Purslane (*Portulaca Oleracea* L.) Leaves Extract Addition in Jelly Candy Making

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Abstract: Purslane or *krokot* (*Portulaca oleracea* L.) can grow in warm climates (tropics and subtropics). Purslane plant is known to contain 41.4-66.4% of the omega-3 fatty acids, linolenic fatty acids (C18:3, n-3). Purslane extract contains unsaturated fatty acids, and more than 10 % consisted of alpha linolenic acid. This study is done to utilize purslane extract in candy jelly production that can be accepted by panelists. Maceration is used to extract purslane leave with three types of solvents (ethanol, ethyl acetate and hexane). The best extract was obtained by calculating the total yield and GC-MS analysis of purslane leaf extract components. The addition of purslane leaf extract to jelly candy uses concentrations of 0.5%, 1.0%, 1.5% and 2.0% (w/w). The observed parameters include physicochemical analysis (Total Dissolved Solids and pH), color, texture and sensory analysis. Selected jelly candies have a concentration of 0,5% purlsane leaf extract. Selected jelly candy has characteristics including ° Hue of 91.54 °, Total Dissolved Solids of 34.68 ° Brix, moisture content of 46.49%, fat content of 1.59%, protein content of 0.43%, ash content of 0.87 % and carbohydrate levels of 50.72%. Then based on the results of GC-MS analysis the selected jelly candy contains linolenic acid.

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1 INTRODUCTION

Purslane (*Portulaca olearacea* L.), in Indonesia is known by the name of *krokot*. *Krokot* is a type of ornamental plant that can grow on warm climate. In some countries (e.g. China), *krokot* is commonly used in traditional medicine to treat diabetes and hypotension; and it is also known for its antifungal, antibiotic, antiinflammation, antiestrogenic, and anticancer properties (Agil, *et al*., 2015; Uddin, *et al*., 2014; Sultana dan Rahman, 2013; dan Zhou, *et al*., 2015; Hanan *et al*., 2014). The leaves contain 41.4-66.4% (1.0-1.6 mg/g) omega-3 fatty acids, which are higher compared to its root and stem.

Omega-3 fatty acid has many beneficial effects to human body, namely its anticoagulative and anti-inflammatory properties. It is also known to be good for the brain. Moreover, omega-3 fatty acids are able to prevent chronic diseases, such as cardiovascular related diseases, hypertension, inheritance of diabetes on fetus during pregnancy, inflammation, hyperlipidemia, and cancer (Diana, 2012; Zhou, *et al*., 2015; Yessoufou, *et al*., 2015; Calviello and Serini, 2010).

Jelly candy is a type of confectionary with soft, chewy, and elastic texture. Gelatin used in the making of jelly candies comes from connective tissues of pig, cow, or skin from poultries (Subaryono and Utomo, 2006; Riaz dan Chaudry, 2004). Due to its non-halal origin, other hydrocolloids such as carrageenan is used as a substitute for gelatin (Atmaka, Nurhartadi and Karim, 2013).

This research is done to determine the addition of *krokot* leaf extract in the production of jelly candies, based on its sensory analysis and physic analysis.

2 MATERIALS AND METHODS

The materials used are fresh krokot leaves obtained from BALITRO, Bogor, food grade solvents (ethanol, ethyl acetate, and hexane), granulated sugar, citric acid, kappa-carageenan, konjac, high fructose syrup (HFS), and orange flavoring. Materials used for analysis consist of distilled water, pro-analysis grade hexane, K_2SO_4, selenium, H_2SO_4 97%, H_2O_2, and saturated boric acid. The equipment used are “Ohaus U-1800 AR 2140” analytical

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balance, heater, cabinet dryer, oven, Tyler sieve (35 mesh), “Buchi” rotary evaporator, “Konica Minolta CR-400” chromameter, furnace, “Aglient 7890B” Gas Chromatograph, “Aglient 5977B” Mass Selective Detector, and desiccator.

2.1 Extraction of *Krokot* Leaf

The extraction of *krokot* leaf is done using maceration method. The leaves are dried using cabinet dryer at 50°C for 24 hours (Abdolshahi, *et al.* (2015);Kaveh, *et al.* (2017), with modification). The dried leaves are reduced in size and sieved using 35-mesh Tyler sieve to obtain *krokot* leaf powder. The powder is macerated using three types of solvent (ethanol, ethyl-acetate, and hexane) with the ratio of 1:4 (w:v) powder to solvent for 72 hours. The liquid is then filtered using Whattman No.1 filter paper and the solvent is evaporated by using rotary evaporator at 45°C with adjusted vacuum pressure based on each solvent to obtain *krokot* leaf extract.

