The Effect of Carrot (Daucus carota) Substitution on Sensory Characteristics of Fruit Leather Janten Banana (Musa eumusa)

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ABSTRACT

Fruit leather is a food product created by mashing and dehydrating fruit flesh into uniform thin sheets with unique texture and fruity flavor. This study aimed to optimize the production of high-quality fruit leather formulated with banana and carrot. The experimental design used in this study was a Complete Randomized Block Design (RBD) with a single factor and 4 replications. Six levels of banana and carrot ratio was used in this research which were (P1) 100:0, (P2) 90:10, (P3) 80:20, (P4) 70:30, (P5) 60:40, and (P6) 50:50. Subsequently, a scoring test was conducted by 15 semi-trained individuals, followed by a hedonic test by 25 untrained panelists. To evaluate data consistency, Bartlett's test and Tuckey's test were applied, and thereafter, variance analysis was conducted to determine the effect between treatments. In cases where a significant effect was observed, further analysis was conducted utilizing the Least Significant Difference Test (LSDT) at a significant level of 5%. The results showed that the carrot concentration affected the overall sensory reception, color, and taste of the fruit leather. The most favorable outcomes were linked to the treatment involving 50% carrot substitution (P6), characterized by color, texture, aroma, taste, and overall acceptance ratings of 3.90 (brownish orange – orange), 3.30 (slightly plastic – plastic), 2.98 (dislike – neutral), 3.59 (neutral – like), and 3.77 (neutral – like), respectively.

Keywords: Banana (var. Janten); carrots; *fruit leather*

INTRODUCTION

Fruit leather is a food product created from crushed fruit pulp that is dried and formed into thin, uniform sheet. Furthermore, it has a specific texture and taste contingent upon the variety employed. It is noteworthy that several recent studies have reported the development of fruit leather (Marzelly et al., 2017). Some examples of fruits that can be used to make fruit leather include soursop (Historiarsih, 2010), pineapple (Sidi et al., 2014), and mango (Safitri, 2012) as well as bananas, including the horn (Fauziah et al., 2015) and *ambon* species (Marzelly et al., 2017). This indicates the potential to further diversify the variety of fruit leather, such as by using *Janten* banana.

Banana (*Musa paradisiaca*) stands as a prominent agricultural commodity in Indonesia. Among its diverse varieties, *Janten* banana (*Musa eumusa*) is interesting to develop into fruit leather due to its appealing sweet taste and relatively affordable price. In the context of nutrition, *Janten* banana also potentially serves as a source of dietary fiber that is beneficial for human health (Musita, 2012). However, so far, its utilization is limited to chips, preserved slices and banana flour (Yassin et al., 2013).

Carrot (*Daucus carota*) is a nutrient-rich vegetable with profound implications for health. In a 100 g of fresh weight, the fruit approximately contains 2.8 g of fiber, vitamin A activity of 835 μgRAE, β-carotene measuring 8280 μg, α-carotene totalling 3480 μg;

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and other constituents (United States Department of Agriculture, 2019b). Even though carrot has numerous potential health benefits, they are often only prepared as vegetable soup (Nurmahmudah et al., 2016). Carrot soup wes less preferred by children. Their aversion to such preparations stems from a preference for whole, physically transformed vegetables that present a more appealing appearance (Hasan, 2017). Therefore, diversification of carrot-derived products is needed to make it more appealing and attractive to children without compromising its nutritional content.

This study, therefore, aimed to determine the optimum formulation for *janten* banana and carrot for making fruit leather with favorable sensory characteristic. Transformation of fruits into fruit leather also beneficial to extend its shelf life, enhance food product diversification, and increase the market value of the fruits (Fauziah et al., 2015). However, the processing of banana to fruit leather confronts a notable challenge, namely the occurrence of enzymatic browning and the Maillard reaction, both of which contribute to an unappealing color. Enzymatic browning arises due to the elevated presence of phenolic compounds and phenolase enzymes inherent in bananas, notably manifesting during stages such as peeling and crushing of the fruit. Simultaneously, the Maillard reaction is spurred by the interaction between carbohydrates, predominantly reducing sugars, and primary amine groups (Arsa, 2016). This reaction is further activated by heating, resulting in the formation of a deeply hued product (referred to as melanoidin) that carries diminished visual appeal, as emphasized by Wang et al. (2012). To counteract these challenges, a strategic approach involves the inclusion of citric acid in conjunction with food coloring. Therefore, the addition of carrots is expected to mitigate these drawbacks and serve as a source of coloration to the end product.

