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EFFECT OF ADDING LEMONGRASS STALKS ON CHARACTERISTICS OF HERBAL DRINK LEMONGRASS - PALM SUGAR AS A FUNCTIONAL FOOD

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ABSTRACT

Palm sugar is a product made from the sap of lontar tree flowers. Palmira Indonesia has started to develop palm sugar products in the form of powder and drinks. The addition of lemongrass stalks can be used as an alternative to improve product characteristics. This study aims to determine the effect of adding lemongrass stalks and to obtain the sensory characteristics of the lemongrass palm sugar herbal drink. This research was conducted using a completely randomized experimental design with the proportion of addition of lemongrass stalks (0%, 5%, 10%, 15%, 20%, and 25%). The data were analyzed by analysis of variance. If it gives a significant effect, then proceed with Duncan's Multiple Range Test. The results showed that the addition of lemongrass had a very significant effect on the scoring test of taste attributes, significantly on the hedonic test of the taste attributes and not significantly on the hedonic test of the color attribute, total acceptance, and the scoring test of the color attribute. The best treatment that can be used to make a lemongrass-sugar palm herbal drink is a 10% addition of lemongrass stalks. The panelist's acceptance of the treatment was liked for taste, color, and total acceptance attributes with the taste scoring criteria being balanced brown sugar and lemongrass and color scoring criteria being red. This treatment was also containing an antioxidant activity was 69.64% with an IC_{50} was 694.50 ppm, a total dissolved solid was 0.52 Brix, and a color characteristic of L* 26.9, a* 23.16, and b* 37.1 with red oxide criteria.

Keywords: adding lemon grass stalks; herbal drink; functional; palm sugar; phytochemical and sensory characteristic

ABSTRAK

Gula lontar merupakan produk gula yang terbuat dari nira yang didapat dari sadapan bunga pohon lontar yang saat ini di bali sudah mulai kembangkan produk gula lontar dalam bentuk powder dan minuman oleh Palmira Indonesia. Dalam pengembangan minuman tersebut, penambahan batang serai dapat digunakan sebagai salah satu alternatif untuk meningkatkan komponen bioaktif dan memperbaiki karakteristik produk, biasanya batang serai digunakan untuk bumbu masak ataupun minuman tradisional.Penelitian ini bertujuan untuk mengetahui pengaruh penambahan batang serai dan mengetahui karakteristik sensori dari minuman herbal serai-gula lontar. Penelitian ini dilakukan dengan menggunakan Rancangan Percobaan Acak Lengkap dengan persentase penambahan batang serai (0%, 5%, 10%, 15%, 20% dan 25%). Data yang diperoleh dianalisis dengan analisis varians. Jika memberikan pengaruh yang signifikan, maka dilanjutkan dengan Uji Jarak Berganda Duncan. Hasil penelitian menunjukkan bahwa penambahan serai berpengaruh sangat nyata terhadap uji skoring atribut rasa, berpengaruh nyata pada uji hedonik atribut rasa dan berpengaruh tidak nyata pada uji hedonik atribut warna, penerimaan total dan uji skoring warna. atribut minuman herbal serai-gula lontar. Perlakuan terbaik yang dapat digunakan untuk membuat minuman herbal sereh-gula lontar adalah penambahan batang serai 10%. Penerimaan panelis terhadap perlakuan adalah atribut rasa (suka) dengan kriteria penilaian rasa (gula lontar dan serai seimbang), atribut warna (suka) dengan kriteria penilaian warna (merah) dan penerimaan total (suka).Perlakuan ini juga mengandung aktivitas antioksidan 69,64% dengan IC_{50} 694,50 ppm, total padatan terlarut 0,52 ^{o}Brix dan karakteristik warna L* 26,9, a* 23,16 dan b* 37,1 dengan kriteria warna merah oksid

Kata Kunci: gula lontar; karakteristik fisikokimia dan sensori; minuman herbal; penambahan batang serai

