The affect of some natural preservative solutions and immersion time on the quality of chrysanthemum cut flowers (Chrysanthemum morifolium L.)

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Abstract. Chrysanthemum morifolium L. is one of the ornamental plants that has problems in maintaining the freshness of the flower. The handling given to maintain the shelf life of the flower is to soak the flowers with a natural preservative solution. This study aims to find out the effect of several types of natural preservative solutions and long soaking on the quality of freshness of chrysanthemum cut flowers, as well as to find out whether there is an interaction between the two treatments. This research was conducted at the Laboratory of Seed Science and Technology and Horticulture Laboratory of the Department of Agrotechnology, Faculty of Agriculture, University of Syiah Kuala, Banda Aceh from March 30 to April 15, 2021. The study used a Complete Randomized Design of a 4 x 3 Factorial pattern with 3 repeats. The parameters observed include the diameter of the full blooming flower, the flower's senescence index, the flower freshness period index, total absorbed solution, color measurement and organoleptic test. The results showed that the combination of treatment between the type of natural solution and the duration of soaking had a very significant effect on the parameters of the total solution absorbed and it had a significant effect on the parameters of the flower freshness index, the texture value of 8 DAT and the overall acceptance value of 10 DAT. The best freshness period of flowers is in the combination of 10% sugar solution type treatment with a 6-hour soaking length.

Keywords: Chrysanthemums, solution, soaking, sugar, freshness, senescence

INTRODUCTION

Chrysanthemum (Chrysanthemum morifolium L.) is one of the ornamental plants used as pot flowers, cut flowers for room decoration or for hand bouquets. Besides being used for ornamental plants, chrysanthemums are also consumed as tea. Chrysanthemum flowers have a variety of beautiful shapes, sizes and colors so that they become the main attraction for consumers. Chrysanthemum flowers with white and yellow colors are more sought after by consumers in the domestic market because they are basic colors that are easy to combine with other colors [22].

Problems that often occur on the business of cut flowers chrysanthemum is the loss results in quality and quantity when handling harvesting and post-harvest such the flowers have withered, broken of stems and leaves and take off the flower petals. The quality of cut flowers that will be marketed is the result from the cultivation of which starts from the selection of varieties in accordance with the climatic conditions and consumer tastes, the process of breeding plants, fertilization, pest and disease control as well as post-harvest handling. The cultivation technique that will either produce a quality cut flowers chrysanthemum in accordance with the needs and market conditions with the quality of the cut flowers that can be seen visually. Post-harvest handling are less well will produce quality results that bad, so it required the effort of handling to keep the resistance of the power save interest. High ambient temperature resulted in cut flowers can not be stored for quite a long time [4].

The freshness and quality of flowers is maintained by applying proper post-harvest handling technology. Without proper post-harvest treatment, fresh produce can decrease by up to 30-40% [20]. One alternative used to maintain the freshness of cut flowers is with a soaking solution. The treatment of flower immersion to maintain the quality of cut flowers...
plants are easily cultivated. This study aims to provide a solution of natural preservatives derived from starfruit juice + 1% sugar that provides the best freshness of cut flowers chrysanthemum.

**METHODOLOGY**

**Materials**

The tools and materials used in this study consisted of 1,000 ml and 100 ml beaker glass, analytical scale, knife, stirring rod, blender, stationery, scissor, fabric filter, camera, 80 pieces of plastic bottles 600 ml, ice boxes, plastic funnels, 80 florets of chrysanthemum cut flowers of Suciyono variety with an efficacy rate of 15-20% derived from Berastagi Flower Garden with a delivery length of 1 day, 6,500 ml of coconut water varieties Dalam Lampah, 2,000 g of betel leaves of Selasih varieties, 1,500 g of green starfruit, 1,000 g of sugar, 35,000 ml of aquadest, label paper, cloth sieve, banana leaves and ice pack.

**Sample Preparation**

**Preparation of the manufacture of aqueous decoction of betel leaf**

Betel leaf which has been sorted then do the washing with running water to remove impurities on the surface. After that, betel leaves weighed as much as 2,000 g and then boiled with the use of distilled water as much as 8 L for ±10 minutes until the stew to a boil. The results of the decoction of the leaves of the betel allowed to advance until warm. Then betel leaf decoction is filtered.

**Preparation of solution of coconut water**

Making a solution of coconut water was carried out with how to choose a coconut that is still fresh. Then coconut water is taken as the 6,500 ml and filtered.

**Manufacture of fruit extract of starfruit**

Star fruit that has been sorted as many as 1,500 g and then washed with running water to remove impurities on the surface. Then starfruit is blended and filtered to obtain the juice.

**Preparation of natural preservative solution 10% sugar solution**

Sugar was weighed as much as 150 g, then dissolved in 1,500 ml of aquadest. After that the solution is put into 18 plastic bottles as much as 500 ml and then labeled according to the treatment.

**Solution of betel leaf and coconut water**

Betel leaf decoction and coconut water were mixed in a ratio of 2:3 and stirred until evenly determine the type of solution and the longer the marinade the most effective to maintain the quality of the freshness of cut flowers chrysanthemum.
The effect of some natural preservative solutions and immersion time on the quality of chrysanthemum cut flowers (Rita Hayati, Ainun Marliah, Rifa Narizky)

Preparation of chrysanthemum cut flowers
Chrysanthemum cut flowers used have a stalk length of about 30 cm with a blooming rate of 15-20%. Before the flower is soaked in a preservative solution, the tip of the stalk is cut about 2 cm in a separate manner so that the absorption of the flower can run well. After the end of the stalk is cut, the flower stalk is put into a plastic bottle that has been filled with each preservative solution with a 20 cm long submerged stalk length.

Each immersion treatment is carried out at different times, namely 2, 4 and 6 hours. After 2, 4 and 6 hours of soaking, the flowers are transferred into 80 plastic bottles that have been filled with 500 ml of aquadest and observed until the 10th day.