MATERIALS AND METHODS

The experimental designed used was a *Completely Randomized Block Design* (CRBD) with one factor and four replications. These included the formulation of *janten* banana (*Musa eumusa*) and carrot mixture at six levels, namely 100:0 (control/P1), 90:10 (P2), 80:20 (P3), 70:30 (P4), 60:40 (P5), and 50:50 (P6). The obtained data were tested for homogeneity of variances using the Bartlett test and Tukey's test. Subsequently, analysis of variance was conducted to determine the treatment effects, followed by further analysis using the BNT test at a significance level of 5%.

Materials

The materials used in this studywere ripe *janten* bananas (*Musa eumusa*) and carrots *(Daucus carota*) obtained from Bambu Kuning Market in Tanjung Karang, Bandar Lampung. Others included granulated sugar, carrageenan sourced from 'Toko Medan' in Bandar Lampung, and citric acid with the brand "Cap Gajah."

Tools

The tools used to make *janten* banana (*Musa eumusa*) and carrot fruit leather included an aluminum tray with a dimension of 27.5 cm x 21 cm x 1.5 cm, a Heraeus oven (220V 50/60 Hz), wrapping materials, a Philips wet blender (220-240 V, 50-60 Hz, 350 W), a digital scale by Shimadzu, an exhaust scale (Five Goats, manual, 5 kg capacity), and sensory evaluation tools such as small plates and spoons.

Methods

The study began by preparing a blended mixture of *janten* banana and carrot to create a pureeThe *janten* bananas and carrots were blanched at a temperature of 65 and 70 °C for 3 minutes. The bananas were peeled, and their skin were discarded, while the carrots were cleaned and washed. Subsequently, the flesh of banana and carrot was weighed according to the formulated ratios of 100:0, 90:10, 80:20, 70:30, 60:40, and 50:50. and the mixture was then crushed by using a blender for 5 minutes, with a *janten* banana and carrot flesh to water ratio of 2:1. The mixture were added with 20% granulated sugar, 0.3% carrageenan and 0.2% citric acid. This combination was subjected to cooking at 70 °C for 2 minutes. After that, the mixture was poured into a baking sheet that has been covered with wrapping, and subsequently flattened using a spatula. The prepared mixture was placed in a cabinet dryer at 50 °C for 24 hours to facilitate drying. Once the mixture had been dried and hardened, the fruit leather was cut into 4x4 cm pieces and rolled up.

Testing of Sensory Properties

Sensory properties evaluations encompass both scoring tests, focusing on texture and color, as well as hedonic tests guaging overall acceptance, taste, and aroma. The scoring test was conducted by 15 semi-trained panelists, who assessed texture (1. Not plastic, 3. Slightly plastic, 5. Plastic) and color (1. Brownish, 3. Brownish orange, 5. Orange) on scale of 1-5. In contrast, the hedonic test involved 25 panelists who lack prior training in the parameters of overall acceptance, taste, and aroma. These panelists rated their preferences on a scale ranging from 1 to 5, denoting varying degrees of liking (very dislike – very like).

RESULTS AND DISCUSSION

Sensory Characteristics

Color

The results of the analysis of variance showed that the carrot substitution had a significant effect on the color of the fruit leather. The observed color values spanned from 1.98 – 3.90, indicating a spectrum from brown – orange-brown. Further insights into the color scoring test for *janten* banana fruit leather with carrot substitution can be found in Figure 1, which presents the outcomes of the BNT advanced test.