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INTRODUCTION

Borassus flabellifer commonly known as Palmyra palm is easily found in Southeast Asia such as India and Indonesia. Palmyra palm known as *lontar* has many benefits and uses as a functional food. According to Gummadi et al., (2016) a product made from the palm plant was found to have anti-inflammatory, anti-rheumatic, antibacterial, analgesic, antipyretic, hypoglycemic, and antioxidant properties. One part of the *lontar* plant that can be used is palm sap. Saranya (2016) reported that palm sap is usually used as a sugar and has several benefits such as a diuretic agent, stimulant, laxative, anti-phlegmatic, tonic, and can function as an antidote and is good for liver health.

The main product of lontar is the sap which is obtained from flower leads and can be drunk directly or processed into sugar. The use of palm sap as sugar in Indonesia has been carried out. One of them was reported by Ledheng dan Naisumu (2020) to improve the quality of processing palm sap which is a product that is used as a regional superior resource in Maubeli Village, East Nusa Tenggara is excavated and developed into printed brown sugar.

In addition, in Bali, the manufacture of brown sugar powder from palm sap has begun in the Ban area, Karangasem. Utilization of palm sap into palm sugar has been carried out which is accommodated by Palmira Indonesia. This group is a social enterprise that produces high-quality organic palmyra sugar made from local natural resources, palmyra palm trees through empowering local communities including local farmers, women, and young people in remote villages of the Eastern part of Bali Island, Karangasem. The palm sugar production process by Palmira Indonesia has obtained a home industry food (*Pangan Industri Rumah Tangga* (P-IRT)) distribution permit and is distributed in retail. The high demand from the public regarding the development of palm sugar products requires Palmira Indonesia to develop products for functional food. Lemongrass is a special type of plant because it contains essential oils which are a supporting factor in the formation of their flavor of the lemongrass plant. Palmira Indonesia intends to develop palm sugar into functional food in the form of herbal drinks with the addition of lemongrass stalks.

The addition of lemongrass stalks in the process of making herbal drinks can increase the bioactive compounds that are good for health and provide unique organoleptic properties for palm sugar products. Evama et al. (2021) reported that the main active ingredients produced by the lemongrass plant are citronellal, geraniol, and citronellol essential oils. Zulfadhli et al., 2017 also reported that other bioactive compounds such as flavonoids, phenols, tannins, saponins, alkaloids, and steroids that support antioxidant activity are also contained in the lemongrass plant.

Based on this, functional food products were developed in the form of making herbal drinks with a combination of palm sugar and lemongrass stalks. The variables observed were the best product were analyzed for their physicochemical such as antioxidant activity, $IC_{50,}$ and the characteristics of the herbal drinks product included organoleptic, color using L*, a* and b*, also Total Dissolved Solids (^{O}brix).

MATERIALS AND METHODS

Material and equipment

The materials used in this study were palm sugar obtained from Palmira Indonesia, dried lemongrass stalks with size (2cm x 2cm) obtained at Badung Market, Aquades (Rofa, Indonesia), 2,2-diphenyl-1- pikrilhidrazil (DPPH) (Sigma Aldrich, USA) and Methanol Pro Analysis (Merck, Germany).

Equipment used in this study included a beaker glass (Pyrex, USA), cylinder (Pyrex, USA), oven (Cole Parmer, USA), analytical balance (Shimadzu, Japan), knife, blender (Phillips, Indonesia), Vortex (Barnsteadl Thermolyne Type 37600 Mixer, USA), UV-Vis spectrophotometer (Biochromsn 133467, UK), micropipette (Dragon Lab, Indonesia) and test tubes (Pyrex, USA).

Sample preparation

Sample preparation in this study was to ensure the availability of the materials used, especially palm

sugar obtained from Palmira Indonesia, and dried lemongrass stalks measuring 2cm x 2 cm. The process of making lemongrass- palm sugar herbal drink is done by adding lemongrass stalks that have been prepared according to the percentage (0%; 5%; 10%; 15%; 20%; 25%) in 200 grams of palm sugar. This study used a completely randomized design (CRD) with the percentage addition of lemongrass stalks. The making of herbal drinks is done by brewing the lemongrass-palm sugar herbal drink which has been formulated according to the treatment in boiling water for 5 minutes with a ratio of 1:15 (w/v). (Ardianta, et al., 2019) with modification.