2.2 Production of Jelly Candy

The production of jelly candy is done by combining the hydrocolloid (carrageenan and konjac) with water at 80-90°C in a separate container for each hydrocolloid. Then, in another container, mix high fructose syrup with granulated sugar. When the sugar has dissolved, mix the sugar and syrup mixture with carrageenan and konjac solution, followed by heating. When the mixture temperature reaches 80°C, add the citric acid and flavoring.

After cooling down to 60°C, krokot leaf extract is added to the mixture (Sugiharto, *et al*., 2015). The jelly candy mixture is then poured to the mold, that has been applied with molding starch. The jelly candy is left to cool down in room temperature (23-30°C) for an hour before transferring to the refrigerator (4-5°C) and left for 24 hours. During refrigeration, the gel sets. Compared to konjac, the gel from carrageenan sets faster. Carrageenan gel sets at around 40-70°C. However, its setting temperature is highly affected by the sugar content of the jelly candy, thus it is hard to determine the specific set temperature for carrageenan (Williams dan Phillips, 2004; Williams and Phillips[1], 2009).

2.3 Characterization of *Krokot* Leaf Powder

Characterization of *krokot* leaf powder was done to determine the chemical composition through proximate analysis (AOAC,2015)

2.4 Characterization of Krokot Leaf Extract

The extracts from three different solvent was calculated for its yield using the formula:

$$\text{Yield (\%)} = \frac{\text{weight of } krokot \text{ leaf extract (g)}}{\text{weight of } krokot \text{ leaf (g)}} \times 100\%$$

Furthermore, the identification of omega-3 fatty acid is determined using GC-MS.

2.5 Analysis of *Krokot* Leaf Extract Added Jelly Candy

The produced jelly candy will be analysed for its pH (AOAC, 2005), Total Soluble Solid (Hasyim 2015), Color (Nielsen, 2010), Texture (Azizah 2012), Sensory Evaluation (Lawless and Heymann, 2010; Kemp, *et al.* 2009), and proximate analysis (AOAC 2015).

3 RESULTS AND DISCUSSION

3.1 Characteristics of *Krokot* Leaf Powder

The chemical composition of krokot leaf powder is shown in Table 1. Based on the analysis done, the moisture content of the krokot leaf powder is 8.44±0.13%, which according to Puspitasari and Proyogo (2017), the moisture content of dry plant sample must not exceed 10%. Thus, krokot leaf powder obtained can be used for the next step, maceration.

Table 1: *Krokot* leaf chemical composition.

Chemical composition	Result (%)
Moisture content	8.44 ± 0.13
Fat	3.96 ± 0.07
Protein	31.75 ± 0.06
Ash	18.24 ± 0.03
Carbohydrate	37.60 ± 0.03

3.2 Characterization of *Krokot* Leaf Extract

Based on the extract yield on Table 2., food grade ethanol gives the highest yield among the solvents used, with the value of 8.30±0.02%. Similar result is obtained from a research by Adiyasa, Wrasiati and Wartini (2015), where ethanol gives the highest extract yield.

Based on the component identification result with GC-MS, all solvent used shows similar result qualitatively, where every extract contains omega-3 fatty acid. Table 3. shows the identification result

Table 2: *Krokot* leaf extract yield.

Solvent Type	Yield (%)
Ethyl-acetate	4.78±0.14
Ethanol	8.30±0.02
Hexane	2.99±0.01

In a research done by Schmid, *et al.*, (2016), ethanol gives higher PUFA (Polyunsaturated Fatty Acid) yield in the extraction of seaweed. Furthermore, ethanol solvent is able to extract higher amount of total fatty acid (TFA). Hence, it is possible that the *krokot* leaf extract obtained by using ethanol as solvent contain high level of PUFA and TFA. Thus, ethanol is chosen as the best solvent for the extraction of *krokot* leaf.

Table 3: Total component identification of *Krokot* leaf extract with GC-MS.

Solvent Type	Retention Time	Qual
Ethyl-acetate	10.314 minutes	98%
Ethanol	10.968 minutes	99%
Hexane	10.540 minutes	94%

3.3 Effect of *Krokot* Leaf Extract Concentration on Total Soluble Solid of Produced Jelly Candy

Based on Figure 1, there is a significant difference in total soluble solids between jelly candy with different level of extract concentration.

