bioactive compounds such as anthocyanins and polyphenols, which serve as natural antioxidants and potential natural colorants in dairy products. This study aims to evaluate the effect of adding RDFP on the physicochemical properties of Greek yogurt. A Completely Randomized Design (CRD) was applied with four treatments and four replications, consisting of a control (T0), 10% RDFP (T1), 20% RDFP (T2), and 30% RDFP (T3). Data were analyzed using ANOVA followed by Duncan's multiple range test. The results indicated that RDFP significantly ($P < 0.01$) influenced total acidity, moisture content, total solids, water holding capacity (WHC), syneresis, antioxidant activity, and color parameters (L*, a*, b*). Significant effects ($P < 0.05$) were also observed on pH and viscosity, while protein and fat contents did not differ significantly ($P > 0.05$). The measured values ranged as follows: pH (4.02–4.60), total acidity (2.39–2.75%), protein (2.93–3.40%), fat (11.28–16.18%), moisture (81.51–85.09%), total solids (14.91–18.49%), WHC (67.12–91.60%), syneresis (6.43–37.93%), viscosity (7156.00–9954.50 mPa), antioxidant activity (6.56–225.46 µmol TE/g), L* (80.72–92.47), a* (−1.19–10.90), and b* (10.24–16.08). Overall, the addition of 30% RDFP produced the best balance of visual appeal and functional quality in Greek yogurt.

1. Introduction

Yogurt is one of the fermented products from cow's milk that involves active starter bacteria containing a mixed culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* which produces lactic acid during fermentation [1]. Lactic acid lowers the pH and acts as a preservative because in acidic conditions pathogenic bacteria cannot grow. Yogurt based on its consistency is divided into drink yogurt and greek yogurt [2]. Greek yogurt is called strained yogurt, typically produced as a concentrated, thick, and semi-solid fermented milk product made after the whey is drained, resulting in a denser and creamier product [3].

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Greek yogurt is known to have a protein content of 32%, and carbohydrates of 34% [4]. Greek yogurt is also more popular with the public than drink yogurt, but some groups, such as children, do not like greek yogurt because the dominant color is white. Interest in consuming greek yogurt in the community can be further increased by adding color. The colors added to food products are usually synthetic food colors such as carnosine, 4R, and erythrosine; this will certainly be dangerous if consumed long-term [5]. One of the natural dyes that can be used to replace synthetic dyes is red dragon fruit peel. Anthocyanin pigments have the potential to make red dragon fruit peel a natural dye for food or drinks to provide attractive colors [6].

Red dragon fruit peel (RDFP) extract adds nutritional content and flavor to greek yogurt. The advantage of dragon fruit peel is that it has a fairly high antioxidant content. RDFP extract contains active compounds of the flavonoid and alkaloid groups [7]. The contents of RDFP are betalain compounds, anthocyanins, vitamin C, vitamin E, vitamin A, alkaloids, terpenoids, flavonoids, thiamine, niacin, pyridoxine, cobalamin, phenolics, carotene, and phytoalbumin [6]. Dragon fruit contains 0.17% fat [8]. RDFP contains glucose, maltose, and fructose as natural sugar sources. The sugar contained in RDFP has an effect during the fermentation process on the activity of lactic acid bacteria in producing lactic acid [9].

The advantages of RDFP are that it is rich in polyphenols and is a good source of antioxidants. The antioxidant and antiproliferative activity of RDFP is stronger in inhibiting the growth of cancer cells compared to the fruit [10]. The lower the pH of yogurt and the total acid increases, the level of syneresis tends to increase, which can cause a decrease in the viscosity of the yogurt texture. To reduce syneresis in yogurt, one way is to add stabilizing compounds such as pectin [11]. Dragon fruit peel contains a fairly high amount of pectin, which is 20.1% [12]. RDFP extract added to greek yogurt is an innovation that creates healthy food in greek yogurt. This study aims to determine the addition of RDFP extract to the physicochemical quality of greek yogurt. The results of this study can provide scientific information as a basis for developing processed milk products that are more nutritious, safe, and visually attractive, as well as a reference for the food industry in creating more natural functional yogurt products [9].