Sensory properties

Research parameters are sensory properties (Soekarto, 1985) which include hedonic tests on the attributes of taste, color, and overall acceptance as well as scoring tests on taste and color attributes on 25 semi-trained panelists. For Hedonic test criteria: 1 = dislike very much, 2 = dislike, 3 = slightly dislike, 4 = neither like nor dislike, 5 = slightly like, 6 = like, 7 = very much like. For the Scoring test of taste criteria: 1 = Brown sugar, 2 = Brown sugar a little lemongrass, 3 = Brown sugar, and lemongrass are balanced, 4 = Brown sugar is very lemongrass and 5 = The taste of lemongrass is very strong and also for scoring test of color criteria: 1 = Brownish red, 2 = Red, 3 = Yellowish red, 4 = Reddish yellow and 5 = Yellow. Samples are presented in plastic cups in random order with specific sample codes, which is controlled to ensure that the panelists do not see all the samples. The sample presented is a sample of lemongrass-sugar palm herbal drink which has been brewed in boiling water for 5 minutes with a ratio of 1:15 (w/v).

Antioxidant activity

The best treatment according to the sensory properties test was continued by testing the Antioxidant Activity and IC_{50} (Shah and Modi, 2015). A total of 1 ml of 0.1 mM DPPH solution in methanol was dissolved with 2 ml of samples of the lemongrass-palm sugar herbal drink in a test tube. Samples were made by weighing 2 g of sample dissolved in 10 ml of methanol. The solution was vortexed and incubated for 30 minutes in the dark at room temperature. The absorbance was read at a wavelength of 517 nm using a spectrophotometer. The blanko used was methanol. The control was made according to the treatment given in the sample testing process but without adding a sample. The percentage of ability to ward off free radicals (antioxidant activity) is calculated by the formula:

$$\text{Antioxidant Activiy (\%)} = \frac{\text{Control Absorbance} - \text{Sampel Absorbance}}{\text{Control Absorbance}} \times 100\%$$

After testing the antioxidant activity, IC_{50} was tested. IC_{50} is the sample concentration required to inhibit 50% of DPPH free radicals. The sample used was a lemongrass-sugar palm drink with the best treatment. The sample concentration was varied from 0, 250, 500, 750, and 1000 mg/ml, then the antioxidant activity was measured. IC_{50} value can be obtained by linear regression equation (Pourmorad, et al., 2006)

RESULTS AND DISCUSSION

Taste attribute

The results showed that the percentage treatment of the lemongrass stalks addition had a very significant effect ($P<0.01$) on the taste scoring test of the lemongrass-palm sugar herbal drink and a significant effect ($P<0.05$) on the hedonic test of the taste of the palm-sugar lemongrass herbal drink. The average scoring and hedonic test scores for the lemongrass-sugar palm drink are shown in Table 1.

Table 1 shows the highest hedonic test value on the taste attributes of the lemongrass-sugar palm drink was obtained in addition to 10% lemongrass stalks and addition of 20% lemongrass stalks which is 6.05 (liked). The average value was not statistically different from the addition of 5% lemongrass stalks was 5.59 (liked), the addition of 15% lemongrass stalks was 6.00 (liked), and the addition of 25% lemongrass stalks was 5.59 (liked). The average value of the lowest hedonic test on the taste attributes of the lemongrass-palm sugar herbal drink was obtained in without the addition of

