Physicochemical Profile of Gummy Candy Made From Semboro Orange (*Citrus Nobilis* Lour Var. *Microcarpa* Hassk) And Rosella (*Hibiscus Sabdariffa* L.) Extract with Various Agar Concentration

Riska Rian Fauziah*, Sony Suwasono and Ani Oktafiana

Department of Agriculture Product Technology, University of Jember, Jalan Kalimantan no. 37, Jember, Indonesia
riska_rf.ftp@unej.ac.id

Abstract. Gummy candy is a snack made from sugar or a mixture of sugars with a particular texture and elasticity. The ingredients for the gummy candy in this study included Semboro orange, dried rosella flower and agar powder. The study aimed to determine the effect of variations in the comparison of Semboro orange and rosella extract as well as the concentration of agar powder and to find out the best formulation for Semboro orange and rosella extract gummy candy. This study used a two-factor Completely Randomized Design (CRD) in the form of comparisons of Semboro orange and rosella flower extract (100%:0% (P0); 75%:25% (P1); 50%:50% (P2) and 25%:75% (P3) (v/v)) and the concentration of agar (2% (K1), 3% (K2), and 4% (K3) (w/v)). The results showed that variations in the ratio of Semboro orange and rosella extract and the concentration of agar powder significantly affected the physical and chemical parameters of Semboro orange and rosella gummy candy. The best formulation was obtained from the P2K1 sample with a 50%:50% Semboro orange and rosella extract ratio and 2% agar powder concentration

Keywords: Gummy Candy, Semboro Orange, Rosella, Physicochemical, Agar Concentration.

1 Introduction

Siamese orange (*Citrus nobilis* Lour Var. *microcarpa* Hassk) is a type of citrus widely cultivated in Indonesia because of its high production, reaching 2.4 million tons in 2021 [1]. One of the centers for producing Siamese orange in East Java Province is Jember Regency, more precisely in Semboro District, better known as Semboro orange. In 2020 the yield of Semboro oranges reached 22.211 tons, according to the Jember Regency Central Bureau of Statistics [2]. Horticultural products have mandatory SNI rules, which were implemented by the Government in 2012. The classification of Siamese oranges follows SNI for tangerines [3]. The categories of tangerines based on SNI are divided into four grades, A, B, C and D, based on the diameter (cm) and weight (grams) per fruit. Grade D is often found in local traditional markets with a reasonably cheap selling price. In addition, fresh Siamese oranges are generally easily damaged because

A. Wafa et al. (eds.), *Proceedings of the 8th International Conference of Food, Agriculture and Natural Resources & the 2nd International Conference of Sustainable Industrial Agriculture (IC-FANRes-IC-SIA 2023)*,
Advances in Biological Sciences Research 41,
https://doi.org/10.2991/978-94-6463-451-8_2

content. Therefore, further processing is needed to increase the economic value of grade D Semboro orange.

One of the processes of Semboro orange to increase their selling value is to use them as a primary ingredient in making gummy candy. Gummy candy is a type of snack made from sugar or a mixture of sugar that is liked by all age groups, both children and adults [4]. In the manufacture of gummy candy, a gel-forming agent is needed to form the desired texture. The gelling material used to manufacture gummy candy can be in the form of agar powder. In addition, to add functional value and strengthen the taste of the gummy candy, other ingredients need to be added, one of which can be derived from rosella flower. Rosella flower contain several bioactive compounds, such as flavonoids and anthocyanin pigments, that function as antioxidants [5] and can benefit health.

Research on the formulation of gummy candy using Semboro orange, rosella flower, and agar has never been done before. Therefore, it is necessary to carry out further tests regarding the formulation of the ratio of Semboro orange and rosella flower extract and the proper concentration of agar powder in manufacturing gummy candy.

2 Material and Method

2.1 Materials

Semboro orange from Tanjung Jember traditional market, dried rosella flower, agar powder, water, sucrose and fructose syrup. Analytical materials include distilled water, 1% starch solution, $CaCO_3$, $(Pb(CH_3COO)_2$, CaC_2O_4, Nelson A and B solutions, arsenomolybdate solution, 0.001 N iodine solution, $Na_2S_2O_3$, DPPH solution, 96% ethanol and ascorbic acid.