Analysis

Diameter of the florescence
The Diameter of the florescence was measured from the outer side of the flower upright using a caliper. This observation was done at 2, 4, 6, 8 and 10 days after treatment (DAT) [12].

Flower wilting index
The flowerness index is done by the scoring method. Changes in the physical appearance of the flower as determining the score of the flower are as follows: a) the flower is in perfect bloom; b) the flower florets are upright with a fresh, brightly colored crown; c) the stem of fresh flowers is green; d) the tip of the flower crown limps, dries, closes (wrinkles) or rolls in; e) the flower crown opens more than 90° against the vertical line; f) drooping stalks at the base of the flower crown, until the flower crown ducks; g) the stalk changes color to brown; and h) there is a change in color to be paler or fade the color of the flower crown [2].

The flower logging test is done using the scoring method, namely by calculating the average score of the panelists. The panelists used were untrained panelists of 10 people. The chrysanthemum cut flowers tested are the whole treatment with 3 repeats. The terms of the score are based on the above description as follows: Score 1 = Fresh (all features a, b, c, described in the text); Score 2 = Starts withering (one or a combination of the features d and e described in the text); and Score 3 = Wither (senescence) (all features f, g and h described in the text) [12].

Flowers vase life index
The freshness of the flowers is seen from the score of the flower's scallops every day for 18 days. Score 3 indicates that it has ended the

Table 1. The arrangement of a combination of solution type treatment and length of immersion to the freshness period of chrysanthemum cut flowers

| Combination of Treatments | Natural Preservative Solution Type Treatment | Length of Immersion (Hours) |
|---------------------------|---------------------------------------------|-----------------------------|
| L₀H₁                      | Control                                     | 2                           |
| L₀H₂                      | Control                                     | 4                           |
| L₀H₃                      | Control                                     | 6                           |
| L₁H₁                      | 10% sugar solution                           | 2                           |
| L₁H₂                      | 10% sugar solution                           | 4                           |
| L₁H₃                      | 10% sugar solution                           | 6                           |
| L₂H₁                      | Decoction of betel leaves + coconut water (2:3) | 2                           |
| L₂H₂                      | Decoction of betel leaves + coconut water (2:3) | 4                           |
| L₂H₃                      | Decoction of betel leaves + coconut water (2:3) | 6                           |
| L₃H₁                      | Starfruit extract 2% + sugar 1%              | 2                           |
| L₃H₂                      | Starfruit extract 2% + sugar 1%              | 4                           |
| L₃H₃                      | Starfruit extract 2% + sugar 1%              | 6                           |

distributed. After that, the solution was put into 18 plastic bottles of 500 ml and then labeled according to the treatment.

Solution of star fruit extract and sugar
The star fruit extract obtained was put into a 1000 ml measuring cup as much as 20 ml then added 10 g of granulated sugar then added aquadest so that the volume became 1000 ml and then stirred. This step is repeated 8 times. After the solution was finished, it was then put into 18 plastic bottles of 500 ml and labeled according to the treatment.
freshness of the flower or the period in which the chrysanthemum cut flower retains its appearance in the vase (day) [12].

**Total absorbed solution (ml)**

Measure the amount of solution absorbed by writing changes in the volume of immersion solution in the measuring glass by using how to measure the initial volume minus the final volume with the following mathematical calculations [28]:

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\text{Total absorbed solution (ml)} = \text{initial volume} - \text{final volume}
\]

**Color rating**

The color value of flowers is measured by looking at the color comparison of chrysanthemum cut flowers using photoshop on photos taken through mobile phone cameras with a resolution of 64 MP that is done after treatment that is 2, 4, 6, 8 and 10 DAT.

The value L indicates the brightness [\(L = 100\) (white) and \(L = 0\) (black)], the value a indicates the color red when it is positive, the gray color when it is worth 0, and the green color when it is negative. While the value b indicates yellow when it is positive, gray when it is worth 0, and blue when it is negative [14].

**Organoleptic test**

Organoleptic tests that will be done by descriptive analysis methods. Descriptive analysis method is the right method because the determination of attributes to be used is determined by researchers and panelists. The attributes used are also based on the quality standards of chrysanthemum flowers. Pre-preliminary tests are required between researchers and panelists. Descriptive analysis methods use panelists who number 10 people and are repeated 3 times on 2, 4, 6, 8 and 10 DAT [14].

**Data Analysis**

The study used a Complete Randomized Design factorial pattern with 2 factors and 3 repeats. The first factor is the influence of 4 types of natural preservative solutions, namely:

- \(L_0\) : Control
- \(L_1\) : 10% sugar solution
- \(L_2\) : Betel leaf stew + young coconut water with a ratio of 2 : 3
- \(L_3\) : Fruit extract 2% + sugar 1%

The second factor is the old influence of soaking consisting of 3 levels, namely:

- \(H_1\) : 2 hours
- \(H_2\) : 4 hours
- \(H_3\) : 6 hours

**RESULTS AND DISCUSSION**

**Diameter of the florescence**

The bloom of the flower indicates that the metabolic process in the flower is still ongoing even though it has been harvested. The relationship between florescence and diameter of the florescence is the bigger level of flowers diameter, so the level of florescence is more bloom. The metabolism that occurs in flowers that have been harvested is respiration and transpiration. This process requires food and water reserves that continue to be used as an energy source so that the longer the thinning which causes marijuana in flowers [28].

