

# The Effect of Type and Concentration of Thickening Agent on the Thickness Dragon Fruit Jam (*Hylocereus polyrhizus*)

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**Abstract.** Dragon fruit is known for its numerous health benefits. These benefits include slowing premature aging, preventing cancer, boosting immunity, increasing appetite, lowering cholesterol, strengthening bones and teeth, preventing diabetes, promoting eye health, maintaining heart health, and promoting healthy skin.

This study was conducted to determine the effect of the type and concentration of thickening agent on the viscosity of red dragon fruit jam (*Hylocereus polyrhizus*). This study used a Randomized Experimental Design (RAK) in a Split Plot Design (RPT) with 2 factors, namely: the type of thickening agent (pectin, CMC, agar-agar) and its concentration (0.5%; 0.1%; 1.5%), which was continued with the Least Significant Difference (LSD) test if the treatment had a significant effect. The parameters analyzed were pH, water content, viscosity and organoleptic tests (aroma, taste, color, and viscosity).

The results of the study showed that the best treatment for red dragon fruit jam was obtained by adding a thickener of CMC (Carboxyl Methyl Cellulose) with a concentration of 1% which resulted in a water content of 41.09%, a viscosity value of 54 Poise and an average hedonic test value of 4.04.

**Keywords:** Jam, Dragon Fruit, Thickener, Viscosity

## Introduction

Fruit is an agricultural commodity needed by everyone. Fruit is a must-have on the menu because it contains vitamins, minerals, and fiber, which aid metabolism. Botanically, fruit is the part of a plant that surrounds a seed, originating from the ovary or flower itself (Sediaoetomo, 2004).

Dragon fruit contains high levels of fiber, antioxidants, and micronutrients such as vitamin C, vitamin B, calcium, and iron, especially red dragon fruit (Warisno, 2010). Red dragon fruit contains bioactive substances that are beneficial to the body, including antioxidants (in the form of ascorbic acid, beta-carotene, and anthocyanin), and dietary fiber in the form of pectin. Red dragon fruit contains several minerals such as calcium, phosphorus, and iron. The vitamin found in red dragon fruit is vitamin C (Pratomo, 2008).

Fresh red dragon fruit cannot be stored for long periods due to its high water content of 90% (Markakis, 1982). One product diversification effort to increase the utility of agricultural products and increase public interest is the use of red dragon fruit as a raw material for jam. Diversifying dragon fruit into jam can also increase its market value. The red dragon fruit used must be ripe and free from signs of decay (Sidauruk, 2011).

Jam is a semi-solid food ingredient made from 45 parts by weight of ingredients to 55 parts by weight of sugar (Desrosier, 1988 in Aisha Dewi S., 2012). Jam can be defined as a product made from crushed fruit or fruit juice, and sugar is added then heated or cooked until a thick texture is formed. This product is generally not consumed directly but is often used as an additional ingredient to provide flavor and aroma

to white bread (Syahrumsyah et.al., 2010). The principle of jam is fermentation, namely the slow enlargement of the sugar solution into the fruit and vegetable tissue.

Jam quality can be assessed through various aspects, such as color, texture, taste, and aroma. One problem in making fruit jam is texture instability, which results in low viscosity. Thickeners can stabilize the texture and viscosity of food products by forming a gel. This gel formation occurs due to the thickener's ability to bind water (Masdiana Padaga, 2005).

Making jam requires the addition of a thickening agent to achieve good consistency. Therefore, this study will examine the effect of "The Type and Concentration of Thickening Agent on the Viscosity of Red Dragon Fruit Jam (*Hylocereus polyrhizus*).

## Methods

The materials and tools used in this research include product manufacturing materials, analytical materials, product manufacturing tools, and analytical tools. The ingredients used to make dragon fruit jam are red dragon fruit, granulated sugar, citric acid, pectin, CMC, and agar-agar.

The materials used for the analysis were dragon fruit jam samples. The tools used in making the dragon fruit jam were a knife, spoon, pan, stove, scales, blender spatula, and bowl. The tools used for the dragon fruit jam analysis were an oven, a cup, a desiccator, cup clamps, an analytical balance, a pH meter, and a Brookfield viscometer.

The treatment design in the preliminary study was to add citric acid at concentrations of 0.5%, 1%, and 1.5%. The formulation for adding citric acid to dragon fruit jam can be seen in the following **Table 1**.