2.2 Preparation of Semboro Orange and Rosella Extract

Semboro orange is obtained by cutting the orange into two parts and squeezing them using an orange press. In contrast, rosella flower extract is obtained by brewing 5 g of rosella flowers in 450 ml of water at 80°C for 5 minutes. The mixture obtained was filtered to obtain rosella flower extract.

2.3 Preparation of Gummy Candy Semboro Orange and Rosella Extract

Gummy candy making refers to research [6] with modifications. Other ingredients such as 25% (w/w) sucrose, 12.5% (w/w) fructose syrup, water, and 2%, 3%, and 4% (w/v) agar powder were heated at 80°C for ± 3 minutes until the sucrose melted. Semboro orange and rosella flower extract are added and reheated for ± 5 minutes. These ingredients are then poured into a baking dish and cooled until it hardens at room temperature. The hardened gummy candies were cut into 1 x 1 x 1 cm sizes and arranged in a tin for further drying in a cabinet dryer at 50°C for 24 hours. The dried gummy candy was analyzed for its physical, chemical, and organoleptic parameters.

2.4 Physical Analysis

Texture. Texture parameters were measured using rheotex [7]. Measuring the texture of the gummy candy is set to a depth of 5 mm. The number indicated by the rheotex needle is the texture value of the sample in units of g/mm. Measurements were made at three different points. The texture value can be obtained from the average measurement value or using Eq. 1:

$$\text{Texture} = \frac{X1+X2+X3}{3} \text{ g/5 mm} \qquad (1)$$

2.5 Chemical Analysis

Moisture Content. Testing the water content of gummy candy using the gravimetric method [8]. Water content can be calculated using Eq. 2:

$$\text{Moisture content (\%)} = \frac{B-C}{B-A} \text{ x } 100\ \% \quad (2)$$

with,
A: weight of the empty weighing bottle
B: weight of weighing bottle + sample (before drying)
C: weighing bottle weight + sample (after drying)

Reducing Sugar Levels. Testing for reducing sugar levels using the Nelson Somogyi method [9]. Reducing sugar content is calculated using Eq. 3:

$$\text{Reducing sugar content (\%)} = \frac{Reducing\ sugar\ (mg) \times Dilution\ factor}{Sample\ weight\ (mg)} \times 100\% \quad (3)$$

Vitamin C Levels. Testing vitamin C gummy candy levels using the iodometric titration method [10]. The titration method determines vitamin C in the form of ascorbic acid. Vitamin C levels can be calculated using Eq. 4:

$$\%\ \text{vitamin C} = \frac{Titration\ volume \times Dilution\ factor \times Ascorbic\ acid\ content}{Sample\ weight} \times 100\% \quad (4)$$

Antioxidant Activity. Testing the antioxidant activity of gummy candy using the DPPH method [11]. Antioxidant activity is expressed in % inhibition. Antioxidant activity is determined through the following Eq. 5:

$$\text{Antioxidant activity} = \frac{Absorbance\ of\ blank - Absorbance\ of\ sample}{Absorbance\ of\ blank} \times 100\% \quad (5)$$

2.6 Organoleptic Test

Gummy candy organoleptic test using a preference test with 25 untrained panelists carried out tests [12]. Parameters tested include color, taste, texture, aroma, and overall. The level of liking is measured by a rating scale including 1 (dislike very much) - 7 (like very much).

2.7 Effectiveness Test

The effectiveness test was used to determine the best formulation for the gummy candy that had been made. The effectiveness test is based on the effectiveness index [13].

2.8 Statistical Analysis

All analyses were carried out in triplicate. Data were analyzed by the analysis of variance (ANOVA) at the 95% confidence level using the IBM SPSS software version 25.0. Duncan's new multiple-range test compared means with a significant difference ($p<0.05$). The organoleptic test was analyzed by the chi-square method.