lemongrass stalks which was 5.00 (slightly liked). This can be interpreted that the panelists liking the taste of the sugar palm herbal drink with the addition of lemongrass stalks compared to those without the addition of lemongrass stalks. This is because lemongrass stalks have volatile oil compounds that can function as aroma compounds and affect the taste of the herbal drinks product. This is supported by the statement of Togatorop et al. (2015) who reported that the addition of lemongrass affects the hedonic value of the beverage's aroma because lemongrass has a strong aroma. This is supported by a statement from Evama et al., (2021) who reported that the main components contained in lemongrass stems were essential oils, such as citronellal, geraniol, and citronellol. The main component of lemongrass essential oil can affect the aroma of the product because it has a distinctive aroma (Satuhu and Yuliani, 2012). Besides the addition of lemongrass, several components contained in palm sugar also influence the taste of the resulting lemongrass-palm sugar herbal drink. Le et al., (2021) reported that a total of 38 volatile compounds were identified in palm sugar and the compound S-(R'R')-2,3-butanediol was thought to contribute to the unique taste of palm sugar.

Table 1. The Average Value of the Hedonic and Scoring Test of the Lemongrass-Palm Sugar Herbal Drink Taste Attributes

Treatments	Hedonic Taste	Taste Score
PO (Without Addition of Lemongrass Stalks (0%))	5,00±1,60b	1,00±0,00e
P1 (Addition of 5% Lemongrass Stalks)	5,59±1,26ab	2,23±0,69d
P2 (Addition of 10% Lemongrass Stalks)	6,05±0,90a	2,64±0,66cd
P3 (Addition of 15% Lemongrass Stalks)	6,00±1,20a	2,82±0,91c
P4 (Addition of 20% Lemongrass Stalks)	6,05±0,95a	3,41±0,91b
P5 (Addition of 25% Lemongrass Stalks)	5,59±1,50ab	4,00±1,02a

Note: Different letters behind the mean value indicate a very significant difference (P<0.01). Hedonic test criteria: 1 = dislike very much, 2 = dislike, 3 = slightly dislike, 4 = neither like nor dislike, 5 = slightly like, 6 = like, 7 = very much like; Scoring test criteria: 1 = Brown sugar, 2 = Brown sugar a little lemongrass, 3 = Brown sugar and lemongrass are balanced, 4 = Brown sugar is very lemongrass and 5 = The taste of lemongrass is very strong.

The results of the scoring test on the taste attributes of the lemongrass-sugar palm herbal drink shown in Table 1 indicate that the panelists can distinguish the taste of herbal drink products that are added with lemongrass stalks. The taste was more bitter when more lemongrass was added. The highest average value was obtained with the addition of 25% lemongrass stalks which was 4.00 (very lemongrass brown sugar) and the lowest average value was obtained in without the addition of lemongrass stalks which was 1.00 (brown sugar). Taste is the process of selecting food products from the cooperation of the five kinds of human senses which include taste, smell, touch, sight, and hearing which can be distinguished from taste or several attributes of food products which include appearance, aroma, taste, texture, and temperature. The higher lemongrass stalks are added, the lemongrass flavor will be stronger in the herbal drink product. This is because lemongrass stalks contain volatile oil compounds. (Evama, et al., 2021) reported that citronellal, geraniol, and citronellol essential oils are the main components of lemongrass. In addition, Satuhu and Yuliani (2012) also reported that the main components of lemongrass essential oil such as citronellal, geraniol, and citronellol act as aroma compounds so that lemongrass has a distinctive aroma.

Color attribute

The results showed that the percentage treatment of the lemongrass stalks addition had no significant effect (P>0.05) on the scoring test and the hedonic test for the color of the lemongrass palm sugar herbal drink. The average value of the scoring and hedonic color tests for the lemongrass-sugar palm herbal drink is shown in Table 2.

Table 2 showed that the panelist's assessment of the hedonic test of the lemongrass sugar palm drink color attribute ranged from 5.27-5.68 with the criteria of slightly liked to like. The average value of the hedonic test on the color attribute of the lemongrass-palm sugar herbal drink was highest in the addition of 20% lemon grass stalks which was 5.68 (liked) while the lowest average was found in the addition of 5% lemongrass stalks which was 5.27 (slightly liked). The addition of lemongrass stalks did not affect the hedonic color test of the

resulting palm sugar lemongrass herbal drink and that indicates the panelist can accept the color of the product.