2. State of the Art

This study offers a novel approach by examining the use of red dragon fruit peel (RDFP) extract as a functional ingredient in Greek yoghurt formulation, a practice rarely reported in the scientific literature. Previous studies have primarily focused on the use of dragon fruit pulp as a color enhancer and antioxidant in fermented dairy products. In contrast, the utilization of the peel, which is rich in betalain pigments, dietary fiber, and bioactive compounds, has not been widely explored. This study specifically assesses the effect of red dragon fruit peel extract on the physicochemical properties of Greek yoghurt. This approach not only introduces innovation in utilizing dragon fruit peel waste as a source of high-value bioactives but also provides a new contribution to the development of yogurt with high nutritional value and potential as a functional food.

3. Method

3.1. Materials and equipment

The materials employed in the analyses comprised saturated potassium oxalate, 0.1 N NaOH, 1% phenolphthalein indicator, 95% ethanol, 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution, pH 4 and pH 7 buffer solutions, petroleum ether, and distilled water. The preparation of greek yogurt utilized equipment such as electronic and analytical balances, stainless steel pans, gas stoves, Duran glass bottles, thermometers, stirring rods, Herma measuring cups, a 400-mesh sieve, pasteurization pots, Bunsen burners, and refrigerators. For the extraction of red dragon fruit peel (RDFP), Pyrex Erlenmeyer flasks, Pyrex beakers, Herma measuring cups, microwave-assisted extraction (MAE) systems, and microwave evaporators were employed. pH measurements were carried out using PIONEER PX224 digital scales and Eutech PH1500 pH meters. Total acidity was determined using burettes, Erlenmeyer flasks, electronic analytical balances, and 1 mL pipettes. Protein content analysis involved Pyrex Erlenmeyer flasks, PIONEER PX224 digital scales, and burettes. For fat content determination, a Pyrex Soxhlet apparatus, desiccator, oven, mortar, and electronic analytical balances were used. The assessment of water content and total solids employed Petri dishes, ovens, desiccators, and electronic analytical balances. Water holding capacity and syneresis were analyzed using an Oregon LC-04S

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centrifuge, 15 mL centrifuge tubes, and electronic analytical balances. Viscosity measurements were performed using a Brookfield NDJ-8S viscometer, while antioxidant activity was evaluated with a UV-Vis spectrophotometer. Color measurements (L*, a*, b*) were conducted using a PCE-CSM3 colorimeter.

3.2. Methods

This study employed a laboratory-based experimental approach using a completely randomized design (CRD). The experiment included four treatment groups, each replicated four times, resulting in a total of 16 samples. Data were further analyzed using Duncan's multiple range test to identify significant differences among the treatments. The treatments consisted of greek yogurt without red dragon fruit peel (RDFP) extract (T0), and Greek yogurt supplemented with 10% (T1), 20% (T2), and 30% (T3) RDFP extract. The selection of these extract concentrations was guided by findings from previous studies [9].

RDFP extraction

The extraction of RDFP was performed using the Microwave-Assisted Extraction (MAE) technique. Fresh RDFP was first sorted and thoroughly rinsed under running water. The peels were then cut into small pieces, approximately 1–2 cm in size, and weighed to obtain 50 g, which was then mixed with 50 mL of distilled water. The extraction was conducted using MAE at 90°C (medium-high power) for 5 minutes. A 50 mL portion of the resulting solution was collected in a glass beaker and subsequently concentrated using a microwave evaporator at 70°C (medium-high power) for 10 minutes. The final extract was stored in a tightly sealed dark glass bottle to prevent exposure to light and kept in a refrigerator for preservation.