3 Results and Discussion

3.1 Physical Analysis

Texture. Texture analysis needs to be done to determine the hardness of gummy candy, which is one of the essential criteria in gummy candy products. The higher the hardness value, the more complex the gummy candy, while the smaller the hardness value, the softer the gummy candy. The results of the analysis of the hardness value of the gummy candy using rheotex are presented in Table 1. The texture of the gummy candy gets more complicated as the concentration of the agar powder used increases. This is because agar-agar powder as a hydrocolloid can form a gel in water and is reversible. It melts when heated and forms a gel again when cooled. A heating process with a temperature higher than the gelling temperature of the agar powder will cause the polymer in the solution to become a random coil. If the temperature is lowered, the polymer will form a double helix structure, and if the temperature drop continues, the polymer will be cross-linked tightly. An increase in helical shape will form

aggregates which act to form a firm gel [14]. In addition, the texture of the gummy candy was also influenced by the ratio of Semboro orange and rosella extract used. This is because acidity (pH) dramatically affects the gel strength of the agar powder due to the inversion of the sucrose used. This inverted sucrose will become reduced sugar so that it will not form crystals and produce soft candy [15].

Table 1. The results of the analysis of the physical parameters of gummy candy

Sample	Texture (g/mm)
Semboro orange : rosella (100%:0%); agar powder 2%	41,11[a]
Semboro orange : rosella (100%:0%); agar powder 3%	154,67[h]
Semboro orange : rosella (100%:0%); agar powder 4%	254,11[j]
Semboro orange : rosella (75%:25%); agar powder 2%	64,56[d]
Semboro orange : rosella (75%:25%); agar powder 3%	212,00[i]
Semboro orange : rosella (75%:25%); agar powder 4%	270,56[k]
Semboro orange : rosella (50%:50%); agar powder 2%	44,22[b]
Semboro orange : rosella (50%:50%); agar powder 3%	130,89[g]
Semboro orange : rosella (50%:50%); agar powder 4%	302,11[l]
Semboro orange : rosella (25%:75%); agar powder 2%	56,89[c]
Semboro orange : rosella (25%:75%); agar powder 3%	88,22[e]
Semboro orange : rosella (25%:75%); agar powder 4%	107,56[f]

Remarks: *Mean values within a column followed by the same letters are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test.

3.2 Chemical Analysis

Moisture Content. Determination of water content is carried out to determine the amount of water bound by the solid components of the material. The water content in a material can determine its appearance, texture, and ability to withstand the attack of microorganisms related to the shelf life of a food product. Testing the water content of the Semboro orange and rosella extract gummy candy is presented in Table 2. Increasing the agar concentration causes an increase in the water content of the gummy candy. This is due to the ability of agar as a lipophilic colloidal compound that can bind water so that the water trapped in the molecular structure of agar increases as the amount of agar is increased [16]. Therefore, the more agar added, the greater the amount of bound water than the amount that evaporates during the cooking process [17].

Reducing Sugar Levels. Reducing sugar is a category of sugar that can be reduced due to free aldehyde or ketone groups. Monosaccharides which include reducing sugars include glucose, fructose, lactose, maltose, and galactose. The results of testing the reduced sugar content in the Semboro orange and rosella extract gummy candy are presented in Table 2. The reduced sugar content of the gummy candy was higher as the addition of rosella flower extract and agar powder increased. The increase in reducing sugar was due to the presence of sucrose in the raw material, the addition of sucrose to the gummy candy dough, and polysaccharides in agar powder. In addition, adding more rosella extract causes the gummy candy dough to have a lower pH so

that it can trigger an inversion when the cooking process takes place. Acids, heat, and mineral content reactions can affect the inversion process. Sucrose is non-reducing because it does not have a reactive OH group, but in the presence of acid, sucrose, and polysaccharides will be hydrolyzed with the help of heat to become inverted sugars in the form of glucose and fructose [18].