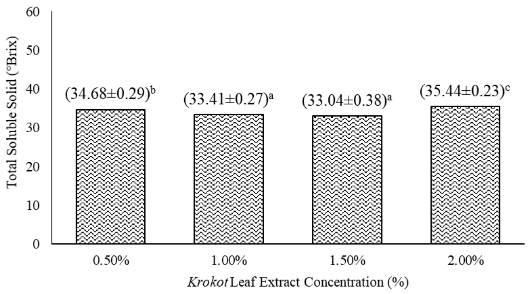

Figure 1: Effect of extract concentration on the value of jelly candy total soluble solid. (Note: Different letter notations indicates a significant difference at $p \leq 0.05$).

It can be seen that there is an increasing trend of total soluble solid when higher level of extract is added. Similar trend is seen on a research by Charoen, et al. (2015), where the total soluble solid of the jelly candy produced increases as the level of guava leaf extract is increased. Another possibility is that increase in total soluble solid is caused by the bonding of free water and other particle through stabilizer, thus increasing the total soluble solid and reducing formation of precipitate (Farikha, et al., 2013).

3.4 Effect of *Krokot* Leaf Extract Concentration on pH of Produced Jelly Candy

Based on Figure 2., there is a significant difference in pH value between jelly candies with different levels of *krokot* leaf extract. In Figure 2, an inverse relationship can be seen on the pH of jelly candy and the addition of *krokot* leaf extract. This is due to the addition of citric acid in the making of jelly candy. The decrease in pH can also be explained due to the addition of carrageenan (Septiani, *et al*. (2013). The presence of anhydrogalactose group on carrageenan decreases the dispersion of carrageenan, thus reducing the (H^+) ion that is bound in the jelly candy, effectively reducing the pH of the product. The jelly candies from every treatment is categorized as acidic to less than 7 pH value. According to Sperbe and Doyle (2009), pH value in candies have range between 2.0 until 8.0.

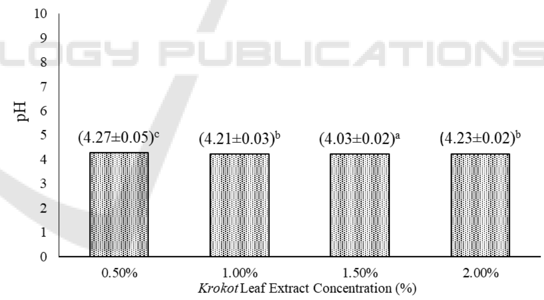

Figure 2: Effect of extract concentration on the value of jelly candy pH. (Note: Different letter notations indicates a significant difference at $p \leq 0.05$).

3.5 Effect of *Krokot* Leaf Extract Concentration on Color of Produced Jelly Candy

The °Hue value of the candy can be seen on Figure 3, where there is no significant difference on °Hue value between jelly candy with different concentration of krokot leaf extract. The °Hue value of the product ranges between 86.91 to 92.52°, where according to Munsell color system, the jelly candy color is categorized as yellow. Increasing the

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concentration of krokot leaf extract will increase the °Hue value of the jelly candy. However, the result obtained is different from visual observation, where the candy shows dark green color. This is due to the presence of antioxidant in the extract used. According to a research by Liu, et al. (2000), krokot contains high level of antioxidant in form of beta-carotene (22-30 mg/g). MacDougall (2002) said that beta-carotene gives yellow orange to food product. According to USDA (2015), a cup of raw carrot contains 10605 µg or 10.6 mg beta-carotene. Due to high level of beta-carotene in the krokot leaf extract, it affects color perceived as yellow.

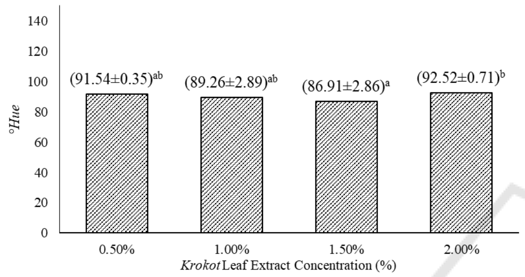

Figure 3: Effect of extract concentration on the value of jelly candy °Hue. (Note: Different letter notations indicates a significant difference at $p \leq 0.05$).