| Table 2. Effect of natural and long-soaked preservative solution types on the diameter of chrysanthemum cut flowers at 2, 4, 6, 8 and 10 DAT |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Treatment                  | Diameter of the florescence (mm) | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
| Type of Solution           |                               |       |       |       |       |       |
| Control (L0)               |                               | 39.43 | 43.24 | 50.50 | 43.69 | 36.12 |
| 10% sugar solution (L1)    |                               | 45.91 | 49.94 | 56.67 | 53.74 | 41.17 |
| Decoction of betel leaves + coconut water (2:3) (L2) | | 37.53 | 41.09 | 52.26 | 50.56 | 39.02 |
| Starfruit extract 2% + sugar 1% (L3) | | 45.97 | 49.76 | 48.73 | 46.48 | 36.63 |
| Length of immersion        |                               |       |       |       |       |       |
| 2 Hours (H1)               |                               | 38.92 | 42.78 | 50.63 | 48.10 | 38.48 |
| 4 Hours (H2)               |                               | 42.06 | 45.64 | 52.17 | 48.00 | 38.21 |
| 6 Hours (H3)               |                               | 45.64 | 49.60 | 53.33 | 49.74 | 38.00 |

Note: DAT = Days After Treatment
The results of research that has been done show the maximum bloom of chrysanthemum cut flowers is in 6 DAT. Table 3 shows that the diameter of the flower tends to bloom more on a 10% sugar solution that is not statistically real different from other treatments because sugar is a source of energy for cut flowers that can improve the process of flower blooming during storage [33]. After a perfect bloom, the diameter of the flower blooms is reduced until finally the flower becomes wilted. Flower blooming is influenced by several factors such as proper harvesting techniques, the amount of solution absorbed and the presence of sufficient nutrients. If these factors are not met, then the flowers will not bloom perfectly [9]. The diameter of the flower tends to bloom more at a 6-hour soaking period which is not statistically real with other treatments, but the difference in the diameter of the largest flower bloom is found at a soaking length of 2 hours 6 HSP with 4 DAT, which is 7.85 mm. This is allegedly because the 2-hour immersion time can inhibit the process of tanning flowers because it is not long the flower stalks in the soaking solution [33].

**Flower wilting index**

The ness of the flower is the reduced freshness of the flower because the turgor pressure on the flower decreases. Transpiration process greatly affects the validity of flowers because cut flowers that lose water more than 10-15% will experience a serious withering process [12].

A 10% sugar solution exerts the best effect on chrysanthemum cut flowers in delaying the flower withering process at 10 HSP. This is because in the solution the amount of nutrients needed for flower metabolism is sufficient and adequate so that the process of respiration and transpiration takes place properly. Sucrose giving can increase the level of freshness in cut flowers [18].

Table 3 shows that the better type of solution at 6 HSP to inhibit flower melting is a 10% sugar solution that is not really different from the betel leaf decoction + coconut water (2:3) which is different from real with 2% starfruit extract + 1% sugar and control.

The 2-hour soaking period tends to indicate the best withered index value compared to other treatments. This is because the soaking of flowers that are too long causes blockage around the base of the cut flower stalk. 4-hour soaking causes microbes around flower smoothers and affects the freshness of flowers. 4-hour soaking causes more microbes to grow in the penduculus of the flowers with the results that there is an inhibit that affects the freshness of the flower [33].

**Flowers vase life index**

One of the determinants of the quality of cut flowers from the moment it is harvested until the flower becomes wilted is the period of freshness of the flower. Table 4 shows that the best natural preservative solution in maintaining the freshness of flowers is a 10% sugar solution that is different from other solutions. This is because the nutrient content in a 10% sugar solution meets the substrate's need for respiration and the transpiration process in flowers is well underway. The other solution besides control is also contain nutrition to keep

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**Table 3.** Effect of natural and long-soaked preservative solution types on the withered index of chrysanthemum cut flowers at 2, 4, 6, 8 and 10 DAT

| Treatment                        | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
|---------------------------------|-------|-------|-------|-------|--------|
| Control (L₀)                    | 1.00  | 1.00  | 1.92 b| 2.18  | 2.22 b |
| 10% sugar solution (L₁)         | 1.00  | 1.00  | 1.36 a| 1.60  | 1.63 a |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 1.00  | 1.00  | 1.67 ab| 2.08  | 2.34 b |
| Starfruit extract 2% + sugar 1% (L₃) | 1.00  | 1.00  | 1.97 b| 2.24  | 2.49 b |

LSD₀.₀₅ = 0.38 0.58

The other solution

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

DAT = Days After Treatment
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Table 4. The effect of natural and long-soaked preservative solution on the index of vase life of chrysanthemum cut flowers

| Treatment | Flowers vase life index (day) |
|-----------|-----------------------------|
| Control (L₀) | 11.11 a |
| 10% sugar solution (L₁) | 16.78 b |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 11.33 a |
| Starfruit extract 2% + sugar 1% (L₃) | 10.56 a |

LSD₀.₀₅ 1.63

Length of immersion

| 2 Hours (H₁) | 12.83 |
| 4 Hours (H₂) | 12.67 |
| 6 Hours (H₃) | 11.83 |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

DAT = Days After Treatment

Tabel 5. The effect of natural and long-soaked preservative solution on the total absorbed solution of chrysanthemum cut flowers

| Treatment | Total absorbed solution (ml) |
|-----------|-----------------------------|
| Control (L₀) | 5.42 b |
| 10% sugar solution (L₁) | 2.00 a |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 2.86 a |
| Starfruit extract 2% + sugar 1% (L₃) | 6.00 b |

LSD₀.₀₅ 1.61

Length of immersion

| 2 Hours (H₁) | 4.94 b |
| 4 Hours (H₂) | 4.54 b |
| 6 Hours (H₃) | 2.73 a |

LSD₀.₀₅ 1.61

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

flowers freshness, however it is more amount of nutritional level of sugar solution than the other solution. When the provision of sucrose is accurate and fulfilled, then the freshness of chrysanthemum cut flowers can last longer [12]. The longest freshness period tends to be seen at the length of the 2-hour soaking while the shortest freshness period tends to be longer at 6 hours. This is because a 6-hour immersion will stimulate the flow of water from the solution into the vascular tissue of the stalk to the flower so that it will spur a sudden increase in the volume of water in the vascular tissue system [33]. The addition of water volume in vascular tissue causes plants to increase the process of respiration accompanied by the formation of more active ethylene thus reducing the shelf resistance of flowers [32].