Vitamin C Levels. Vitamin C can increase the body's resistance to disease and is an antioxidant that neutralizes toxins and free radicals in the blood and body-cell fluids. The results of measuring vitamin C in the Semboro orange and rosella extract gummy candy can be seen in Table 2. Vitamin C levels increased with increasing agar-agar powder added and decreased with reduced Semboro orange. The more ingredients containing vitamin C are added, the higher the vitamin C content will be [19]. In addition, using agar-agar powder as a hydrocolloid can increase vitamin C, a hydrocolloid substance that can bind water. High agar concentrations can form stronger colloidal dispersions (double helix structure) to inhibit the oxidation of vitamin C and protect vitamin C more strongly with a strong matrix [20].

Antioxidant Activity. Antioxidant activity testing was carried out using the DPPH (2,2 diphenyl-1-picrylhydrazyl) method, which is considered more superficial, more accessible, faster, and more sensitive and only requires a small number of samples compared to other methods. The results of measurements of vitamin C in the resulting Semboro orange and rosella extract gummy candy can be seen in Table 2. The increased antioxidant activity occurred with increasing rosella extract and agar powder added. This is because rosella flower extract has more bioactive components than Semboro orange in alkaloids, tannins, phenolics, flavonoids, steroids, terpenoids, and saponins [21]. In addition, the use of agar powder in manufacturing gummy candy is thought to protect antioxidant compounds from damage. This is because the agar powder has more hydroxyl groups, so the ability to form a double helix structure is high. The more double helix formed, the stronger the ability to protect antioxidant compounds in a three-dimensional matrix from heating and oxygen so that many antioxidant compounds are not damaged [22].

Table 2. Results of chemical parameter analysis of gummy candy

Sample	Moisture content (%)	Reducing sugar level (%)	Vitamin C level (%)	Antioxidant activity (%)
Semboro orange : rosella (100%:0%); agar powder 2%	28,47^{a}	22,80^{bc}	0,04^{h}	26,14^{a}
Semboro orange : rosella (100%:0%); agar powder 3%	29,57^{b}	20,43^{a}	0,05^{i}	26,43^{a}
Semboro orange : rosella (100%:0%); agar powder 4%	33,81^{f}	23,80^{ef}	0,07^{j}	26,38^{a}

Semboro orange : rosella (75%:25%); agar powder 2%	28,39[a]	23,07[cd]	0,04[fg]	27,53[b]
Semboro orange : rosella (75%:25%); agar powder 3%	28,68[a]	22,40[b]	0,04[fg]	27,41[b]
Semboro orange : rosella (75%:25%); agar powder 4%	31,48[e]	24,28[f]	0,04[gh]	29,40[c]
Semboro orange : rosella (50%:50%); agar powder 2%	28,88[a]	23,51[de]	0,04[de]	30,26[d]
Semboro orange : rosella (50%:50%); agar powder 3%	30,73[cd]	23,61[de]	0,03[cd]	36,65[f]
Semboro orange : rosella (50%:50%); agar powder 4%	31,30[de]	24,94[g]	0,04[ef]	33,47[e]
Semboro orange : rosella (25%:75%); agar powder 2%	28,89[a]	24,91[g]	0,02[a]	40,07[h]
Semboro orange : rosella (25%:75%); agar powder 3%	30,19[c]	25,48[g]	0,03[b]	38,90[g]
Semboro orange : rosella (25%:75%); agar powder 4%	31,46[e]	26,30[h]	0,03[c]	43,67[i]

Remarks: *Mean values within a column followed by the same letters are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test.

3.3 Organoleptic Test

Color. Color is one of the sensory properties of food products which is a determining factor for quality and a determinant of consumer acceptance for consuming these products. Therefore, color becomes an essential part of food properties. The color sensory test values can be seen in Figure 1. The chi-square test results at a significant level of 5% treatment of variations in the comparison of Semboro orange and rosella extract and the addition of agar powder had no significant effect on the color preference of gummy candy. The addition of Semboro orange and rosella extract as much as 25%:75% and agar powder as much as 4% in the manufacture of gummy candy makes the color of the gummy candy dark yellow. The color of the gummy candy is mostly determined by the natural color of the rosella extract, namely the anthocyanin pigment. In addition, adding the same sugar to each gummy candy treatment will cause a caramelization process to occur so that the resulting chocolate color is relatively the same [23].