Greek yogurt process

The preparation of greek yogurt started with 500 mL of fresh cow's milk combined with 50 g of skim milk powder, which was gently stirred until fully dissolved. RDFP extract was then added at concentrations of 0%, 10%, 20%, and 30%. Pasteurization of the mixture was performed using a high-temperature short-time process (72 °C for 15 s). The pasteurized mixture was then cooled to 42 °C to support the metabolic activity of lactic acid bacteria. A yogurt starter culture composed of *Lactobacillus* subsp. *bulgaricus* and *Streptococcus thermophilus* was inoculated at 3% (v/v) with an equal proportion of both strains and mixed until uniform. Fermentation was conducted in a styrofoam container at room temperature for 24 h. Following fermentation, the product was strained through a 400-mesh sieve to separate whey, after which it was refrigerated for 4 h to obtain greek type yogurt. The yogurt was then transferred into glass containers and kept under refrigerated storage prior to further analyses.

pH analysis

Yogurt pH was measured using a calibrated digital pH meter. Approximately 30 mL of homogenized sample was placed in a 50 mL beaker, and the pH was recorded after calibration with standard buffer solutions at pH 4.0 and 7.0 [1].

Total acid

Determination of yogurt titratable acidity was carried out by acid–base titration. A 10 mL portion of the sample was transferred into a container, followed by the addition of 1% phenolphthalein indicator. The sample was then titrated with 0.1 N sodium hydroxide solution until the development of a stable light pink color marked the endpoint [13].

Protein content

Yogurt protein concentration was quantified using a formaldehyde-based titration technique. Approximately 2 g of the sample was transferred into an Erlenmeyer flask and diluted with 20 mL of distilled water. A saturated potassium oxalate solution (0.4 mL) and phenolphthalein indicator were subsequently added. The resulting mixture was titrated with 0.1 N sodium hydroxide until the appearance of a persistent pale pink color indicated the endpoint [1].

Fat content

Determination of yogurt fat was carried out through Soxhlet-based solvent extraction. Approximately 5 g of oven-dried yogurt was enclosed in filter paper and inserted into the extraction unit, with a pre-weighed receiving flask placed beneath the chamber. Diethyl ether (500 mL) served as the extracting solvent, and extraction was performed under reflux conditions for about 5 h until the solvent recovered

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in the flask became colorless. The receiving flask was subsequently removed, dried in an oven at 105 °C, and reweighed, with the mass difference used to calculate lipid content [14].

Water content

Water content was determined by a gravimetric oven-drying method. Approximately 5 g of sample was weighed in a pre-dried cup and heated at 100–102 °C for 6 h. The sample was cooled in a desiccator and reweighed repeatedly until a constant mass was achieved, with moisture content calculated from weight loss [1].

Total solid

The determination of total solids is based on the determination of water content. The steps for testing total solids include weighing a petri dish, inserting a 5 g yogurt sample into the dish, and then weighing it, and the dish containing the sample is placed in an oven at 105^{o}C for 24 hours. The sample dish contains a solution in a desiccator and is reweighed, then the results (%) of water content are obtained. Total solids are obtained from 100% minus % water content [15].

Water holding capacity

Water holding capacity (WHC) testing by centrifugation. A 10 g yogurt sample was centrifuged at 3000 rpm for 10 minutes at 4^{o}C. After centrifugation, the supernatant was collected and weighed [15].

Syneresis

The yogurt syneresis test was conducted using centrifugation. The yogurt sample, which weighed as much as 5g, was then centrifuged at 3800 rpm and 10°C for 15 minutes. After that, the sedimentation was weighed [16].

Viscosity

Yogurt viscosity was measured using a digital viscometer (Brookfield NDJ-8S) equipped with spindle No. 4 at 30 rpm and 25 °C. Prior to measurement, samples were gently stirred for 60 s to simulate typical consumer handling. [17]

Antioxidant IC50

Antioxidant activity was evaluated using the DPPH. Methanolic extracts of yogurt were reacted with 0.05% DPPH in the dark for 30 min, and absorbance was measured at 517 nm to calculate IC_{50} values from inhibition curves [18].

L*a*b color

Instrumental color characteristics of the yogurt were assessed using a PCE-CSM3 colorimeter (PCE Americas Inc., FL, USA). Prior to analysis, the device was standardized with a white calibration tile. Color attributes were subsequently recorded in the CIE Lab* system, where L* indicates lightness, a* represents the green (−) to red (+) axis, and b* denotes the blue (−) to yellow (+) axis [19].