**Table 1.** Formulation for adding citric acid to make dragon fruit jam

Material	Composition					
	0.5%		1%		1.5%	
	%	Gram	%	grams	%	Gram
Dragon fruit	64.5	322.5	64	320	63.5	317.5
Sugar	35	175	35	175	35	175
Citric Acid	0.5	2.5	1	5	1.5	7.5
Total	100	500	100	500	100	500

The treatment design in the main study used three types of thickening agents: pectin, CMC, and agar-agar, with three dosage levels: 0.5%, 1%, and 1.5%. The formulation of thickening agents added to dragon fruit jam can be seen in the following **Table 2**.

**Table 2.** Formulation for adding thickening agents to dragon fruit jam

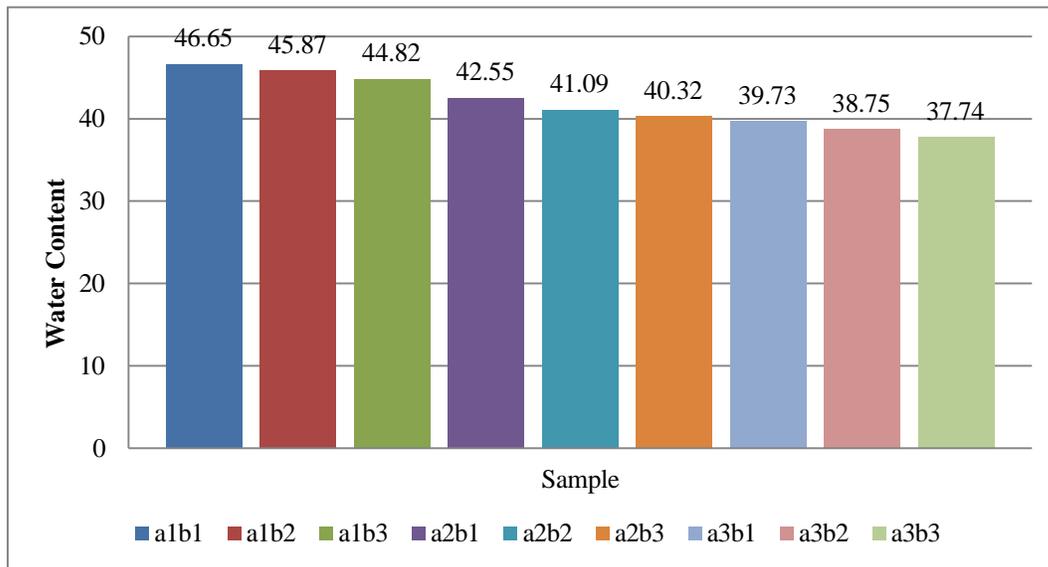
Material	Composition					
	0.5%		1%		1.5%	
	%	grams	%	Gram	%	Gram
Dragon fruit	64	320	63.5	317.5	63	315
Sugar	35	175	35	175	35	175
Thickening agent:						
- Pectin	0.5	2.5	1	5	1.5	7.5
- CMC						
- Agar-agar						
Citric Acid	0.5	2.5	0.5	2.5	0.5	2.5
Total	100	500	100	500	100	500

## Result and Discussion

Results should be clear and concise. The discussion should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

### Water content

Water content is the amount of water contained in a material expressed as a percentage (%). Water content is also a very important characteristic of food ingredients because water can affect the appearance, texture, and taste of food ingredients. Water content in food ingredients also determines the freshness and durability of the food ingredients, high water content makes it easy for microorganisms to multiply, so that changes in food ingredients will occur (Winarno, 2004). The results of the analysis of water content tests on red dragon fruit jam can be seen in **Figure 1**.



**Figure 1.** Average percentage of water content of dragon fruit jam with the addition of pectin, CMC, and agar-agar at concentrations of 0.5%, 1%, and 1.5%.

**Figure 1.** shows that the highest percentage of water content in dragon fruit jam, namely 46.65%, was found in the sample with the addition of 0.5% pectin (a1b1), while the lowest water content of 37.74% was found in the sample with the addition of 1.5% agar-agar (a3b3).