Aroma. Aroma is an essential indicator in the food industry because it can quickly assess whether or not the product is accepted [24]. The value of the sensory aroma test can be seen in Figure 1. The results of the chi-square test at a significant level of 5% treatment of variations in the comparison of Semboro orange and rosella extract and the addition of agar powder had no significant effect on the preference for the aroma of gummy candy. Aroma is a particular substance or component with several functions in food because it can attract consumer preferences. The most preferred gummy candy aroma by the panelists was dominated by the distinctive aroma of rosella and orange, which comes from volatile components such as ethanal, octanal, nonanal, citral, ethyl butanoate, d-limonene, α-pinene [25]. In addition, hydrocolloid compounds do not have volatile components, so they do not significantly affect the aroma of gummy candy [26].

Taste. The taste of food is an essential factor because it can determine the consumer's final decision to accept or reject food. The value of the sensory taste test can be seen in Figure 1. The addition of more rosella extract causes the level of preference for the gummy candy flavor to increase. The addition of rosella extract causes the pH of the mixture to get lower so that the taste of the gummy candy is sour. The pH of rosella extract ranges from 1.35 to 3.46 [27]. In addition, the value of the taste attribute of gummy candy tends to decrease with the addition of more and more agar powder. The decrease in taste is suspected because the more agar powder added will cover the taste of the Semboro orange and rosella. The gelling agent can cause a foreign taste in gummy candy [28].

Texture. Texture can be felt through taste or touch, which is vital because it gives an impression of the product's characteristics. The value of the texture sensory test can be seen in Figure 1. The gummy candy that the panelists liked was gummy candy which has a chewy and elastic texture. Panelists generally judged the texture of the gummy candy by pressing with their fingers and during chewing. The addition of too high agar causes the texture of the gummy candy to get more complex than gummy candy which adds a little agar powder. This is because agar powder can quickly form a gel. After all, it dissolves easily in water. Increasing the hydrocolloid content in food formulations will increase the thickness of the product [29].

Overalls. Organoleptic tests are carried out to determine preferences or acceptance of a product that is produced and require several panelists to represent sure consumers. The results of this preference test are the key to consumers' acceptance or rejection of products. The overall test value of gummy candy can be seen in Figure 1. Several factors influence a person's preference for a product such as taste, appearance, attractiveness, high nutritional content, and benefits for the body [30]. The addition of rosella extract at a concentration of 50% with 2% agar powder gave an excellent impression to the panelists, as evidenced by the assessment of the color, aroma, taste, and texture attributes which had a relatively favorable rating.

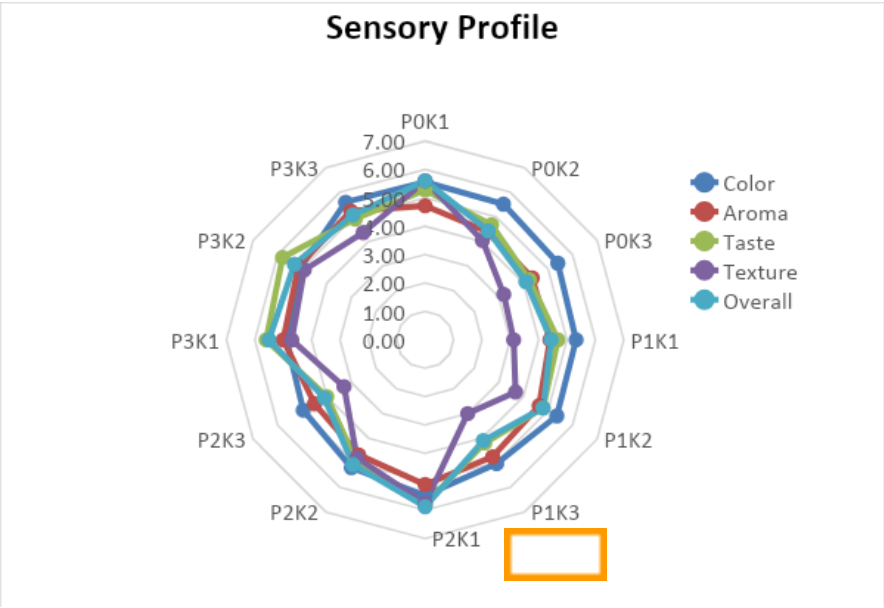

Figure 1. Gummy candy sensory test results

Remarks: *The chi-square test showed that the treatment given was significantly different ($p < 0.05$) in taste, texture, and overall preference.