4. Results and Discussion

The results of the study on the effect of RDFP extract on the physicochemical quality of greek yogurt are presented in Table 1**.** The parameters analyzed included pH, titratable acidity, total dissolved solids, viscosity, and total lactic acid bacteria. These measurements were conducted to evaluate changes in the physical and chemical properties of greek yogurt due to the addition of RDFP extract at various concentrations.

Table 1. Physicochemical quality greek yogurt

Variable	T0	T1	T2	T3
pH ± SD	4.6±0.08^{b}	4.4±0.18^{ab}	4.2±0.29^{ab}	4.05±0.35^{a}
Total acid (%) ± SD	2.39±0.07^{a}	2.55±0.05^{ab}	2.66±0.19^{c}	2.75±0.07^{c}
Protein content (%) ± SD	3.25 ± 0.14	3.02 ± 0.22	3.40 ± 0.11	2.93 ± 0.52
Fat content (%) ± SD	16.00±4.32	11.28±1.50	16.18±1.66	14.96±2.24

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Water content (%) ± SD	81.51±0.71^{a}	84.14±1.30^{b}	84.54±0.93^{b}	85.09±0.48^{b}
Total solids (%) ± SD	18.49±0.71^{a}	15.86±1.30^{a}	15.46±0.93^{a}	14.91±0.48^{b}
WHC (%) ± SD	91.60±1.17^{b}	77.08±7.89^{a}	77.05±5.01^{a}	67.12±4.79^{a}
Syneresis (%) ± SD	6.43±0.33^{a}	19.93±2.89^{ab}	29.07±6.10^{b}	37.93±3.32^{b}
Viscosity (mPa's) ± SD	9954.50±534.81^{a}	8483.50±850.02^{a}	8433.25±1413.35^{a}	7156.00±1394.61^{b}
Antioxidant IC50 ± SD	225.46 ± 66.45^{d}	51.36 ± 20.46^{bc}	47.96 ± 28.78^{b}	6.56 ± 3.43^{a}
L* color ± SD	92.47±0.26^{b}	87.13±1.34^{ab}	84.50±2.32^{a}	80.72±1.74^{a}
a* color ± SD	-1.19 ±0.21^{a}	4.27±1.47^{ab}	7.44±2.58^{b}	10.90±1.90^{b}
b* color ± SD	16.08 ± 0.52^{b}	12.99±1.82^{ab}	12.18±2.63^{ab}	10.24±2.27^{a}

Means different superscripts (a-c) indicate highly significant differences ($P < 0.01$) in total acidity, water content, total solids, WHC, syneresis, antioxidant activity, and L* a* b* color. Superscripts (a-b) indicate significant differences ($P < 0.05$) in pH and viscosity, while those without notation do not indicate significant differences ($P > 0.05$) in protein and fat content. The samples were T0 (control / no RDFP extract addition), T1 (10% RDFP extract addition), T2 (20% RDFP extract addition), and T3 (30% RDFP extract addition).

4.1. pH

Table 1 showed that the addition of RDFP extract had a significantly different effect ($P<0.05$) on pH. The average pH value ranged from 4.05-4.6. The highest pH, which was 4.6, was obtained from greek yogurt without treatment (T0), while the lowest pH, which was 4.05, was obtained from treatment (T3) with greek yogurt with the addition of 30% RDFP extract. The pH of greek yogurt ranged from 3.58-4.64 [20]. This study shows that the pH is by previous studies. Lactic acid bacteria utilize monosaccharides in red dragon fruit juice during fermentation, producing lactic acid which lowers the pH, so increasing the concentration of red dragon fruit juice further lowers the pH [21]. The pH decreases with increasing amounts of RDFP extract due to the activity of lactic acid bacteria which break down lactose into lactic acid [14]. The lactic acid produced is a product of sugar metabolism, which causes a decrease pH of yogurt. The more sugar that can be metabolized, the more organic acids are produced, so the pH will automatically be lower [22].