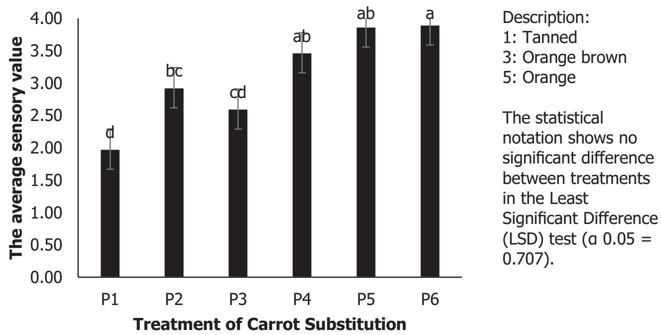

Figure 1. Color sensory test results

Based on Figure 1, the assessment of the fruit leather by panelist in treatment P6 (50% carrot) showed an average score of 3.9 (orangish-brown). This value was not significantly different from P5 (40% carrot) and P4 (30% carrot), with an averages of 3.87 (orangish-brown) and 3.47 (orangish-brown), respectively. According to this data, the proportion of 30-50% carrot content yielded higher color scores compared to treatment P1, P2, and P3 with average scores of 1.98 (brownish - orangish-brown), 2.60 (brownish - orangish-brown), and 2.93 (orangish-brown), respectively. This divergence be attributed to the presence of β-carotene, a compound that confers an orangish tint to the fruit leather. Originally, the product showed a brown color due to a combination of enzymatic and non-enzymatic reactions.

Based on the study data obtained, it was discovered that carrot substitution within the range of 30% to 50% was capable of providing an orangish color, thereby minimizing the brown color due to browning reactions. This report aligned with the observation of Sari & Bahar (2014) who conducted study on sticks supplemented with carrot puree. It was stated that higher levels of the puree content resulted in a progressively intensified orangish coloration. Fajriyati (2011) expounded on the origin of the orangish color in carrots, attributing it to the presence of carotenoid pigments. Among these pigments, β-carotene stand out as the prominent contributor to the coloration (Amiruddin, 2013). Additionally, Winarno (2004), mentioned that the content of β-carotene increases as the color of the vegetable becomes darker. According to Amiruddin (2013), the pigment assumes a pivotal role, serving not only as driving force behind color transformation (orangish) but also as a source of provitamin A, enhancing the nutritional value of food. According to the United States Department of Agriculture (2019a) carrots and bananas contain 8280 μg and 26 μg of β-carotene, an antioxidant that can inhibit aging processes and contribute to overall health maintenance (Octaviani et al., (2014) in Putri, (2016)).

Texture

The results of the variance analysis indicate that carrot substitution does not significantly affect the texture of the fruit leather. The texture values ranged from 2.97 to 3.50 (not plastic - slightly plastic). Figure 2 shows the results of the calculation of the texture scoring test for *janten* banana fruit leather with carrot substitution.