3.4 Effectiveness Test

Food products must have good nutritional content and sensory assessments that the panelists can accept. Gummy candy, one of the semi-wet food products, must also meet these criteria. The results of the effectiveness test of the Semboro orange and rosella extract gummy candy can be seen in Figure 2. The highest value of the effectiveness of the Semboro orange and rosella extract gummy candy was in the P2K1 sample (the comparison of Semboro orange and rosella extract was 50%:50%, and the addition of agar powder was 2%). Regarding physical parameters, the P2K1 sample has a texture of 44.22 g/mm. Regarding chemical parameters, the P2K1 sample had a moisture content of 28.88%, reducing sugar content of 23.51%, vitamin C content of 0.03%, and antioxidant activity in an inhibition percentage of 30.26%. The hedonic sensory assessment of the P2K1 sample obtained a favorable rating on the overall rating of 5.88.

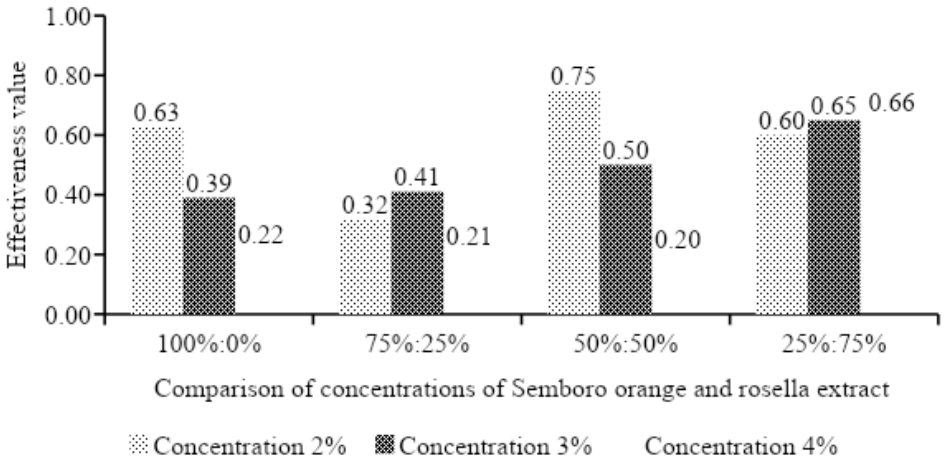

Figure 2. Test value of the effectiveness of gummy candy

4 Conclusions

Variations in the ratio of Semboro orange and rosella extract and the concentration of agar powder had a significant effect on the physical, chemical, and organoleptic properties in the form of taste, texture, and overall and had no significant impact on the organoleptic properties in the form of color and aroma. The best formulation based on the effectiveness test was obtained in the P2K1 sample (50%:50% ratio of Semboro orange and rosella extract and 2% agar powder added). The P2K1 sample had a texture of 44.22 g/mm, a moisture content of 28.88%, a reducing sugar content of 23.51%, vitamin C content of 0.03%, and antioxidant activity in inhibition percentage of 30.26%. The hedonic sensory assessment of the P2K1 sample obtained an overall rating of 5.88.