**Table 3.** The Effect of Type and Concentration of Thickener on Water Content of Dragon Fruit Jam

Sample	Average	Notation
a1b1	6.86	h
a1b2	6.8	g
a1b3	6.73	f
a2b1	6.56	e

Sample	Average	Notation
a2b2	6.44	d
a2b3	6.38	c
a3b1	6.34	c
a3b2	6.26	c
a3b3	6.18	a

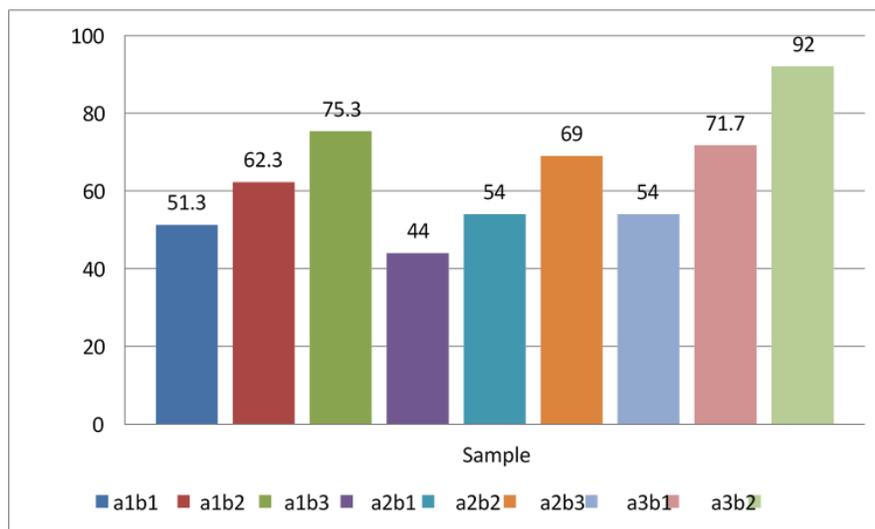
**Table 3.** Shows that there are differences in the addition of types and concentrations of thickening agents to red dragon fruit jam. This is because the type and concentration of thickening agents affect the water content of red dragon fruit jam. The results of the analysis of variance test show that the type and concentration of thickening agents on the water content of red dragon fruit jam do not significantly affect the sample with the addition of 1.5% CMC (a2b3) and the sample with the addition of 0.5% agar-agar (a3b1) but significantly affect the sample with the addition of 0.5% pectin (a1b1), the sample with the addition of 1% pectin (a1b2), the sample with the addition of 1.5% pectin (a1b3), the sample with the addition of 0.5% CMC (a2b1), the sample with the addition of 1% CMC (a2b2), the sample with the addition of 1% agar-agar (a3b3), and the sample with the addition of 1.5% agar-agar (a3b3).

The addition of thickening agents, sugar, and citric acid affects the water content of jam, increasing its viscosity. Thickening agents bind water, increasing the viscosity of the jam and reducing its water content (Dian S. et al., 2010).

The maximum water content for fruit jam is 35% based on SNI 1995. Of the nine red dragon fruit jam samples, the water content obtained did not meet the standard. The red dragon fruit jam with the best water content was selected based on the sample that had the water content closest to the SNI standard. The best water content was in sample a3b3, which is dragon fruit jam with the addition of agar-agar at a concentration of 1.5%. Processing red dragon fruit into jam can reduce the water content contained in the dragon fruit by 40-50%.

#### Viscosity

Viscosity is a measure of friction within a fluid, and is influenced by the number of particles in a solution, and the amount of thickening agent added will affect the viscosity value (Glicksman 1983). The higher the dosage added to red dragon fruit jam, the higher the viscosity value. The results of the viscosity test analysis on red dragon fruit jam can be seen in **Figure 2**.



**Figure 2.** Average percentage of viscosity of dragon fruit jam with pectin, CMC, and agar-agar at concentrations of 0.5%, 1%, and 1.5%.

**Figure 2.** shows that the highest viscosity of dragon fruit jam of 92 poise is found in treatment (a3b3) namely with the addition of Agar-agar with a concentration of 1.5%, while the lowest viscosity of 44 poise is found in treatment (a2b1) namely with the addition of CMC with a concentration of 0.5%. Based on the average viscosity values obtained, it can be seen that the agar-agar thickener has a higher viscosity value, followed by pectin and finally CMC. The difference in viscosity values for each type of thickener is thought to be due to each thickener having a different water-binding capacity.