Total absorbed solution (ml)
The presence of an absorbed solution indicates that the flower still absorbs water and nutrients to carry out metabolic processes even though the flower has been harvested. The process of respiration takes place due to the energy reserves in the nutrient content of the soaking solution. In addition to energy providers, the soaking solution serves to replace water loss due to the flower transpiration process [30]. Therefore, the soaking solution should have sufficient nutrients and be easily absorbed by the flower.

Table 5 shows that the type of solution absorbed by chrysanthemum cut flowers is mostly found in 2% starfruit extract + 1% sugar which is not really different from control but is different from betel leaf decoction + coconut water (2:3) and 10% sugar solution. Star fruit extract 2% + sugar 1% more absorbed by cut flowers because the solution is acidic due to the addition of star fruit juice. The pH required in a soaking solution for optimal absorption and no embolism to occur is 3.5-5.0 [5]. The pH of solutions below 4 is more easily absorbed by
chrysanthemum cut flowers [16]. In addition, the administration of certain concentrations of sugar or sucrose in the soaking solution can maintain osmotic pressure [33]. A low pH soaking solution can increase water absorption by the stem, reduce embolism and slow bacterial growth [27].

Absorption of betel leaf decoction solution + coconut water (2:3) and 10% lower sugar solution because the concentration of both solutions is higher and more concentrated than other solutions. The concentration of betel leaf stew in the solution soaking betel leaf decoction + coconut water (2:3) is too high to cause the solution to become hypertonic [10]. The solution is hypertonic because the concentration of liquid in the soaking solution is higher than the concentration of liquid in the flower stalk tissue, so it will trigger osmosis. The water molecules in the stalk will be sucked out due to the difference in osmosis pressure [29]. A 10% sugar solution is difficult to absorb because the concentration of sugar in the solution is very high. The higher the concentration of sugar will inhibit the absorption ability of flowers because the higher the concentration of sugar, the more concentrated the solution will be more difficult to absorb [11].

The length of the 2-hour soak indicates a higher absorption of the solution which is different from the real difference with the 6-hour soaking length but not real contrast to the 4-hour soaking length. The length of the 6-hour soak indicates the lowest absorption of the solution. This is likely due to the time of immersion that is too long to cause blockages around the flower's mouth so that the absorption of water by the flowers is less [33].

**Color rating**

Color measurements on flowers are measured using the Photoshop application of flower images taken through a mobile phone camera with a camera resolution of 64 MP. The results of color measurement due to the influence of several types of natural preservative solutions and long soaking can be seen in Table 6.

**Color L**

The L value in color measurements indicates the brightness level (93.29 - 73.29) in chrysanthemum cut flowers. Table 7 shows that this type of solution does not affect the brightness of the flower, but the brightness value tends to be higher in the controls. This is because the control does not contain dyes. The change in flower color begins to be seen at 6 DAT and begins to fade due to the flower's ness because of the flower had been entered whitering phase and the source of the flowers energy had been exhausted. The process of changing the color of flowers is a common symptom in most cut flowers especially entering the stage of marijuana [21].

The length of the soak does not affect the change in the brightness of the flower. The color value L of the flower in each observation shows a relatively equal value in each treatment. The color value of L in flowers decreases over time. This can be seen from the decrease in the color value of L from the first observation to the last observation at 10 DAT. Generally, the length of the soaking causes the color of the flower to be darker, but chrysanthemum cut flowers with a soaking length of 6 hours have the same color as the 8-hour soaking period due to a saturated soaking solution [26].

**Color a**

The type of natural preservative solution and long soaking effect is not noticeable on the parameters of the color measurement value of a chrysanthemum cut flower. This is because this type of natural preservative solution does not contain green / red dyes so it does not affect the color of the flower. The value a in the color measurement indicates the color of the green/red coordinates ((-1.29) – 8.67). Value a is the parameter used to assess the color change from green to red. If the value a is positive then the color change will go towards red, conversely if the value a is negative then the color change will go in the direction of green [23].

The length of the soak does not affect the change in the green/red color of the flower because of soaking time is only affects how much or not the amount os solution that absorbed. The factors that affects flower color is not found in the duration of immersion but it is found in the type of solution, except the soaking solution has a color substance. The color value of a flower on each observation shows a relatively equal value in each treatment. The color value a on observations of days 2 to 8 after treatment indicates a negative value. This indicates that flowers tend to be green. While on observation 10 HSP the color value a indicates a positive value. This indicates that chrysanthemum cut flowers have experienced marijuana so it tends to be red. The change in color of green to redness in the flower is a clue to know the flower has begun to wither [17].
Table 6. Effect of natural and long-soaked preservative solution types on the color rating value of chrysanthemum cut flowers at 2, 4, 6, 8 and 10 DAT