4.2. Total acid

Table 1 shows that the addition of RDFP extract had a very significant effect ($P<0.01$) on total acid. The average value of total acid ranged from 2.39-2.75%. The highest total acid, which was 2.75%, was obtained from treatment (T3) with greek yogurt plus 10% RDFP extract, while the lowest total acid, which was 2.39%, was obtained from greek yogurt without treatment (T0). The total titratable acid in greek yogurt ranged from 0.86 to 1.41% [9]. This study showed a higher total acid than the total titratable acid in greek yogurt. Lactic acid bacteria use sugar as an energy source for their growth and produce lactic acid as a metabolite during the fermentation process [20]. Red dragon fruit peel contains glucose, maltose, and fructose as natural sugar sources [9]. The sugar functions for lactic acid bacteria to create acidic conditions by utilizing the nutrients as a food source that is processed into lactic acid, thereby lowering the pH [23]. This opinion is in line with [24], which states that the availability of sufficient nutrients will increase the number of bacterial cells, allowing optimal sugar breakdown, which ultimately increases total acid and lowers pH.

4.3. Protein content

Table 1 shows that the addition of RDFP extract had no significant effect ($P>0.05$) on the protein content. The average protein content ranged from 2.93-3.40%. The highest protein content, namely 3.40%, was obtained from treatment (T2) with greek yogurt with the addition of 20% RDFP extract, while the lowest

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protein content, namely 2.93%, was obtained from treatment (T3) with greek yogurt with the addition of 30% RDFP extract. Greek yogurt in the control treatment (T0) had an average protein content of 3.25% higher than that with the addition of 10% (T1) and 30% (T3) RDFP extract. The factor that influenced the decrease in the protein content of Greek yogurt with the addition of 10% and 30% RDFP extract was the protein content. RDFP extract contains little protein [12]. The protein content of RDFP without treatment is only 8% [25]. The addition of 20% RDFP extract (T2) has the highest protein content of 3.40%, this is in accordance with research conducted Sawitri et al. (2023), the addition of 20% RDFP to frozen yogurt, gives an average protein content value of 4.11% higher than T0.

4.4. Fat content

Table 1 shows that the addition of RDFP extract has no significant effect (P>0.05) on fat content. The average fat content ranges from 11.28-16.18%. The highest fat content, namely 16.18%, was obtained from treatment (T2) greek yogurt with the addition of 20% RDFP extract, while the lowest fat content, namely 11.28%, was obtained from treatment (T1) greek yogurt with the addition of 10% RDFP extract. The fat content of greek yogurt ranges from 0-10.8% [20]. This study shows a higher fat content than the fat content of greek yogurt. The decreased fat content at T1 and T3 can be influenced by the activity of lactic acid bacteria. Lactic acid bacteria absorb the fat content of a material and use it as an energy source for growth [26]. The increased fat content at T0 and T2 can occur because the manufacture of greek yogurt is carried out by treatment so the quality of fresh milk obtained is different. The fat content in yogurt is influenced by the fat content of the mixed ingredients used during manufacture and depends on the type of raw materials used [3]. Yogurt made from cow's milk has a higher fat content. The high amount of fat is due to the use of fresh milk as the main ingredient, which is then supplemented with the addition of skim milk in the yogurt-making process [26].

4.5. Water content

Table 1 indicates that RDFP extract significantly affected the water content of greek yogurt (P< 0.01). The average water content from 81.51-85.09%. Water values increased from 81.51% in the control (T0) to 85.09% in the treatment containing 30% RDFP extract (T3). This progressive rise suggests that the higher intrinsic water content of the RDFP extract contributed to the increased water level of the yogurt. Research conducted by Fitratullah et al. (2019), found that RDFP extract has a water content of 72.15. In addition to RDFP extract incorporation, the use of a liquid starter culture may also contribute to the elevated water content. According [18], the addition of a starter in liquid form can cause the water content of yogurt to be higher because the water contained in it will be greater.