**Table 4.** The Effect of Thickener Type and Concentration on the Viscosity of Dragon Fruit Jam

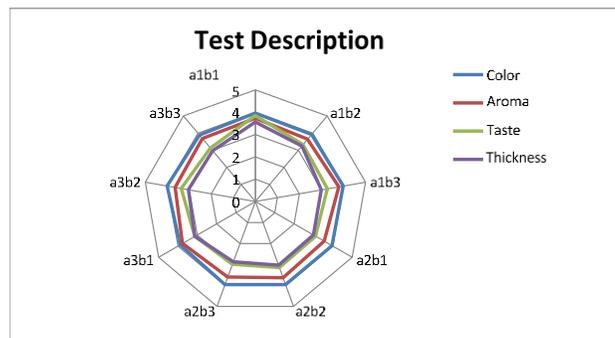
Sample	Average	Notation
a1b1	7.19	b
a1b2	7.92	c
a1b3	8.7	e
a2b1	6.67	a
a2b2	7.38	b
a2b3	8.33	d
a3b1	7.38	b
a3b2	8.5	d
a3b3	9.62	f

**Table 4.** This indicates that there are differences in the type and concentration of thickening agent added to red dragon fruit jam. This is because the type and concentration of thickening agent affect the viscosity of red dragon fruit jam.

The results of the analysis of variance test showed that the type and concentration of thickening agent on the viscosity of red dragon fruit jam did not significantly affect the sample with the addition of 0.5% pectin (a1b1), the sample with the addition of 1% CMC (a2b2), the sample with the addition of 1% CMC (a2b2), the sample with the addition of 1.5% pectin (a2b3), the sample with the addition of 0.5% agar-agar (a3b1), and the sample with the addition of 1% agar-agar (a3b2). However, it significantly affected the sample with the addition of 0.5% CMC (a2b1), the sample with the addition of 1% pectin (a1b2), the sample with the addition of 1.5% pectin (a1b3), and the sample with the addition of 1.5% agar-agar (a3b3).

So far, there is no good standard for jam viscosity. As a comparison, research conducted by Winda WA et al. (2016) with the best results adding 10% carrots to red dragon fruit jam has a viscosity value of 42130 mPas or 42.13 poise. The results of Yuliani HR's research (2011) with the best results, namely the addition of 0.75% pectin and 0.5% citric acid to young coconut shell jam has a viscosity value of 89600 ps or 89.6 poise. Also, the results of Setyaningsih's research (2004) showed the viscosity value of pineapple jam products with the addition of sugar seaweed (1:1:3) which was carried out at 78550 cp or 78.55 poise.

### Organoleptic Color



**Figure 3.** Red Dragon Fruit Jam Description Test

Color is a crucial aspect of consumer acceptance of food products. Color is a primary and most important quality factor compared to other attributes such as taste and texture (Burrows, 2009). Color in food can be a benchmark for quality and can also be used as an indicator of freshness or ripeness (Winarno, 2010).

**Figure 3.** shows the average hedonic test results of the color of dragon fruit jam are in the range between normal and like. The highest value of the panelists' preference for the color of dragon fruit jam was obtained in the treatment of adding pectin with a concentration of 1.5% (a1b3) and adding agar-agar with a concentration of 1% (a3b2). While the lowest value was obtained in the treatment of adding agar-agar with a concentration of 0.5% (a3b1) and adding agar-agar with a concentration of 1.5% (a3b3). The results of the analysis of variance test on panelists' acceptance showed that the addition of the type and concentration of thickening agents did not significantly differ in the color of red dragon fruit jam.

The color of the jam produced by red dragon fruit jam is a deeper red than the original fruit color. According to SNI (1995), the standard color for fruit jam is normal. The color of the dragon fruit jam met SNI requirements because all samples had colors that, according to panelists' acceptance results, fell within the range of "average" to "like."

#### Organoleptic Aroma

Aroma is one of the factors that determines whether a food is acceptable to consumers. A food's aroma largely determines its deliciousness. Foods without aroma are less popular with consumers. Delicious food is characterized by a pleasant aroma (Winarno, 2008).

**Figure 3.** shows that dragon fruit jam with 1.5% pectin added (a1b3) had the most preferred aroma. Meanwhile, the aroma with the lowest preference level was obtained by the treatment with 0.5% CMC added (a2b1).