| Treatment                                      | Colors value |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
|------------------------------------------------|--------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
|                                                |              | 2 DAT                            | 4 DAT                            | 6 DAT                            | 8 DAT                            | 10 DAT                           |                                 |                                 |                                 |                                 |
|                                                |              | L a b                            | L a b                            | L a b                            | L a b                            | L a b                            |                                 |                                 |                                 |                                 |
| Control (L₀)                                   | 89.39 (1.35) | -0.94 10.83 92.44                | -0.67 11.78 95.72                | -0.89 11.78 86.72                | -1.00 10.39 73.94                | 8.67 26.39 b                     |                                 |                                 |                                 |                                 |
| 10% sugar solution (L₁)                        | 92.78 (1.22) | -0.51 8.94 93.00                | -1.17 8.60 86.00                | -0.72 8.28 a 85.83               | -0.94 8.62 79.89                | 0.78 14.22 a                     |                                 |                                 |                                 |                                 |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 92.61 (1.11) | -0.44 8.72 92.22                | -1.17 9.00 87.17                | -1.22 9.89 ab 89.11              | -1.17 9.78 73.78                | 7.67 23.33 ab                    |                                 |                                 |                                 |                                 |
| Starfruit extract 2% + sugar 1% (L₃)           | 93.28 (1.30) | -0.83 8.11 92.39                | -1.06 9.50 86.61                | -0.89 12.28 b 91.28              | -1.22 10.78 74.30                | 7.50 23.44 ab                    |                                 |                                 |                                 |                                 |
|                                                |              |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| LSD₀.₀₅                                          |              | 2.90                             |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| Length of immersion                             |              |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
| 2 Hours (H₁)                                   | 91.96 (1.34) | -1.00 10.17 92.88              | -0.96 9.92 89.21                | -1.25 10.04 91.00                | -1.00 10.08 77.21                | 4.92 (3.69)                     |                                 |                                 |                                 |                                 |
| 4 Hours (H₂)                                   | 91.67 (1.17) | -0.46 8.33 92.67              | -1.04 9.54 84.38                | -0.75 10.92 86.21                | -1.29 9.83 76.00                | 6.33 (3.47)                     |                                 |                                 |                                 |                                 |
| 6 Hours (H₃)                                   | 92.42 (1.23) | -0.67 8.96 92.00              | -1.04 9.67 85.54                | -0.79 10.71 87.50                | -0.96 9.83 73.29                | 7.21 (3.33)                     |                                 |                                 |                                 |                                 |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.
L: Brightness level (L=100 is white, L=0 is black)
a: Coordinates of green/red color (negative values are green, 0 values are gray and positive values are red)
b: Coordinates of yellow/blue color (negative values are blue, 0 values are gray and positive values are yellow)
DAT = Days After Treatment
Color b

This type of natural preservative solution has a real effect on the parameters of color measurement value b chrysanthemum cut flowers at 6 and 10 DAT while the length of soaking has no real effect on the color parameters b chrysanthemum cut flowers. The value b in the color measurement indicates the color of the yellow/blue coordinates (8.11 – 28.39). The value b is the parameter used to assess the color change from yellow to blue. If the value b is positive then the color change will go in the direction of more yellow, conversely if the value b is negative then the color change will go towards blue [23].

Observation of 6 DAT shows that the lowest color value b in flowers is in the 10% sugar solution treatment which indicates that the color of the flower tends to be white so this solution is the best treatment compared to other solutions. Observation of 10 DAT shows that the lowest color value b in flowers is found in the treatment of 10% sugar solution which indicates that the color of the flower begins to yellowish but still maintains the freshness of the flower so that this solution is the best treatment because it is able to maintain the freshness and color of the flower up to 10 DAT. This indicates that the flower soaked with a 10% sugar solution is still fresh and is in a perfect bloom phase because the energy source for the flower is still fulfilled. Sugar in a flower preservative solution serves as an energy source for flowers [4].

The length of the soak does not affect the yellow/blue color change of the flower and the color value of the flower b on each observation shows a relatively equal value in each treatment. The color value b on the flower indicates that the color of the flower tends to be yellowish. The highest color value b in the flower is at 10 DAT which indicates that the color of the flower has yellowed. The yellow color indicates that the flower has undergone undice [31].

**Organoleptic results**

**Color**

Color is a physiological component to receive the perception of light which greatly determines consumer acceptance of a material or product [1]. In order for the color of the flowers to remain attractive, the flowers are given special treatment to maintain the quality of their freshness. This is because this treatment inhibits the process of transpiration and respiration. The process of transpiration and respiration is a metabolic process that requires a substrate so that the process can run so that nutrients in flowers are reduced which results in color changes. The organoleptic value of color is measured by looking at the value given by the panelist, the lower the value, the better the level of favorites of the panelists and vice versa. Organoleptic test results showed that the color of chrysanthemum cut flowers that were treated with a sugar solution of 10% at 8 DAP had better color attributes compared to other solutions. This is because a 10% sugar solution is able to maintain the freshness of the flower so that the color of the flower is brighter and attractive. Attractive flower color provides satisfaction and a sense of pride for consumers [26].

**Table 7. Effect of type of natural preservative solution and soaking time on organoleptic value of chrysanthemum cut flower color at 2, 4, 6, 8 and 10 DAT**

| Treatment | Color | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
|-----------|-------|-------|-------|-------|-------|--------|
| Type of Solution |       |       |       |       |       |        |
| Control (L₀) | 7.52  | 7.52  | 7.45  | 8.09 b | 8.87  |        |
| 10% sugar solution (L₁) | 6.36  | 6.36  | 5.62  | 5.82 a | 6.38  |        |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 6.86  | 6.86  | 5.98  | 7.31 ab | 8.57  |        |
| Starfruit extract 2% + sugar 1% (L₃) | 6.83  | 6.83  | 6.75  | 8.24 b | 9.04  |        |
| LSD₀.₀₅ | 1.74  |       |       |       |       |        |
| Length of immersion |       |       |       |       |       |        |
| 2 Hours (H₁) | 6.39  | 6.39  | 5.91  | 7.10  | 7.96  |        |
| 4 Hours (H₂) | 7.27  | 7.27  | 6.54  | 7.30  | 8.26  |        |
| 6 Hours (H₃) | 7.02  | 7.02  | 6.89  | 7.70  | 8.43  |        |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05. DAT = Days After Treatment
Organoleptic values tended to be higher in the long 6-hour soaking treatment at 10 DAT which indicated that the color of the flowers with this treatment was more brownish compared to other treatments. The lowest organoleptic value at 10 DAT tends to be found in the long treatment of 2 hours of soaking. The longer the flower experiences immersion, the darker or older the resulting color [26].