References

1. Badan Pusat Statistik 2022 Produksi tanaman buah-buahan 2021 Badan Pusat Statistik: Jakarta [Online] Available at (https://www.bps.go.id/indicator/55/62/2/produksi-tanaman-buah-buahan.html) (Accessed: 23 January 2023)
2. Badan Pusat Statistik 2021 Produksi buah–buahan dan sayuran tahunan menurut jenis tanaman (Kw.) 2017–2020 Badan Pusat Statistik: Jember [Online] Available at (https://jemberkab.bps.go.id/statictable/2021/11/08/323/produksi-buah-buahan-dan-sayuran-tahunan-menurut-jenis-tanaman-kw-2017-2020.html) (Accessed: 23 January 2023)
3. Badan Standarisasi Nasional 2009 SNI 3165-2009 Tentang Jeruk Siam Jakarta: Badan Standarisasi Nasional
4. Mufida R T, Darmanto Y S and Suharto S 2020 Karakteristik permen jeli dengan penambahan gelatin sisik ikan yang berbeda *Jurnal Ilmu dan Teknologi Perikanan* 2(1) pp 29-36 [online] Available at https://doi.org/10.14710/jitpi.2020.8086 (Accessed: 17 Januari 2023)
5. Purbowati I S 2014 Nanoenkapsulasi ekstrak kelopak bunga rosela (Hibiscus sabdariffa L.) hasil optimasi ekstraksi berbantu gelombang sebagai bahan antibakteri dan antioksidan Disertasi Bogor: IPB University
6. Verawati N, Aida N, Assrorudin and Wijayanto A 2020 Pengaruh konsentrasi agar-agar terhadap karakteristik kimia dan sensori permen jeli buah mangga kweni (Mangifera odorata Griff) AGRITEKNO: Jurnal Teknologi Pertanian 9(2) pp 81-87 [online] Available at https://doi.org/10.30598/jagritekno.2020.9.2.81 (Accessed: 29 Juni 2023)
7. Fitriani D E, Kuswandi B and Wulandari L 2022 Penggunaan indikator film edible berbasis antosianin Hibiscus rosa-sinensis L untuk monitoring kesegaran tomat ceri e-Journal Pustaka Kesehatan 10(1) [online] Available at https://doi.org/10.19184/pk.v10i1.12616 (Accessed: 13 Juni 2023)
8. AOAC 2005 Official method of analysis of the association at official analytical chemist Washington D C: Benyamin Franklin Station
9. Sudarmadji S, Haryono B and Suhardi 1997 Prosedur analisa untuk bahan makanan dan pertanian Yogyakarta: Liberty
10. Evana and Barek M S 2021 Determination of vitamin c (ascorbic acid) contents in two varieties of melon fruits (Cucumis melo L.) by iodometric titration Fullerene Journ. Of Chem 6(2) pp 143-147 [online] Available at https://doi.org/10.37033/fjc.v6i2.342 (Accessed: 3 Juni 2023)
11. Yuliani Ni N, Sambara J and Mau M A 2016 Uji aktivitas antioksidan fraksi etil asetat ekstrak etanol rimpang jahe merah (Zingiber officinale var. Rubrum) dengan metode DPPH (1,1-Diphenyl-2- Picrylhydrazyl) JURNAL INFO KESEHATAN 4(1) pp 1092-1111