Table 2. The Average Value of the Hedonic and Scoring Test of the Lemongrass-Palm Sugar Herbal Drink Color Attributes

Treatments	Hedonic Color	Color Score
PO (Without Addition of Lemongrass Stalks (0%)	5,41±1,10	1,55±0,91
P1 (Addition of 5% Lemongrass Stalks)	5,27±1,12	1,55±0,67
P2 (Addition of 10% Lemongrass Stalks)	5,59±0,91	1,77±0,87
P3 (Addition of 15% Lemongrass Stalks)	5,41±1,18	1,95±0,90
P4 (Addition of 20% Lemongrass Stalks)	5,68±0,99	2,14±1,21
P5 (Addition of 25% Lemongrass Stalks)	5,36±1,14	2,27±1,16

Note: Hedonic test criteria: 1 = dislike very much, 2 = dislike, 3 = slightly dislike, 4 = neither like nor dislike, 5 = slightly like, 6 = like, 7 = very much like; Scoring test criteria: 1 = Brownish red, 2 = Red, 3 = Yellowish red, 4 = Reddish yellow and 5 = Yellow.

The results of the color attributes scoring test of the lemongrass-palm sugar herbal drink as presented in Table 2 show that the panelist's assessments ranged from 1.55-2.27 with the Red criteria. The highest average value in the assessment of the color attribute scoring test was obtained in addition of 25% lemongrass stalks which was 2.27 (red) and the lowest average value was obtained in the sample without the addition of lemongrass stalks and also the addition of 5% lemongrass stalks which is 1.55 (red). The addition of lemongrass stalks at a certain percentage causes an increase in the average value of the color attribute scoring test of the resulting lemongrass-sugar palm drink that became darker. The color produced by the lemongrass herbal drink in each treatment is included in the red color criteria. This is because the color of palm sugar dominates more than the color given by lemongrass. Maillard reaction is one of the factors that affected the formation of color in sugar. This is because glucose and fructose with amino groups play an important role in the formation of color in sugar. In addition, the addition of lemongrass stalks has not been able to affect the color. This could be because the percentage of lemongrass added was not optimal to change the color of the herbal drink produced. According to (Omarta et al., 2020) lemongrass in the form of an extract has a characteristic pale yellow color.

Overall acceptances

The results showed that the percentage treatment of the lemongrass stalks addition had no significant effect (P>0.05) on the hedonic test of the lemongrass-palm sugar herbal drink overall acceptance attribute. The average value of the hedonic test on the overall acceptance attribute of the lemongrass-sugar palm drink is shown in Table 3.

Table 3. The Average Aalue of the Hedonic Test of the Lemongrass-Palm Sugar Herbal Drink's Overall Acceptance

Treatments	Overall Acceptance
PO (Without Addition of Lemongrass Stalks (0%))	5,14±1,67
P1 (Addition of 5% Lemongrass Stalks)	5,55±1,26
P2 (Addition of 10% Lemongrass Stalks)	6,05±1,00
P3 (Addition of 15% Lemongrass Stalks)	5,91±1,11
P4 (Addition of 20% Lemongrass Stalks)	5,95±0,95
P5 (Addition of 25% Lemongrass Stalks)	5,68±1,36

Note: Hedonic test criteria: 1 = dislike very much, 2 = dislike, 3 = slightly dislike, 4 = neither like nor dislike, 5 = slightly like, 6 = like, 7 = very much like

Table 3 showed that the panelist's assessment of the hedonic test of the lemongrass-sugar palm drink's overall acceptance attribute ranged from 5.14 to 6.05 with the criteria of slightly liked to like. The average value of the hedonic test on the overall acceptance attribute of the lemongrass-sugar palm drink was highest in addition to 10% lemon grass stalks which was 6.05 (liked). The lowest value on the overall acceptance attribute of lemongrass herbal drink - palm sugar was found in the sample without the addition of lemongrass stalks which was 5.14 (slightly liked). The assessment of the overall acceptance attribute of the panelists was influenced by several factors such as the color and taste of the lemongrass-palm sugar herbal drink.