Texture
The organoleptic value of texture is measured by looking at the value that panelists give to the texture of the flower crown. Low texture value indicates that the flower crown is still tense/hard and vice versa. Organoleptic test results showed that the texture of chrysanthemum cut flowers that were treated with a 10% sugar solution had a more strained texture that was not real different from the solution of betel leaf decoction + coconut water (2:3) but was real different from other solutions at 6 DAT. This is because a 10% sugar solution contains carbohydrates that serve as respiration substrates. The change in the texture of the flower from tense to soft is caused by the process of respiration, so that the reshuffle of carbohydrates into water-soluble compounds is increasing so that the texture of the flower becomes softer [6].

Organoleptic test results showed that the texture of the flowers was relatively the same due to prolonged soaking treatment. Organoleptic values tended to be higher in the 4-hour soaking length at 8 DAT which indicated that the texture of flowers with this treatment was softer compared to other treatments. The lowest organoleptic value at 8 HSP is found at a 6-hour soaking length. Changes in texture are affected by metabolism such as respiration so that cell or tissue damage can occur [24].

Aroma
Aroma is the component that is most noticed by consumers besides attractive colors. The aroma in flowers is produced from the compounds contained in the flower. Commonly found compounds are aliphatic alcohol esters and short-chain fatty acids [15]. The aroma on the flower will disappear as the flower undergoes a withering process. Soaking the flowers with a preservative solution will inhibit the process of withering the flower.

The organoleptic value of the aroma is measured by looking at the value given by the panelist, the higher the value, the more fragrant the flower, the lower the value, the less the flower aroma. Organoleptic test results showed that the scent of chrysanthemum cut flowers treated with a sugar solution was 10% more fragrant at 6 HSP which was different from the controls but not real different from other treatments and at 10 DAT that were not real different from the controls. This indicates that a 10% sugar solution is able to maintain the freshness of the flower so that the flower's aroma remains fragrant. Aroma is a component used as a determinant of the occurrence of damage to the product [13].

Organoleptic test results showed that the aroma of flowers with long soaking treatment was relatively the same. Long soaking does not have an effect on changes in the aroma of flowers. This is because the aroma of flowers is caused by organic compounds in volatile flowers [8].

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**Table 8. Effect of natural and long-soaked preservative solution types on organoleptic values of chrysanthemum cut flowers texture at 2, 4, 6, 8 and 10 DAT**

| Treatment | Type of Solution | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
|-----------|------------------|-------|-------|-------|-------|--------|
| Control   | L_0              | 8.01  | 8.01  | 8.43  b | 9.97  | 9.19   |
| 10% sugar solution | L_1    | 6.44  | 6.44  | 6.31  a | 8.14  | 7.70   |
| Decoction of betel leaves + coconut water (2:3) | L_2 | 7.36  | 7.36  | 7.47  ab | 8.96  | 9.09   |
| Starfruit extract 2% + sugar 1% | L_3 | 7.94  | 7.94  | 8.17  b | 9.51  | 9.25   |
| LSD_{0.05} |                  | 1.47  |       |       |       |        |

**Length of immersion**

| 2 Hours (H_1) | 7.07  | 7.07  | 7.47  | 9.15  | 8.65 |
| 4 Hours (H_2) | 7.66  | 7.66  | 7.70  | 9.22  | 9.00 |
| 6 Hours (H_3) | 7.59  | 7.59  | 7.62  | 9.07  | 8.78 |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of \( \alpha=0.05 \).

DAT = Days After Treatment

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The affect of some natural preservative solutions and immersion time on the quality of... (Rita Hayati, Ainun Marliah, Rifa Narizky)
able to maintain the freshness of the flower so
treatments. This is because the sugar solution is
coconut water (2:3) but is
from the decoction of betel leaves + young
strands is still strong and not easily detached
which indicates that the structure of the flower
cut flowers that are treated with
crown strands are released. The structure of
flower crown are not easily detached, on the
flower petal structure and the strands of the
panelist, the higher the value, the stronger the
measured by looking at the value given by the
Organoleptic value of the structure is

| Structure       | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
|-----------------|-------|-------|-------|-------|--------|
| Control (L₀)    | 8.41  | 8.41  | 7.21 a | 7.77  | 7.00 ab |
| 10% sugar solution (L₁) | 9.22  | 9.22  | 8.38 b | 8.25  | 7.71 b  |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 9.13  | 9.13  | 7.92 ab | 8.69  | 6.36 a  |
| Starfruit extract 2% + sugar 1% (L₃) | 9.21  | 9.21  | 8.16 b | 8.60  | 6.15 a  |
| LSD₀.₀₅        | 0.80  | 1.18  |
| Length of immersion |
| 2 Hours (H₁)   | 9.12  | 9.12  | 7.95  | 8.03  | 6.88   |
| 4 Hours (H₂)   | 9.10  | 9.10  | 7.89  | 8.82  | 6.94   |
| 6 Hours (H₃)   | 8.77  | 8.77  | 7.92  | 8.14  | 6.59   |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

DAT = Days After Treatment

Table 10. Effect of natural and long-soaked preservative solution types on organoleptic values of chrysanthemum cut flower structure at 2, 4, 6, 8 and 10 DAT

| Structure | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
|-----------|-------|-------|-------|-------|--------|
| Control (L₀)  | 8.89 a | 8.89 a | 7.72  | 7.00  | 5.83   |
| 10% sugar solution (L₁) | 10.94 b | 10.94 b | 8.71  | 7.74  | 7.73   |
| Decoction of betel leaves + coconut water (2:3) (L₂) | 10.15 b | 10.15 b | 8.91  | 7.23  | 6.13   |
| Starfruit extract 2% + sugar 1% (L₃) | 9.01 a | 9.01 a | 8.37  | 6.71  | 6.10   |
| LSD₀.₀₅    | 1.00  | 1.00  |
| Length of immersion |
| 2 Hours (H₁) | 9.94  | 9.94  | 8.86  | 7.32  | 6.70   |
| 4 Hours (H₂) | 9.64  | 9.64  | 8.06  | 7.32  | 6.29   |
| 6 Hours (H₃) | 9.66  | 9.66  | 8.35  | 6.87  | 6.36   |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