In color analysis, °Hue value is directly affected on the values a* and b*. Based on Figure 4 and Figure 5, the range of a* and b* value for the candy is between -0.08 to 0.61 and 1.71 to 27.42 respectively. From the result, it can be perceived that every jelly candy has different color. Lower a* value indicates green color. While higher b* value indicates yellow and lower b* value will lean towards blue color (Nielsen, 2010). Because of this, °Hue value obtained leans toward yellow color.

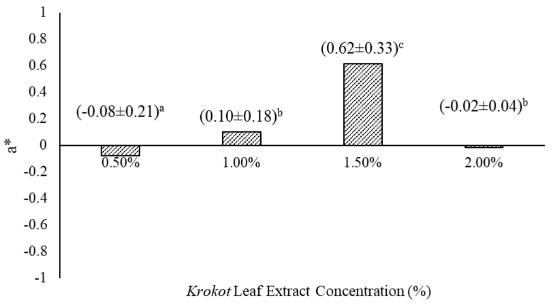

Figure 4: Effect of extract concentration on the value of jelly candy a* value. (Note: Different letter notations indicates a significant difference at $p \leq 0.05$).

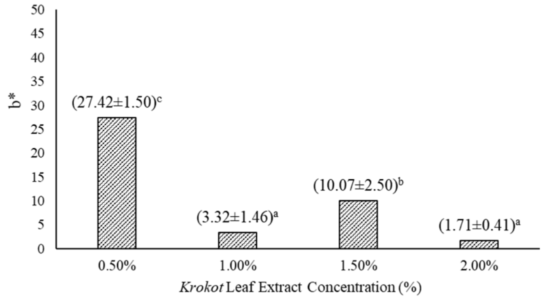

Figure 5: Effect of extract concentration on the value of jelly candy b*. (Note: Different letter notations indicates a significant difference at $p \leq 0.05$).

3.6 Effect of *Krokot* Leaf Extract Concentration on Texture of Produced Jelly Candy

Texture is an important parameter when determining the physical characteristic of jelly candy. The type and concentration of gelling agent used will determine the texture of jelly candy produced (Imeson, 2010). The observed parameters used in texture analysis of jelly candy are hardness, springiness, cohesiveness, chewiness, and gumminess.

Based on Figure 6, *krokot* leaf extract has a significant effect towards the hardness of jelly candy produced. Hardness value tend to decrease as the lever of extract is increased. Lower hardness value indicates softer texture, and vice versa (Octaviana, Purwijantiningsih and Pranata, 2013).

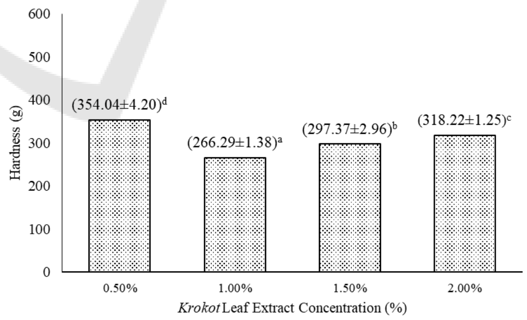

Figure 6: Effect of extract concentration on the value of jelly candy hardness. (Note: Different letter notations indicates a significant difference at $p \leq 0.05$).

Decrease in hardness can also due to jelly candy, which considered hygroscopic, absorbs water when exposed to environment with high humidity and temperature, making the product softer when analyzed (Koswara, 2009; Rahmi, et al., 2012).

Based on Figure 7., no significant difference is shown between different level of extract concentration towards the springiness of jelly candy. Springiness of jelly candy is usually not affected by the addition of different levels of extract concentration. Similar result is shown in a research by Atmaka, Nurhartadi and Karim (2013), where different *Curcuma zanthorrhiza* extract concentration shows no significant effect to the elasticity of jelly candy produced.

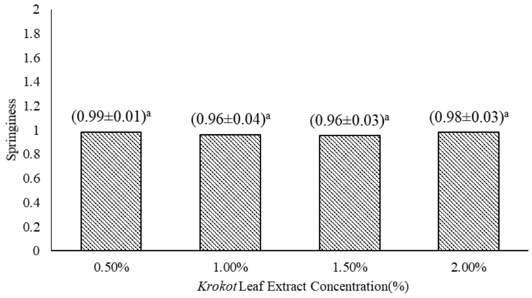

Figure 7: Effect of extract concentration on the value of jelly candy springiness. (Note: Different letter notations indicates a significant difference at p≤0.05). at p≤0.05).