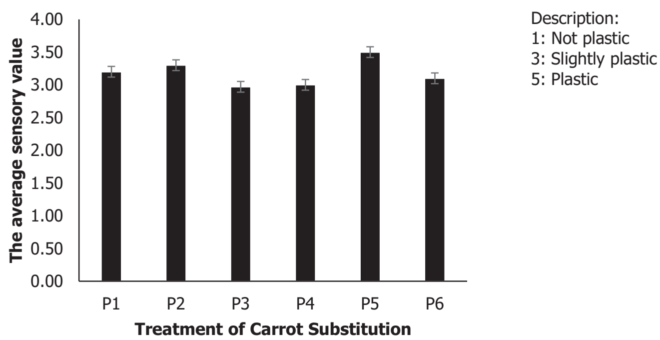

Figure 2. Texture sensory test results

In this study, the texture of the fruit leather was slightly plastic. However, the primary contributors were not solely carrots and bananas. This was attributed to the fact that the both fruits have low pectin content (Ropiani, 2006). The pH value of the *janten* banana fruit puree ranges from 5.07 to 5.18 (primary data, 2021). According to a study conducted by Angelia (2017), pH levels of carrots range between 5.77 to 6.273 (acidic to neutral pH). As such, the gel-forming activity of pectin was sub-optimal. This was supported by Desrosier (1998) who stated that to achieve the optimal gel-forming activity by pectin, an acidic pH level between 2.4 – 3.2 was required. Additional ingredients, such as carrageenan were used as a stabilizer and gel-forming agent, and citric acid as an acidifying agent, with equal amounts in each treatment, respectively at 0.3% and 0.2%.

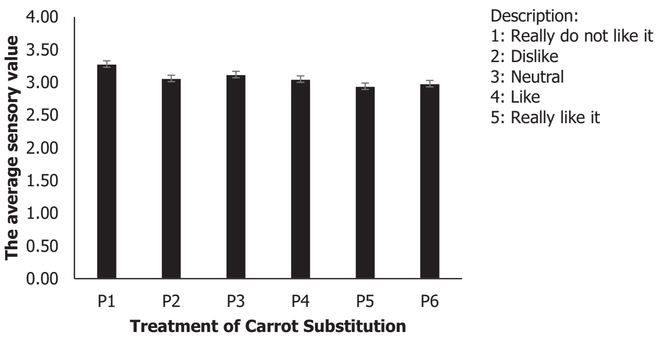

Figure 3. The results of the aroma sensory test

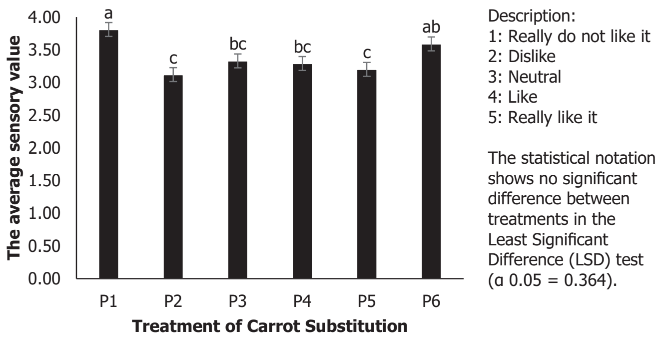

Figure 4. Taste sensory test results

Aroma

The variance analysis for the aroma parameter indicated that carrot substitution does not significantly affect the aroma of the fruit leather. The aroma values ranged from 2.94 to 3.28 (dislike - neutral). Figure 3 showed the results of the calculation of the hedonic test for the aroma of *janten* banana fruit leather with carrot substitution.

Sensory analysis was conducted using hedonic testing, focusing on the aroma parameter of *janten* banana fruit leather with carrot substitution. The results showed that the addition of carrot concentrations ranging from 0 to 50% did not have a significant impact. The aroma from ripe bananas has been effective in minimizing the earthy aroma of carrots. The variation in the intensity was attributed to transformations or degradations, including modifications (hydrogenation and substitution), rearrangements, and degradation into primary metabolites (Luckner, 1984). As a result, the volatile compounds in carrots were replaced by those from *janten* banana. The aroma can also be influenced by the formation of flavor compounds through Maillard reactions (Mauron, 1981). According to Mauron (1981), from a nutritional perspective, the Maillard reaction in food serves as a creator of flavor and aroma. In most cases, the formation of flavor compounds was highly influenced by factors such as temperature, time, reducing sugars, and amino acids present in the ingredients. Eriksson (1981) stated that the higher the temperature and longer the heating time, the more extensive the Maillard reaction occurs. Mottram report (1994) cited in Hustiany (2016) study outlined the crucial role played by amino acids containing sulfur from S-heterocycles as significant source of aroma contribution in food materials.

Taste

The results of the analysis of variance showed that carrot substitution had a significant effect on the taste of fruit leather. The taste value ranged from 3.12 to 3.81 (neutral – likes). Figure 4 shows the results of the calculation of the BNT advanced test conducted on the hedonic evaluation of *janten* banana fruit leather flavor with carrot substitution.