Physicochemical characteristics of herbal drinks with the best treatment

The physicochemical characteristics of the palm sugar herbal drink with the best treatment were tested on color criteria with L*, a*, and b* using a colorimeter application, total dissolved solids (^{o}Brix) using a refractometer, antioxidant activity, and IC_{50}. The addition of 10% lemongrass stalks was selected as the best treatment based on the best sensory characteristics that had been tested on semi-trained panelists. The results of the physicochemical characteristics test which include antioxidant activity, total dissolved solids (^{o}Brix), IC_{50}, and color criteria which include L*, a*, and b* lemongrass- palm sugar herbal drink shown in Table 4.

Table 4. The Average Value of the Lemongrass-Palm Sugar Herbal Drink Physicochemical Test

Treatment	Antioxidant Activity (%)	IC_{50} (ppm)	Total Dissolved Solids (^{O}brix)	L*	a*	b*
P2 (Addition of 10% Lemongrass Stalks)	69,64±2,81	694,50±48,36	0,52±0,08	26,9±7,03	23,16±2,96	37,1±8,04

Table 4 shows the average value of the physicochemical test of the lemongrass palm sugar herbal drink in the best treatment was a 10% addition of lemongrass stalks. Sample testing with the best treatment was carried out with 5 replications. The physicochemical characteristics obtained antioxidant activity of 69.64% with an IC_{50} value of 694.50 ppm (very weak), a total dissolved solids (TSS) value of 0.52 ^{o}Brix with color criteria L* 26.9, a* 23.16 and b* 37.1 which has the color criteria of red oxide.

The average value of lemongrass- palm sugar herbal drink antioxidant activity was influenced by the bioactive compounds that function as antioxidants contained in each ingredient. This is supported by the statement of Silou et al., (2017) who reported that lemongrass stalks contain essential oils such as citronellal (40-48%), geraniol (10-22%), citronellol (10-12%), limonene (2-3%), geranyl acetate (1-2%), linalool (1%) which can function as antioxidants. In addition, (Najmah et al., 2021) also reported that the n-hexane fraction of lemongrass contains ar-turmerone as an antioxidant, as well as beesioside N and notohamosin A that can function as antidiabetic. In addition, the palm sugar used also contributes several compounds as antioxidants. This is supported by the statement from Le et al., (2021) who reported that palm sugar contains total phenolics ranging from 1.78-5.15 mg GAE/g and contains several vitamins such as vitamins B1, B2, B3, B5, B6, vitamin C, vitamin D, folic acid and vitamin E which can function as antioxidants.

The IC_{50} value obtained from the lemongrass-palm sugar herbal drink with the best treatment was 694.50 ppm. The criteria for the IC_{50} value are very weak. This is because, in the production process of lemongrass-palm sugar herbal drinks, the ingredients go through several processes such as heat treatment. The presence of bioactive compounds that functions as an antioxidant which is indicated by the identification of the percentage of antioxidant activity and the IC_{50} of the product indicates that the herbal drink produced from the combination of lemongrass stalks and palm sugar can be categorized to be an herbal drink.

CONCLUSION

The conclusion of this study is the additional percentage of lemon grass stalks has a very significant effect on the scoring test of the taste attribute, significantly affects the hedonic test of the taste attribute, and has no significant effect on the hedonic test of the color attribute, overall acceptance and the color attribute scoring test of the lemongrass-sugar herbal drink. The best treatment that can be used to make a lemongrass-sugar palm herbal drink is a 10% addition of

lemongrass stalks. The panelist's acceptance of the treatment was hedonic taste attribute (liked) with taste scoring criteria (balanced brown sugar and lemongrass), hedonic color attribute (liked) with color scoring criteria (red), and overall acceptance (liked). This treatment was also able to produce an antioxidant activity value of 69.64% with an IC_{50} value of 694.50 ppm, a total dissolved solid of 0.52 ^{o}Brix, and a color characteristic of L* 26.9, a* 23.16 and b* 37.1 with red oxide criteria.