Based on Figure 8., there is a significant difference towards the cohesiveness of jelly candy between different levels of extract. Cohesiveness value of jelly candy tends to increase as the amount of extract added is increased. The increase and decrease in cohesiveness value is affected by things like moisture content, sugar, and other minor components, which may affect the molecular bond of the gel structure (Rahmi, *et al*., 2012; Delgado and Bañón, 2014).

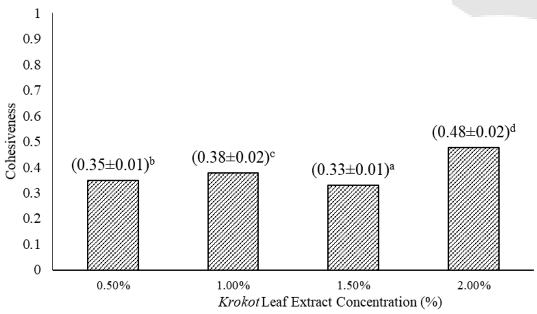

Figure 8: Effect of extract concentration on the value of jelly candy cohesiveness. (Note: Different letter notations indicates a significant difference at p≤0.05).

As seen on Figure 9., there is a significant difference of jelly candy chewiness between different levels of extract concentration. A research by Purwaningtyas, Suhartatik and Mustofa (2017), however, shows no effect on chewiness from the addition of *suji* and *sirih* leaf exract. The increase in chewiness of the jelly candy produced may be attributed by the moisture content, total soluble solids, and gelling agent working synergistically (Delgado and Bañón, 2014).

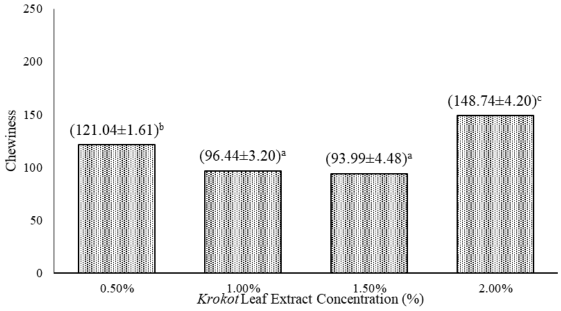

Figure 9: Effect of extract concentration on the value of jelly candy chewiness. (Note: Different letter notations indicates a significant difference at p≤0.05).at p≤0.05).

Despite increasing value, the gumminess of jelly candy produced shows no significant difference between different levels of extract added. Gumminess shows gel strength, where it is affected by moisture content, total soluble solids, and presence of other minor components. (Delgado and Bañón, 2014; Rahmi, *et al*., 2012).

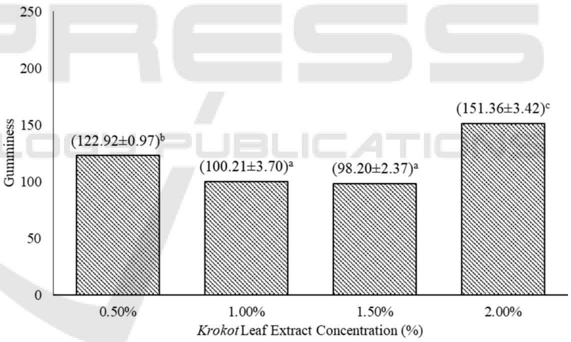

Figure 10: Effect of extract concentration on the value of jelly candy guminess. (Note: Different letter notations indicates a significant difference at p≤0.05). at p≤0.05).

3.7 Effect of *Krokot* Leaf Extract Concentration on Sensory Evaluation of Produced Jelly Candy

As shown on Table 4., higher extract concentration shows an increase score in color albeit not significant. Higher level of extract will show greener color jelly candy.

Table 4: Effect of *Krokot* Leaf Extract to scoring of jelly candy.

Concentration	Color	Flavor
0.5%	4.04±1.9[a]	4.40 ±1.03[c]
1%	5.11±1.22[b]	3.53±1.10[b]
1.5%	5.00±1.15[b]	3.33±1.40[b]
2%	5.36±1.12[b]	2.89±1.48[a]

Addition of higher extract concentration exhibit significant effect to the flavor score of jelly candy. According to Table 4., panelist gives lower score on higher extract concentration due to addition of higher amount extract affects the flavor of candy negatively. Based on the result, addition of krokot leaf extract to jelly candy up to 2.0% shows no significant difference to the aroma and chewiness score.

Hedonic sensory evaluation is done by determining the likeability of panelist towards color, flavor, and overall. The result is expressed in Table 5.