12. Ahmad D and Mujdalipah S 2017 Karakteristik organoleptik permen jeli ubi (Ipomea batatas (l). lam cv.) akibat pengaruh jenis bahan pembentuk gel EDUFORTECH 2(1) pp 52-58 [online] Available at https://doi.org/10.17509/edufortech.v2i1.6174 (Accessed: 17 June 2023)
13. De Garmo E G, Sullivan W G and Canada 1984 Engineering economy New York: Mc Milan Pub.Company
14. Glicksman M 1983 Food hydrocolloid volume II Florida: CRC Press Inc
15. Astuti S, Zulferiyenni and Yuningsih Ni N 2015 Pengaruh formulasi sukrosa dan sirup glukosa terhadap sifat kimia dan sensori permen susu kedelai Jurnal Teknologi Industri & Hasil Pertanian 20(1) pp 25-37 [online] Available at http://dx.doi.org/10.23960/jtihp.v20i1.25%20-%2037 (Accessed: 9 June 2023)
16. Kurniawan T W and Deglas W 2019 Pemanfaatan kulit buah jeruk mandarin (Citrus reticulata) dalam pembuatan permen jelly dengan variasi konsentrasi bubuk agar Jurnal Pertanian Dan Pangan 1(2) pp 1-5
17. Putri I R, Basito and Widowati E 2013 Pengaruh konsentrasi agar-agar dan karagenan terhadap karakteristik fisik, kimia, dan sensori selai lembaran pisang (Musa paradisiaca L.) varietas raja bulu Jurnal Teknosains Pangan 2(3).
18. Wilberta N, Sonya N T and Lydia S H R 2021 Analisis kandungan gula reduksi pada gula semut dari nira aren yang dipengaruhi pH dan kadar air Bioedukasi 12(1) [online] Available at http://dx.doi.org/10.24127/bioedukasi.v12i1.3760 (Accessed: 17 Juni 2023)
19. Karsinah, Silalahi F H and Manshur A 2010 Markisa asam (Passiflora edulis Sims) buah eksotik kaya manfaat Iptek Hortikultura 6:34.
20. Verawati N, Aida N, Assrorudin and Wijayanto A 2020 Pengaruh konsentrasi agar-agar terhadap karakteristik kimia dan sensori permen jeli buah mangga kweni (Mangifera odorata Griff) AGRITEKNO: Jurnal Teknologi Pertanian 9(2) pp 81-87 [online] Available at https://doi.org/10.30598/jagritekno.2020.9.2.81 (Accessed: 29 Juni 2023)
21. Aryati D L, Rohadi and Pratiwi E 2020 Aktivitas antioksidan ekstrak kelopak bunga rosela (H. sabdariffa L.) merah pada berbagai suhu pemanasan Jurnal Teknologi Pangan Dan Hasil Pertanian 15(1) pp 1–9 [online] Available at http://dx.doi.org/10.26623/jtphp.v13i1.1845 (Accessed: 11 June 2023)
22. Susilowati S M, Affandi D R and Sari A M 2016 Kajian metode ekstraksi dengan variasi konsentrasi ekstrak secang (Caesalpinia sappan L.) terhadap karakteristik permen jeli herbal Jurnal Teknosains Pangan 5(2)
23. Buckle K A, Edwards R A, Fleet G H, and Wootton M 2007 Ilmu pangan Jakarta: Universitas Indonesia Press
24. Johannes J, Lalujan L E and Djarkasi G S S 2021 Pengaruh gelatin terhadap karakteristik kimia dan sensori permen jelly pisang kepok (Musa paradisiaca formatypical) dan buah naga merah (Hylocereus polirhyzus) Sam Ratulangi Journal of Food Research 1(1) pp 1-9
25. Estiasih T and Ahmadi K 2009 Teknologi pengolahan pangan Jakarta: PT Bumi Aksara
26. Jumri, Yusmarini and Herawati N 2015 Mutu permen jeli buah naga merah (Hylocereus polyrhizus) dengan penambahan karaginan dan gum arab JOM FAPERTA 2(1)
27. Ali F F and Arqomah R 2013 Ekstraksi zat warna dari kelopak bunga rosella (study pengaruh konsentrasi asam asetat dan asam sitrat) Jurnal Teknik Kimia 1(19) pp 26-34 [online] Available at https://doi.org/10.26714/jpg.9.1.2019.39-52 (Accessed: 7 June 2023)
28. Eveline, Santoso J and Widjaya I 2011 Kajian konsentrasi dan rasio gelatin dari kulit ikan patin dan kappa karagenan pada pembuatan jeli Jurnal Pengolahan Hasil Perikanan Indonesia 14(2) pp 98-105 [online]. Available at https://doi.org/10.17844/jphpi.v14i2.5318 (Accessed: 20 Juni 2023)
29. Piccone P, Rastelli S L and Pittia P 2011 Aroma Release and sensory perception of fruit candies model systems Procedia Food Science 1 pp 1509-1515 [online]. Available at 10.1016/j.profoo.2011.09.223 (Accessed: 1 Juni 2023)

30. Nursalim Y and Razali Z Y 2007 Bekatul makanan yang menyehatkan Jakarta: Agromedia Pusaka

.