**Table 5.** The Effect of Type and Concentration of Thickener on the Aroma of Dragon Fruit Jam

Sample	Average	Notation
a1b1	2,054	c
a1b2	2,035	b
a1b3	2,074	d
a2b1	2.01	a
a2b2	2,035	b
a2b3	2,025	a
a3b1	2.06	d
a3b2	2.03	b
a3b3	2.04	b

**Table 5.** This indicates that there are differences in the type and concentration of thickening agent added to red dragon fruit jam. This is because the type and concentration of thickening agent affect the aroma of red dragon fruit jam.

The results of the analysis of variance test on panelist acceptance showed that the type and concentration of thickening agent on the aroma of red dragon fruit jam had a significant effect on the sample with the addition of 0.5% pectin (a1b1) only, while in the other samples the type and concentration of thickening agent on the aroma of red dragon fruit jam did not have a significant effect.

Fruit jam must have a normal aroma (SNI, 1995). A normal aroma can be said to be an aroma that is acceptable to the panelists. Based on the results of the panelists' acceptance, the nine dragon fruit jam samples had a normal aroma because they were at the level of normal to like, so it can be said that the aroma of the red dragon fruit jam was in accordance with the standard.

#### Organoleptic Taste

Taste is the tongue's response to stimuli provided by a food, which is one of the important factors influencing the level of panelist/consumer acceptance of a food product. Taste perception is divided into four tastes: sweet, salty, sour, and bitter (Winarno, 1997).

Taste plays a crucial role in the parameters of a food product. Even if a food product has a good color, aroma, and texture, if it tastes bad, it won't be accepted by consumers.

Figure 3 shows that dragon fruit jam with the addition of agar-agar at a concentration of 0.5% (a3b1) had the most preferred taste. Meanwhile, the lowest preference value was obtained by the treatment with the addition of CMC at a concentration of 1.5% (a2b3).

**Table 6.** The Effect of Type and Concentration of Thickener on the Taste of Dragon Fruit Jam

Sample	Average	Notation
a1b1	2,083	c
a1b2	1,954	b
a1b3	1,944	b
a2b1	1,902	b
a2b2	1,913	b
a2b3	1,871	a
a3b1	1.9	b
a3b2	1.96	b
a3b3	1.9	b

**Table 6.** Shows that there are differences in the addition of types and concentrations of thickening agents to red dragon fruit jam. This is because the type and concentration of thickening agents affect the taste of red dragon fruit jam. The results of the analysis of variance test on panelist acceptance showed that the type and concentration of thickening agents on the taste of red dragon fruit jam had a significant effect on samples with the addition of 0.5% pectin (a1b1) and samples with the addition of 1.5% CMC (a2b3). While in samples with the addition of 1% pectin (a1b2), samples with the addition of 1.5% pectin (a1b3), samples with the addition of 0.5% CMC (a2b1), samples with the addition of 1% CMC (a2b2), samples with the addition of 0.5% agar-agar (a3b1), samples with the addition of 1% agar-agar (a3b2), and samples with the addition of 1.5% agar-agar (a3b3) the type and concentration of thickening agents did not significantly affect the taste of red dragon fruit jam.

Fruit jam must have a normal taste (SNI, 1995). Based on the results of the taste test, the nine red dragon fruit jam samples had a normal taste because it was in the range between normal to like, and it can be concluded that the red dragon fruit jam has a taste that meets the SNI (1995) standard.

#### Organoleptic Viscosity

Figure 3. showed that dragon fruit jam with the addition of CMC with a concentration of 0.5% (a2b1) and agar-agar with a concentration of 0.5% (a3b1) had the most preferred viscosity. Meanwhile, the lowest preference value was obtained by the treatment of adding pectin with a concentration of 1% (a1b2) and a concentration of 1.5% (a1b3), as well as the addition of CMC with a concentration of 1.5% (a2b3).