Based on Figure 4, the evaluation of the taste of *janten* banana fruit leather with carrot substitution shows that the panelists assigned an average score of 3.81 to treatment P1 (0% carrot). This value was not significantly different from P6 (50% carrot) with an average score of 3.59 (neutral - like). According to this data, the proportions of 0% and 50% carrot were more preferred compared to P3, P4, P5, and P2, with average scores of 3.33, 3.29, 3.20, and 3.12, respectively. The taste of the fruit leather was influenced by the distinct flavor of the banana. While this product delivers a sweet taste, it effectively retains the distinctive essence of the underlying fruit used (Nurlaely, (2002) in Sidi et al. (2014)). In this study, it was evident that treatments P1 (0% carrot) and P6 (50% carrot) were considered the best treatments. This is because some panelists preferred the sweet taste of the fruit leather, while others liked the a balanced level of sweetness and acidity.

Some bananas have a distinctive and thick taste, such as the *kepok* banana (Eriyana et al., 2017). According to Prabawati *et al*. (2008) in T. K. Putri *et al*. (2015), Ambon, Siem, and Raja bananas have a sweet taste and strong aroma. Arun & Bahl (2007) reported that bananas have yellowish, purplish-white flesh, taste sweet, and have a rather soft texture. Based on this information, the fruit was observed to have a sweet taste due to the sugar content. According to Ikhsan et al. (2014) bananas undergo a respiration process which results in the conversion of starch into sugar. As a result, ripe bananas exhibit a sweeter taste compared to their unripe counterparts.

Overall Acceptance

The results of the analysis of variance showed that carrot substitution had a significant effect on the overall acceptability of fruit leather. The overall acceptance value ranged from 3.13 to 3.77 (neutral – likes). Figure 5

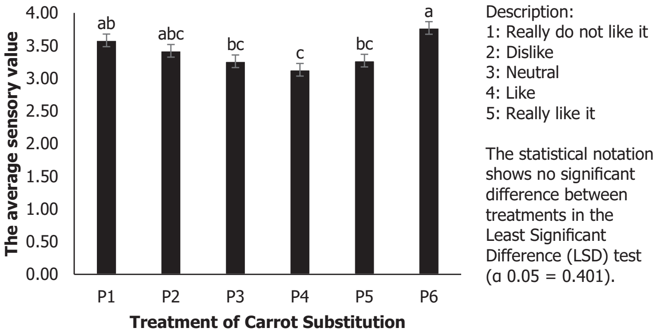

Figure 5. Overall acceptance of sensory test results

shows the results of the calculation of the BNT follow-up test conducted on the hedonic test for the acceptance parameters of *janten* banana fruit leather with carrot substitution.

According to Figure 5, the overall acceptance of *janten* banana fruit leather with a substitution of carrots indicated that treatment P6 achieved an average score of 3.77. This value does not show significant deviation from P1 and P2, which recorded average scores of 3.58 and 3.42, respectively. These results underscore that the 50% carrot mixture generates analogous overall acceptance outcomes when contrasted with the 0% and 10% carrot compositions. It is noteworthy that the 50% carrot composition was favored over treatment P5, P3, and P4, with average scores of 3.27, 3.26, and 3.13.

Best Treatment

The best treatment for *janten* banana fruit leather with carrot substitution was determined through the sensory tests conducted on color, taste, texture, aroma, and overall acceptance. The recapitulation of the best treatment selection data is presented in Table 1.

The best treatment was selected based on sensory characteristics such as color, taste, aroma, texture, and overall acceptance. This was achieved using star notation, which involves assigning letters according to the number of stars. The star notation was given to the letters that are categorized as the best for their respective parameters, as well as those not significantly different from the best parameter. Since the aroma and texture parameters did not show significant differences, the selection of the best treatment focused on the remaining three parameters, namely overall acceptance, taste, and color. Therefore, the best fruit leather was observed to be treatment P6, which was *janten* banana fruit leather with 50% carrot substitution.