4.6. Total solid

Table 1 varying levels of RDFP extract exerted a highly significant effect on the total solids content (P < 0.01). Total solids values ranged from 14.91% to 18.49%, with the highest proportion observed in the control treatment (T0) and the lowest recorded in treatment T3 containing 30% RDFP extract. The total solids value of greek yogurt decreased due to the addition of RDFP extract which has a fairly high water content. The water content in greek yogurt increases with the increasing concentration of RDFP extract, causing a decrease in total solids and also viscosity [9]. Total solids in milk play a role in forming texture, yogurt with the addition of extract in liquid form has a different texture from the control, the more the addition of extract is, the thinner the yogurt texture [27]. Another factor that can affect the total solids value is the greek yogurt filtration process. Yogurt is filtered for 4 hours in the refrigerator to reduce its water content so that the total solids increase and the texture becomes thicker. The filtration process in greek yogurt makes the total solids higher and the lactose content lower compared to regular yogurt, so the texture becomes thicker or semi-solid [2].

4.7. Water holding capacity

Table 1 increasing levels of RDFP extract exerted a highly significant effect on the water holding capacity (WHC) of greek yogurt (P < 0.01). The WHC values declined progressively from 91.60% in the control treatment (T0) to 67.12% in the formulation containing 30% RDFP extract (T3), indicating a concentration-dependent reduction in water retention capacity. WHC decreased because the RDFP extract contains quite a lot of air, so the more it is added to greek yogurt, the lower its WHC will be. WHC of yogurt is greatly influenced by the condition of casein micelles, especially its hydration properties [19]. pH affects the amount of water incorporated through its effect on the charge on the

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protein, so that at the isoelectric point pH the ability to bind water will decrease due to the increased attraction between protein molecules. The greater the value WHC of yogurt, the better quality of the yogurt produced because it can hold more free water coming out of the yogurt [6].

4.8. Syneresis

Table 1 shows that the addition of RDFP extract has a very significant effect (P <0.01) on syneresis. The average syneresis value ranges from 6.43-37.93%. The highest syneresis, which is 37.93%, was obtained from treatment (T3) with greek yogurt with the addition of 30% RDFP extract, while the lowest syneresis, which is 6.43%, was obtained from the control greek yogurt (T0). Greek yogurt syneresis ranges from 36.84-.67% [17] This study shows that syneresis is in accordance with greek yogurt syneresis. The highest syneresis value occurs because, at a lower pH, the solubility of protein and casein tends to decrease, thereby increasing interactions between proteins and reducing interactions between protein and water [2]. Syneresis occurs due to the shrinkage of the three-dimensional structure of the protein network, which results in the weakening of the protein-whey bond and ultimately separates the whey from the yogurt [17] When the protein network shrinks, the entire structure shrinks proportionally, so that the protein's ability to bind or retain water is lost [28].

4.9. Viscosity

Table 1 shows that the addition of RDFP extract had a significant effect (P<0.05) on viscosity. The average viscosity of greek yogurt ranged from 7156.00 - 9954.50 mPa. The average viscosity of greek yogurt decreased with increasing concentrations of RDFP extract. The highest viscosity of greek yogurt was in the control treatment (T0) of 9954.50 mPa's, while the lowest viscosity was in the treatment of 30% RDFP extract (T3) of 7156.00 mPa's. The viscosity of greek yogurt decreased due to the increasing addition of RDFP extract which resulted in a lower total solid content. In their study stated that the higher the addition of a liquid to a material, the lower the total amount of dispersed solids so a small amount of solid components will cause a decrease in the viscosity value [29]. Viscosity is related to pH value, decreasing pH can cause hydrolysis, resulting in yogurt having different viscosities depending on the acidity of each substrate. Gel formation will also decrease as the pH value decreases because H+ ions play a role in the hydrolysis process of glycosidic bonds [30].