Table 5: Effect of *Krokot* Leaf Extract to hedonic of jelly candy.

Concentration	Color	Flavor	Overall
0.5%	5.08±0.99[b]	5.47±1.06[c]	5.29±0.87[c]
1%	4.23±1.20[a]	4.73±1.27[b]	4.74±1.16[b]
1.5%	4.14±1.32[a]	4.37±1.53[ab]	4.44±1.28[ab]
2%	3.90±1.44[a]	4.11±1.67[a]	4.29±1.54[a]

3.9 Effect of *Krokot* Leaf Extract Concentration on Proximate Analysis of Produced Jelly Candy

The chosen jelly candy is the one with 0.5% krokot leaf extract. The proximate analysis of the chosen jelly candi is shown on Table 6. Based on the identification result of jelly candy with chosen krokot leaf extract using GC-MS, it is shown that the jelly candy contains alpha-linolenic, which is an omega-3 fatty acid. The total component analysis of jelly candy is shown on Table 7.

Table 6: Effect of *Krokot* Leaf Extract to scoring of jelly candy.

Composition	Result (%)
Moisture Content	46.49±0.30
Ash Content	0.87±0.00
Fat	1.59±0.01
Protein	0.43±0.00
Carbohydrate (*by difference*)	50.72±0.13

Table 7: Effect of *Krokot* Leaf Extract to scoring of jelly candy.

Sample	Retention Time	Qual
Jelly candy with 0.5% *krokot* leaf extract	13,636 minutes	99%

4 CONCLUSIONS

Proximate analysis shows krokot leaf powder has moisture content of 8.44%, which will be extracted using by maceration on the next stage. Highest extract yield is obtained by using food grade ethanol as solvent, with 8.30% yield. From GC-MS analysis, it is shown that extract using food-grade solvents (ethanol, ethyl acetate, hexane) contains alpha-linolenic fatty acid. Addition of krokot leaf extract decreases the lightness of jelly candy produced. While the texture of jelly candy produced is improved, the chewiness is not affected. The °Hue value is not affected by the increase of extract concentration. The jelly candy with 0.5% krokot leaf extract is chosen based on panelist acceptance with overall acceptance score of 5.29. The chosen jelly candy has color of yellowish green with °Hue value of 91.54%. The characteristic of chosen jelly candy produced has total soluble solids of 34.68 °Brix, 46.49% moisture content, 1.59% fat content, 0.43% protein content, 0.87% ash content, and 50.72% carbohydrate content. Based on GC-MS result, the chosen jelly candy contains alpha-linolenic acid with retention time of 13.636 minutes and 99% qual.

REFERENCES

Abdolshahi, A., Majd, M., Rad, J., Taheri, M., Shabani, A. and Teixeira da Silva, J. (2013). Choice of solvent extraction technique affects fatty acid composition of pistachio (*Pistacia vera* L.) oil. *Journal of Food Science and Technology*, 52(4), pp.2422-2427.

Adiyasa, I., Wrasiati, N. and Wartini, N. (2015). Efektivitas Jenis Pelarut dan Lama Ekstraksi Terhadap Karakteristik *Concrete* Minyak Atsiri Kulit Jeruk Mandarin (*Citrus reticulata*) [Effectivity of Solvent Type and Extraction Time to the Concrete Characteristic of Mandarin Orange (*Citrus reticulata*) peel essential oil]. *Jurnal Rekayasa dan Manajemen Agroindustri*, 3(4), [online] pp.21-29. Available at: https://ojs.unud.ac.id/index.php/jtip/article/view/16929.

Atmaka, W., Nurhartadi, E. and Karim, M. (2013). Pengaruh penggunaan campuran karaginan dan konjak terhadap karakteristik permen jeli temulawak (*Curcuma xanthorrhiza* Roxb.) [Effect of carrageenan and konjac mixture towards curcuma (*Curcuma xanthorrhiza* Roxb.) jelly candy]. *Jurnal Teknosains Pangan*, [online] 2(2), pp.66-74. Available at: https://jurnal.uns.ac.id/teknosains-pangan/article/view/4380

Azizah, N. (2012). Pembuatan Permen Jelly dari Karaginan dan Konjak dengan Aplikasi Prebiotik Xilo-Oligosakarida [Production of Carrageenan and Konjac Based Jelly with application of Xylo-Oligosaccharide Prebiotic]. Bogor: Institut Pertanian Bogor

Calviello, G. and Serini, S. (2010). *Dietary Omega-3 Polyunstaturated Fatty Acids and Cancer*. New York: Springer Science+Business Media B.V.