CONCLUSION

In conclusion, the optimal composition for creating *janten* banana fruit leather with carrot substitution involved a balanced blend of 50% *janten* banana and 50% carrot. This particular combination resulted in a formulation that showed attributes such as color, texture, aroma, taste, and overall acceptance ratings of 3.90, 3.30, 2.98, 3.59, and 3.77, respectively.

CONFLICT OF INTEREST

The author declared that there was no conflict of interest in completing this study. This statement was truthfully made by the author and if after this research this statement is proven to be untrue, they are prepared to be legally prosecuted.

REFERENCES

Amiruddin, C. (2013). Pembuatan Tepung Wortel (*Daucus carrota* L) dengan Variasi Suhu Pengering. In *Skripsi*. Universitas Hasanuddin.

Angelia, I. O. (2017). Kandungan pH, total asam tertitrasi, padatan terlarut dan vitamin C pada beberapa komoditas hortikultura. *Journal of Agritech Science*, *1*(2), 68–74.

Table 1. Recapitulation of the best treatment selection data

Parameter	Treatment					
	P1	P2	P3	P4	P5	P6
Color	1,98^{d}	2,93^{bc}	2,60^{cd}	3,47^{ab}*	3,87^{a}*	3,90^{a}*
Texture	3,20	3,10	2,97	3,00	3,50	3,30
Aroma	3,28	3,06	3,12	3,05	2,94	2,98
Taste	3,81^{a}*	3,12^{c}	3,33^{bc}	3,29^{bc}	3,20^{c}	3,59^{ab}*
Overall Acceptance	3,58^{ab}*	3,42^{abc}*	3,26^{bc}	3,13^{c}	3,27^{bc}	3,77^{a}*

Arsa, M. (2016). Proses Pencoklatan (*Browning Process*) pada Bahan Pangan. In *Skripsi*. Universitas Udayana.

Arun, B., & Bahl, B. S. (2007). *A Textbook of Organic Chemistry*. S.Chand & Company LTD. New Delhi.

Desrosier, N. W. (1998). *Teknologi Pengawetan Pangan*. UI Press. Jakarta.

Eriksson, C. (1981). *Maillard Reaction in Food: Chemical, Physiological and Technological Aspects.* Pergamon Press. Oxford.

Eriyana, E., Syam, H., & Jamaluddin. (2017). Mutu dodol pisang berdasarkan substitusi berbagai jenis pisang (*Musa paradisiaca*). *Jurnal Pendidikan Teknologi Pertanian*, *3*, 34–41.

Fajriyati, M. (2011). Optimasi proses pemanasan pada pembuatan chips wortel kaya karotenoid menggunakan *Response Surface Methodology*. *Jurnal AgriTechno*, *4*(1).

Fauziah, E., Widowati, E., & Atmaka, W. (2015). Kajian karakteristik sensoris dan fisikokimia *fruit leather* pisang tanduk (*Musa corniculata*) dengan penambahan berbagai konsentrasi karagenan. *Jurnal Aplikasi Teknologi Pangan*, *4*(1), 11–16.

Hasan, A. M. (2017). *Penyebab Anak-anak Tak Suka Makan Sayur dan Buah.* diakses pada tanggal 29 September 2020. https://tirto.id/ckEz?utm_source=CopyLink&utm_medium=Share.

Historiarsih, R. Z. (2010). Pembuatan *Fruit Leather* Sirsak-Rosella. In *Skripsi*. Universitas Pembangunan Nasional Veteran Surabaya.

Hustiany, R. (2016). *Reaksi Maillard - Pembentukan Citarasa dan Warna pada Produk Pangan*. Lambung Mangkurat University Press. Banjarmasin.

Ikhsan, A. M., Tamrin, & Kadir, M. Z. (2014). Pengaruh media simpan pasir dan biji plastik dengan pemberian air pendingin terhadap perubahan mutu pada buah pisang kepok (*Musa Normalis* L). *Jurnal Teknik Pertanian Lampung*, *3*(2), 173–182.