DAT = Days After Treatment

Structure
The organoleptic value of the structure is measured by looking at the value given by the panelist, the higher the value, the stronger the flower petal structure and the strands of the flower crown are not easily detached, on the contrary the lower the value, the easier the crown strands are released. The structure of chrysanthemum cut flowers that are treated with a 10% sugar solution has the highest value which indicates that the structure of the flower strands is still strong and not easily detached seen at 2 and 4 DAT which is not real different from the decoction of betel leaves + young coconut water (2:3) but is different from other treatments. This is because the sugar solution is able to maintain the freshness of the flower so that the flower crown is not easily detached

Organoleptic test results showed that the structure of flowers with long-standing soaking treatment was relatively the same. The length of the soaking has no effect on changes in the structure of the flower. The structure of flowers due to the length of soaking does not show a difference on the same day of observation but changes in the structure of the flower crown are very visible from the first observation to the last observation. Observations at 10 DAT showed that the structure of the flower was already weak so that the flower crown easily detached due to the flower had withered.
Table 11. Effect of natural and long-standing preservative solution types on organoleptic values of chrysanthemum cut flowers brightness at 2, 4, 6, 8 and 10 DAT

| Treatment                        | Brightness Level |
|----------------------------------|------------------|
|                                  | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
| Type of Solution                 |       |       |       |       |        |
| Control (L0)                     | 7.94  | 7.94  | 7.31  | 7.86 b| 8.84  |
| 10% sugar solution (L1)          | 7.05  | 7.05  | 5.73  | 5.94 a| 6.66  |
| Decoction of betel leaves + coconut water (2:3) (L2) | 7.15  | 7.15  | 6.57  | 7.56 ab| 8.67  |
| Starfruit extract 2% + sugar 1% (L3) | 7.60  | 7.60  | 6.57  | 8.47 b| 9.34  |
| Length of immersion              |       |       |       |       |        |
| 2 Hours (H1)                     | 7.24  | 7.24  | 6.23  | 7.14  | 7.95  |
| 4 Hours (H2)                     | 7.74  | 7.74  | 6.72  | 7.55  | 8.68  |
| 6 Hours (H3)                     | 7.33  | 7.33  | 6.70  | 7.69  | 8.51  |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.
DAT = Days After Treatment

Table 12. Effect of natural and long-soaked preservative solution types on organoleptic values of overall reception of chrysanthemum cut flowers at 2, 4, 6, 8 and 10 DAT

| Treatment                        | Overall acceptance |
|----------------------------------|---------------------|
|                                  | 2 DAT | 4 DAT | 6 DAT | 8 DAT | 10 DAT |
| Type of Solution                 |       |       |       |       |        |
| Control (L0)                     | 7.68 a | 7.68 a | 7.32 a | 6.52 | 5.17 a |
| 10% sugar solution (L1)          | 9.60 b | 9.60 b | 9.58 b | 8.83 | 8.55 b |
| Decoction of betel leaves + coconut water (2:3) (L2) | 9.32 b | 9.32 b | 8.90 b | 7.17 | 5.97 a |
| Starfruit extract 2% + sugar 1% (L3) | 8.29 ab | 8.29 ab | 8.31 ab | 6.70 | 5.25 a |
| LSD0.05                          | 1.46  | 1.46  | 1.37  | 2.02 |        |
| Length of immersion              |       |       |       |       |        |
| 2 Hours (H1)                     | 9.37  | 9.37  | 8.82  | 7.47  | 6.30  |
| 4 Hours (H2)                     | 8.70  | 8.70  | 8.54  | 7.33  | 6.24  |
| 6 Hours (H3)                     | 8.10  | 8.10  | 8.23  | 7.11  | 6.17  |

Note: Numbers followed by the same letter in the same column are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.
DAT = Days After Treatment

Brightness level

The organoleptic value of brightness level is measured by looking at the value given by the panelist, the lower the value, the brighter the brightness level of the flower and vice versa. Organoleptic test results of brightness levels showed that the brightness level of chrysanthemum cut flowers that were given a 10% sugar solution treatment at 8 DAT was brighter which was not different from the decoction of betel leaves + young coconut water (2:3) but was different from other treatments. This is because flowers soaked with a 10% sugar solution still maintain the freshness of the flower. The sugar content in a 10% sugar solution becomes a source of energy for cut flowers so that flower independence can be delayed [4]. Brightness levels tend to be more noticeable at 4-hour soaking lengths at 10 DAT. This indicates that the brightness value of flowers with this treatment is darker compared to other treatments. The longer the flower undergoes immersion, the darker or older the color will be. The color measurements using RHS-MCC, the color value of petal gerbera at 4-6 hours soaking produces a darker color (Dark Green Blue) and more concentrated than the length of 2 hours immersion (Dark Green) [26].

Overall acceptance

The organoleptic value of overall acceptance is measured by looking at the value given by the panelist, the higher the value, the better the level of preference of the panelist and vice versa. the
sugar solution treatment with a 6-hour soaking period optimizes the absorption of nutrients and prolongs the life of the flowers. This is due to the appearance of a higher percentage of the flower that is not really different from the treatment of L_1H_2 and L_2H_2, but is actually different from the treatment of L_0H_1, L_1H_1, and L_2H_1. This shows that the best treatment to maintain the freshness of chrysanthemum cut flowers is a 10% sugar solution with a 6-hour soaking length although the length of immersion has no statistically real effect, but the best length of soaking tends to be seen at the length of the soak for 6 hours. The carbohydrate content in sugar serves as an energy source for flowers to perform respiration and the 6-hour soaking period optimizes the absorption of solutions [4].