**Table 7.** Effect of Type and Concentration of Thickener on the Thickness of Dragon Fruit Jam

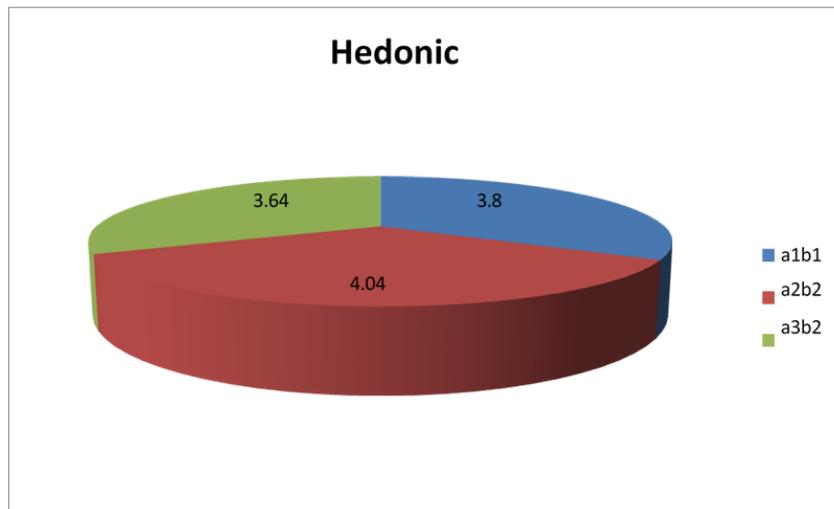
Sample	Average	Notation
a1b1	2,014	d
a1b2	1,934	c
a1b3	1,871	a
a2b1	1.87	a
a2b2	1,881	a
a2b3	1,838	a
a3b1	1.9	b
a3b2	1.88	a
a3b3	1.86	a

**Table 7.** shows that there are differences in the type and concentration of thickening agent added to red dragon fruit jam. This is because the type and concentration of thickening agent affect the viscosity of red dragon fruit jam.

The results of the analysis of variance test on panelist acceptance showed that the type and concentration of thickening agent on the viscosity of red dragon fruit jam had a significant effect on the samples, samples with the addition of 0.5% pectin (a1b1), samples with the addition of 1% pectin (a1b2) and with the addition of 0.5% agar-agar (a3b1). While in samples with the addition of 1.5% pectin (a1b3), samples with the addition of 0.5% CMC (a2b1), samples with the addition of 1% CMC (a2b2), samples with the addition of 1.5% CMC (a2b3), samples with the addition of 1% agar-agar (a3b2), and samples with the addition of 1.5% agar-agar (a3b3) the type and concentration of thickening agent did not have a significant effect on the viscosity of red dragon fruit jam.

There is no standard thickness for fruit jam, the best thickness of red dragon fruit jam is determined based on the level of preference based on the results of panelists' acceptance.

#### Hedonic Test



**Figure 4.** Hedonic Test of Red Dragon Fruit Jam

**Figure 4.** shows that the most preferred red dragon fruit jam is red dragon fruit jam with the addition of CMC at a concentration of 1% (a2b2). Meanwhile, the lowest preference value was obtained by the treatment of adding agar-agar at a concentration of 1% (a3b2).

CMC (Carboxyl Methyl Cellulose) has physical properties that do not alter the aroma, taste, or color of a product. This is why dragon fruit jam with CMC added is the most preferred sample. The results of the analysis of variance of panelists' acceptance showed that the type and concentration of thickener did not significantly affect the level of preference for red dragon fruit jam.

Determination of hedonic test samples based on the average results of the description test of the parameters of color, aroma, taste, and viscosity obtained the most preferred sample by the panelists from each type of thickener. In the pectin thickener, the most preferred result was the pectin sample with an additional concentration of 0.5% (a1b1). In the CMC thickener, the most preferred result was the CMC sample with an additional concentration of 1% (a2b2). And in the agar-agar thickener, the most preferred result was the agar-agar sample with an additional concentration of 1% (a3b2).

### Conclusion

From the results of observations during the research, it can be concluded that the highest water content is 46.65% (a1b1) red dragon fruit jam with the addition of pectin with a concentration of 0.5%. While the lowest water content is 37.74% in sample (a3b3) red dragon fruit jam with the addition of agar-agar with a concentration of 1.5%. The highest viscosity of red dragon fruit jam is 92 Poise in sample (a3b3), namely red dragon fruit jam with the addition of agar-agar with a concentration of 1.5%. While the lowest viscosity is 44 Poise in sample (a2b1), namely red dragon fruit jam with the addition of CMC with a concentration of 0.5%. The results of the analysis of variance show that the addition of the type and concentration of thickening agents to the viscosity of dragon fruit jam is not significantly different in color and hedonic tests, but is significantly different in aroma, taste, water content and viscosity of red dragon fruit jam.

The best sample obtained was the treatment sample (a2b2), namely the CMC type thickener with a concentration of 1%. With a water content of 41.09%, a viscosity of 54 Poise and the results of the hedonic test showed that sample a2b2 was the most preferred sample.

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