Charoen, R., Savedboworn, W., Phuditcharnchnakun, S. and Khuntaweetap, T. (2015). Development of Antioxidant Gummy Jelly Candy Supplemented with Psidium guajava Leaf Extract. *KMUTNB International Journal of Applied Science and Technology*, 8(2), pp.145-151.

Delgado, P. and Bañón, S. (2014). Determining the minimum drying time of gummy confections based on their mechanical properties. *CyTA - Journal of Food*, 13(3), pp.329-335.

Diana, F. (2012). Omega 3. *Jurnal Kesehatan Masyarakat*, 2(6).

Farikha, I., Anam, C. and Widowati, E. (2013). Pengaruh jenis dan konsentrasi bahan penstabil terhadap karakteristik fisikoimmia sari buah naga merah (*Hylocereus polyrhizus*) selama penyimpanan [Effect of Type and Concentration of Stabilizer towards Physicochemical Characteristic of Red Dragonfruit (*Hylocereus polyrhizus*) Juice during Storage]. *Jurnal Teknosains Pangan*, 2(1), pp.30-38.

Hasyim, H. and Rahim, A. (2015). Karakteristik Fisik Kimia dan Organoleptik Permen Jelly dari Sari Buah Srikaya pada Variasi Konsentrasi Agar-Agar [Physical, Chemical, and Organoleptic Characteristic of Soursop Juice Jelly Candy with Carying Agar Concentration]. . *Abrotekbis*, 3(4), pp.110-116

Hunterlab. (2012). Measuring Color using Hunter L, a, b versus CIE 1976 L*a*b*. [online] Available at: http://www.hunterlab.com [Accessed 21 Nov. 2017].

Imeson, A. (2010). *Food Stabilisers, Thickeners and Gelling Agents*. New Delhi: Blackwell Publishing Ltd.

Kaveh, M., Eidi, A., Nemati, A. and Boskabady, M. (2017). The Extract of Portulaca oleracea and Its Constituent, Alpha Linolenic Acid Affects Serum Oxidant Levels and Inflammatory Cells in Sensitized Rats. *Iran J Allergy Asthma Immunol.*, 16(3), pp.256-270. Available at: http://ijaai.tums.ac.ir/index.php/ijaai/article/view/1078.

Kemp, S., Hollowood, T. and Hort, J. (2009). *Sensory Evaluation a Practical Handbook*. United Kingdom: Wiley-Blackwell.

Koswara, S. (2009). *Teknologi Pembuatan Permen* [Confectionary Processing Technology].

Lawless, H. and Heymann, H. (2010). *Sensory Evaluation of Food*. New York: Springer.

MacDougall, D. (2002). *Colour in Food. England*: Woodhead Publishing.

Nielsen, S. (2010). *Food Analysis Laboratory Manual*. 20th ed. New York: Springer Science+Business Media LLC.

Octaviana, P., Purwijantiningsih, L. and Pranata, S. (2013). Kualitas Permen Jelly dari Albedo Kulit Jeruk Bali (*Citrus grandis* L. Osbeck) dan Rosela (*Hibiscus sabdariffa* L.) dengan Penambahan Sorbitol [Quality of Grapefruit Albedo (*Citrus grandis* L. Osbeck) and Roselle (*Hibiscus sabdariffa* L.) Jelly Candies with the Addition of Sorbitol]. Jurnal Biologi, [online] pp.1-12. Available at: http://e-journal.uajy.ac.id/id/eprint/4386.

Official Methods of Analysis of AOAC International. (2005). 15th ed. Washington, D.C.: The Association of Official Analytical Chemists, p.212.

Purwaningtyas, H., Suhartatik, N. and Mustofa, A. (2017). Formulasi Permen Jelly Ekstrak Daun Sirih (*Piper betle* L.) dan Daun Suji (*Pleomele angustofolia*) [Formulation of Jelly from Candy Betel (*Piper betle* L.) – Suji (*Pleomele angustofolia*) Leaf Extract]. *Jurnal Teknologi dan Industri Pangan*, [online] 2(1), pp.25-30. Available at: http://ejurnal.unisri.ac.id/index.php/jtpr/article/view/1532.