4.10. Antioxidant IC50

Table 1 show that the addition of RDFP extract showed a very significant difference (P <0.01) in antioxidant activity. The average IC50 value of greek yogurt with the addition of RDFP extract was in the range of 6.56 - 225.46. Based on this statement, it can be said that the (T3) greek yogurt sample is included in the very strong category because it has an IC50 value of 6.56, (T2) is also included in the very strong category because it has an IC50 value of 47.96, while the (T1) sample is included in the strong category because it has an IC50 value of 51.36, and the (T0) sample is included in the weak category because the IC50 value is 225.46. The IC50 value is the concentration value of the sample to measure the ability of a sample's antioxidant activity to oxidize free radicals by 50%, the lower the IC50 value, the higher the antioxidant activity [24]. A compound is said to have very strong antioxidant activity if the IC50 value is less than 50, a strong IC50 group between 50-100, a moderate group if the IC50 value is 101-150, and a weak group if the IC50 value is between 150-200 [31], The factor that causes the difference in IC50 values is the difference in the amount of addition in each treatment. Antioxidant activity increases due to the addition of RDFP is dominated by purple, so antioxidant activity is related to anthocyanin content. Anthocyanins in red dragon fruit have antioxidant activity, the more RDFP is added, the stronger the antioxidant activity [32].

4.11. L* color

Table 1 shows that the addition of RDFP extract showed a very significant difference (P <0.01) in the L* color value of greek yogurt. The average value of the L* color value of greek yogurt with the addition of RDFP extract was in the range of 80.72 - 92.47. The treatment with the lowest L* color value was T3 with a value of 80.72, while the treatment with the highest value was T0 with a value of 92.47. Greek yogurt experienced a decrease in the L* color value along with the addition of RDFP extract, this is in accordance with the opinion of [33]. that the increase in color is in line with the increasing concentration of RDFP extract. The L* color value decreased in line with the research of [32], which stated that the more RDFP extract was added 0-15% to cendol, the L* value also decreased 96.16–84.20.

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4.12. a* color

Table 1 shows that the addition of RDFP extract showed a very significant difference (P <0.01) in the a* color value of greek yogurt. The average a* color value of greek yogurt with the addition of RDFP extract was in the range -1.19 - 10.90. The treatment with the lowest a* color value was T0 with a value of -1.19, while the treatment with the highest value was T3 with a value of 10.90. Based on the results of the color analysis of greek yogurt with the addition of RDFP extract, the average a* (redness) color was more than 0. The difference in a* value was based on the difference in the concentration of RDFP extract. The pigment responsible for the red-purple color of dragon fruit is anthocyanin compounds including betacyanin which are abundant in the skin. Red dragon fruit and its skin contain betacyanin pigments which give a purplish red color [34]. Anthocyanin pigments, including betacyanin, apart from influencing the a* value of the sample, can also influence the b* value (yellowness) [19].

4.13. b* color

Table 1 shows that the addition of RDFP extract showed a very significant difference (P <0.01) in the b* color value of greek yogurt. The average b* color value of greek yogurt was in the range of 10.24 - 16.08. The treatment with the lowest b* color value was T3 with a value of 10.24, while the treatment with the highest value was T0 with a value of 16.08. Color analysis of greek yogurt with the addition of RDFP extract showed that the higher the percentage addition, the lower the value or towards blue. This is because the RDFP extract used in the study has a reddish-purple visual color. RDFP contains anthocyanins which are a group of red to blue pigments [35]. Another factor that can be estimated to cause a deep purplish red color in the extract is due to its processing which goes through evaporation which is useful for removing the diluent, namely aquades, so that the color produced after the evaporation process becomes more concentrated [33].

5. Conclusions

In conclusion, the results showed that greek yogurt added with RDFP extract offers an interesting combination of taste and health benefits. RDFP is rich in antioxidants, vitamins, and fiber, which can improve the nutritional quality of greek yogurt. This addition makes yogurt more attractive, both in terms of color and taste, with a touch of sweetness and freshness. In addition, this content can also help improve digestion and strengthen the immune system. The addition of 30% extract is considered the optimal proportion. Therefore, the combination of greek yogurt RDFP extract is an innovative choice for those who want to enjoy healthy and delicious food.

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7. References

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