Luckner, M. (1984). Transformation and Degradation of Secondary Products. In *Secondary Metabolism in Microorganisms, Plants and Animals* (2nd ed., Issue D 6, pp. 63–67). Springer-Verlag. https://doi.org/10.1007/978-3-662-02384-6_5

Marzelly, A. D., Yuwanti, S., & Lindriati, T. (2017). Karakteristik Fisik, kimia, dan sensoris *fruit leather* pisang ambon (*Musa paradisiaca* S.) dengan Penambahan gula dan karagenan. *Jurnal Agroteknologi*, *11*(02), 172–185. https://doi.org/10.19184/j-agt.v11i02.6526

Mauron, J. (1981). The Maillard reaction in food; a critical review from the nutritional standpoint. *Progress in Food & Nutrition Science*, *5*(1–6), 5–35.

Musita, N. (2012). Kajian kandungan dan karakteristiknya pati resisten dari berbagai varietas pisang. *Jurnal Dinamika Penelitian Industri*, *23*(1), 57–65.

Nurmahmudah, D. K., Aruben, R., & Suyatno. (2016). Faktor-faktor yang Mempengaruhi konsumsi makan buah dan sayur pada anak pra sekolah PAUD TK Sapta Prasetya Kota Semarang. *Jurnal Kesehatan Masyarakat*, *03*(01), 244–255.

Putri, G. S. N. (2016). Karakteristik Selai Wortel (*Daucus carota* L.) dengan Penambahan Pektin. In *Skripsi*. Universitas Diponegoro.

Ropiani. (2006). Karakteristik Fisik dan pH Selai Buah Pepaya Bangkok. In *Skripsi*. Institut Pertanian Bogor.

Safitri, A. A. (2012). Studi Pembuatan *Fruit Leather* Mangga-Rosella. In *Skripsi*. Universitas Hasanuddin.

Sari, J. M., & Bahar, A. (2014). Pengaruh substitusi tepung mocaf (*modified cassava flour*) dan penambahan puree wortel (*Daucus carota* L) terhadap sifat organoleptik *stick*. *E-Journal Boga*, *03*(02), 26–35.

Sidi, N. C., Widowati, E., & Nursiwi, A. (2014). Pengaruh penambahan karagenan pada karakteristik fisikokimia dan sensoris *fruit leather* nanas (*Ananas Comosus* L. *Merr*.) dan wortel (*Daucus Carota*). *Jurnal Aplikasi Teknologi Pangan*, *3*(4), 122–127.

T. K. Putri, Veronika, D., Ismail, A., Karuniawan, A., Maxiselly, Y., Irwan, A. W., & Sutari, W. (2015). Pemanfaatan jenis-jenis pisang (*Banana* dan *Plantain*) Lokal Jawa Barat berbasis Produk Sale dan Tepung. *Kultivasi*, *14*(2), 63–70. https://doi.org/10.24198/kultivasi.v14i2.12074.

United States Department of Agriculture. (2019a). *Food Data Central (Bananas, raw: SR Legacy, 173944)*.

United States Department of Agriculture. (2019b). *Food Data Central (Carrots, frozen, unprepared: Foundation, 746764)*. https://fdc.nal.usda.gov/fdcapp.html#/food-details/746764/nutrients

Wang, D., Lin, H., Kan, J., Liu, L., Zeng, X., & Shen, S. (2012). Food chemistry. In *Food Chemistry*. https://doi.org/10.1201/b18894-16

Winarno, F. G. (2004). *Kimia Pangan dan Gizi* (11th ed.). PT. Gramedia Pustaka Utama. Jakarta.

Yassin, T., Hartanto, R., Haryanto, A., & Tamrin. (2013). Pengaruh komposisi gas terhadap laju respirasi pisang janten pada penyimpanan atmosfer termodifikasi. *Jurnal Teknik Pertanian Lampung*, *2*(3), 147–160.