Puspitasari, A. and Proyogo, L. (2017). Perbandingan Metode Ekstraksi Maserasi dan Sokhletasi terhadap Kadar Fenolik Total Ekstrak Etanol Daun Kersen (*Mutingia calabura*) [Comparison Between Maceration and Soxhlation Extraction Method Towards Total Phenolic Content of *Kersen* (*Mutingia calabura*) Leaf Ethanol Extract]. *Jurnal Ilmiah Cendekia Eksakta*, [online] 2(1). Available at: https://www.publikasiilmiah.unwahas.ac.id/index.php/CE/article/view/1791.

Rahmawati, P. and Adi, A. (2016). Daya Terima dan Zat Gizi Permen Jeli dengan Penambahan Bubuk Daun Kelor (*Moringa oleifera*) [Acceptance and Nutritional Value of Jelly Candy with the Addition of Moringa (*Moringa oleifera*) Leaf Powder]. *Media Gizi Indonesia*, [online] 11(1), pp.86-93. Available at: https://e-journal.unair.ac.id/MGI/article/view/4413.

Rahmi, S., Tafzi, F. and AnggrainiQ, S. (2012). Pengaruh Penambahan Gelatin Terhadap Pembuatan Permen Jelly Dari Bunga Rosella (*Hibiscus sabdariffa* Linn) [Effect of Gelatin Addition Towards the making of Jelly Candy from Rosella (*Hibiscus sabdariffa* Linn) Flower]. *Jurnal Penelitian Universitas Jambi*, 14(1), pp.37-44.

Riaz, M. and Chaudry, M. (2004). *Handbook of halal food production*. Washington, D.C: CRC Press LCC.

Schmid, M., Guihéneuf, F. and Stengel, D. (2016). Evaluation of food grade solvents for lipid extraction and impact of storage temperature on fatty acid composition of edible seaweeds *Laminaria digitata* (Phaeophyceae) and *Palmaria palmata* (Rhodophyta). *Food Chemistry*, 208, pp.161-168.

Septiani, I., Basito, B. and Widowati, E. (2013). Pengaruh Konsentrasi Agar-agar dan Karagenan terhadap Karakteristik Fisik, Kimia, dan Sensori Selai

Lembaran Jambu Biji Merah (*Psidium guajava* L.) [Effect of Agar-agar and Carrageenan towards its Physical, Chemical, and Sensory Characteristic of Guava (*Psidium guajava* L.) Sheeted Jam]. *Jurnal Teknologi Hasil Pertanian*, 4(1), pp.27-35.

Sperber, W. and Doyle, M. (2009). *Compendium of Microbiological Spoilage of Foods and Beverages*. London: Springer Science+Business Media, LLC.

Subaryono and Utomo, B. (2006). The Use of Carrageenan–Konjac in Jelly Candy Production. *Jurnal pascapanen dan bioteknologi kelautan dan perikanan*, 1(1), pp.19-26.

Sugiharto, R., Setyani, S. and Rikafilanti, N. (2015). Efek fortifikasi minyak ikan terhadap kadar omega-3 dan sifat sensori roti tawar selama penyimpanan [Effect of fish oil fortification to the level of omega-3 and sensory of bread during storage]. *Jurnal Teknologi Industri & Hasil Pertanian*, 20(1), pp.38-50.

Uddin, M., Juraimi, A., Hossain, M., Nahar, M., Ali, M. and Rahman, M. (2014). Purslane Weed (*Portulaca oleracea*): A Prospective Plant Source of Nutrition, Omega-3 Fatty Acid, and Antioxidant Attributes. *The Scientific World Journal*, 2014, pp.1-6.

U.S Departemen of Agriculture National Nutrient Data (USDA). (2015). *USDA National Nutrient Data Base for Standard Reference "Beta Carotene*".

Williams, P. and Phillips, G. (2004). *Gums and Stabilizer for Food Industry 12*. UK: The Royal Society of Chemistry.

Williams, P. and Phillips, G. (2009). *Handbook of Hydrocolloids,* 2nd edition. UK: Woodhead Publishing Limited

Yessoufou, A., Nekoua, M., Gbankoto, A., Mashalla, Y. and Moutairou, K. (2015). Beneficial Effects of Omega-3 Polyunsaturated Fatty Acids in Gestational Diabetes: Consequences in Macrosomia and Adulthood Obesity. *Journal of Diabetes Research*, 2015, pp.1-11.

Zhou, Y., Xin, H., Rahman, K., Wang, S., Peng, C. and Zhang, H. (2015). Portulaca oleracea L: A Review of Phytochemistry and Pharmacological Effects. BioMed research international.

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