**Table 13. Effect of the interaction of solution type and length of soaking on the index of freshness of chrysanthemum cut flowers (day)**

| Type of Solution | Length of immersion |
|------------------|---------------------|
|                  | 2 Hours (H_1) | 4 Hours (H_2) | 6 Hours (H_3) |
| Control (L_0)    | 11.33 Aab       | 12.00 Bb      | 10.00 ABa     |
| 10% sugar solution (L_1) | 17.00 Ba     | 16.00 Da      | 17.33 Ca      |
| Decoction of betel leaves + coconut water (2:3) (L_2) | 11.33 Ab     | 13.67 Cc      | 9.00 Aa       |
| Starfruit extract 2% + sugar 1% (L_3) | 11.67 Ab     | 9.00 Aa       | 11.00 Bb      |

LSD_{0.05} 1.63
Note: Numbers followed by the same letter (lowercase seen by row and capital letter by column) are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

**Table 14. The interaction effect of the type of solution and the duration of immersion on the total solution absorbed (ml)**

| Type of Solution | Length of immersion |
|------------------|---------------------|
|                  | 2 Hours (H_1) | 4 Hours (H_2) | 6 Hours (H_3) |
| Control (L_0)    | 6.25 Bb        | 5.83 Bb       | 4.17 Ba       |
| 10% sugar solution (L_1) | 2.92 Aa     | 1.50 Aa       | 1.58 Aa       |
| Decoction of betel leaves + coconut water (2:3) (L_2) | 4.42 Ab     | 1.25 Aa       | 2.92 ABb      |
| Starfruit extract 2% + sugar 1% (L_3) | 6.17 Bb     | 9.58 Cc       | 2.25 Aa       |

LSD_{0.05} 1.61
Note: Numbers followed by the same letter (lowercase seen by row and capital letter by column) are not significantly different based on the Least Significant Difference (LSD) test at the level of α=0.05.

Panelist's assessment of the appearance leads more to the color and texture of the flower and the absence of damage to the flower [14]. The results of the overall admission organoleptic test showed that most panelists gave the best overall acceptance value on chrysanthemum cut flowers that were given a 10% sugar solution treatment based on attributes seen at 10 DAT that differed markedly from other treatments. This is because the flowers soaked in a 10% sugar solution are still fresh and have an attractive appearance.

Organoleptic test results showed that the value was relatively equal to overall interest acceptance due to prolonged soaking treatment. Organoleptic values tended to be higher in the 2-hour soaking long treatment at 4 DAT which indicated that the value of the interest was preferred compared to other treatments. The least preferred flower is chrysanthemum with a 6-hour soaking. This is due to the appearance of the flower that has a withered part at the end of the petal [26].

**Flowers vase life index**

Table 13 shows that the period of freshness of the interest is higher in the interaction of 10% sugar solution treatment with a 6-hour soaking length that is not really different from the treatment of L_1H_1 and L_1H_2, but is actually different from the treatment of L_0H_1, L_1H_1, and L_2H_1. This shows that the best treatment to maintain the freshness of chrysanthemum cut flowers is a 10% sugar solution with a 6-hour soaking length although the length of immersion has no statistically real effect, but the best length of soaking tends to be seen at the length of the soak for 6 hours. The carbohydrate content in sugar serves as an energy source for flowers to perform respiration and the 6-hour soaking period optimizes the absorption of solutions [4].

**Total absorbed solution (ml)**

Table 14 shows that the highest total absorbed solution was found in the interaction between 2% starfruit extract + 1% sugar solution with 4 hours of immersion which was significantly different from the interactions of other treatments. This indicated that the most easily absorbed treatment was 2% starfruit extract + 1% sugar with 4 hours of immersion. This is because star fruit extract 2% + 1% sugar has a low pH so that it is easily absorbed by flower stalks and 4 hours of soaking time optimizes the absorption of preservative solution.
Soaking solutions with low pH can increase water absorption by stems, reduce embolism and slow down bacterial growth [27]. Soaking for too long causes blockages around the flower pediculus so that less water is absorbed by the flowers [33].

**Organoleptic Results**

**Texture at 8 DAT**

Table 15 shows that the flower texture is in the interaction of 10% sugar solution treatment and 6 hours of soaking which is not significantly different from the interaction of boiled betel leaf + coconut water (2:3) and 4 hours of soaking time, but significantly different from the interactions of other treatments. This shows that the interaction of 10% sugar solution and 6 hours of soaking and boiled betel leaf + young coconut water (2:3) with 4 hours of soaking is better able to maintain the quality of flower texture than other interactions. The 10% sugar solution is able to maintain the flower's texture because it contains carbohydrates which are a source of energy for flowers to carry out respiration. The proper and fulfilled administration of sucrose will cause the freshness of chrysanthemum cut flowers to last longer [12]. Soaking for 6 hours will optimize the absorption of the solution so that the flower texture is maintained.

**Overall acceptance at 10 DAT**

Table 16 showed that the best assessment the panelists gave of overall interest acceptance was in the interaction of 10% sugar solution treatment and the 6-hour soaking length was markedly different from other treatment interactions. This suggests that according to panelists the flowers given the interaction of the L1H3 treatment have the most interesting components. The carbohydrate content in the sugar solution becomes a substrate respiration for the flower so that the freshness of the flower persists and the appearance of the flower is more attractive. Panelists' assessment of appearance leads more to the color, and texture of the flower and the or absence of damage to the flower [15].

**CONCLUSION**

The best type of natural preservative solution to maintain the freshness period of chrysanthemum cut flowers is a 10% sugar solution with a flower freshness period of 16.78 days. The length of soaking is not affect to the quality of flowers freshness.
ACKNOWLEDGMENT

The researcher would like to thank the Faculty of Agriculture, Syiah Kuala University, Banda Aceh, Indonesia, which has supported this research.

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