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REFERENCES

Ardianta, I.K., Yusa, N.M. and Putra, I.N.K. 2019. Pengaruh Suhu Pencelupan Terhadap Karakteristik Minuman Teh Herbal Kulit Buah Naga Merah (*Hylocereus polyrhizus*). *Jurnal Ilmu dan Teknologi Pangan (ITEPA)*, 8(1), p.18.

Evama, Y., Ishak and Sylvia, N. 2021. Ekstraksi Minyak Serai Dapur (*Cymbopogoon Citratus*) Menggunakan Metode Maserasi. *Jurnal Teknologi Kimia Unimal*, 10(2), pp. 57–70.

Gummadi, V.P., Battu, G.R., Diyya, M.S. and Manda, K.A. 2016. A review on palmyra palm (*Borassus flabellifer*). *International Journal of Current Pharmaceutical Review and Research*, 8(2), pp. 17–20.

Le, D.H.T., Chiu, C., Chan, Y., Wang, C.C.R., Liang, Z., Hsieh, C., Lu, W., Mulio, A.T., Wang, Y. and Li, P. 2021. Bioactive and physicochemical characteristics of natural food: Palmyra palm (*Borassus flabellifer* Linn.) syrup, *Biology*, 10(10), pp. 1–15.

Ledheng, L. and Naisumu, Y.G. 2020. Pemanfaatan Nira Lontar Menjadi Gula Merah Cetak Di Kelurahan Maubeli, Kecamatan Kota Kefamenanu, Kabupaten TTU – NTT. *Bakti Cendana*, 3(1), pp. 26–33.

Najmah, H. and Faridah, D.N. 2021. Antioxidant Activity, Inhibition α-Glucosidase of Cymbopogon nardus (L.) Rendle and Identification of Active Compounds. *Curr. Biochem*, 8(1), pp. 24–36.

Omarta A. Jayuska, and Silalahi, I.H. 2020. Karakterisasi Komponen Destilat Minyak Sereh Wangi (*Cymbopogon nardus* L. Rendle) dari Kecamatan Kuala Behe Kabupaten Landak. *Indonesian Journal of Pure and Applied Chemistry*, 3(3), pp. 33–43.

Pourmorad, F., Hosseinimehr, S.J. and Shahabimajd, N. 2006. Antioxidant activity, phenol, and flavonoid contents of some selected Iranian medicinal plants. *African Journal of Biotechnology*, 5(11), pp. 1142–1145.

Saranya P. 2016. Characterization of palmyra fruit (*Borassus flabellifer* Linn) pulp and development of ready-to-serve beverage from palmyra fruit pulp. Ph.D. thesis, Periyar University.

Shah, P. and Modi, H.A. 2015. Comparative Study of DPPH, ABTS, and FRAP Assays for Determination of Antioxidant Activity. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 3(6), pp. 636–641.

Silou, T., Bikanga, R., Nsikabaka, S., Nombault, J., Mavoungou, C., Figuérédo, G. and Chalchat, J.C. 2017. Plantes aromatiques du plateau des cataractes (Bassin du Congo). Caractérisation du chémotype de l'huile essentielle de (*Cymbopogon nardus* (L.) Rendle acclimaté au Congo-Brazzaville. *Biotechnology, Agronomy and Society and Environment*, 21(2), pp. 105–116.

Satuhu, Y., and Sri, Y. 2012. *Panduan Lengkap Minyak Atsiri*. Jakarta: Penebar Swadaya.

Soekarto, S. T. 1985. *Penilaian Organoleptik*. Bhatara Karya Aksara: Jakarta.

Togatorop, D.M.,.Nainggolan, R.J and Lubis, L.M. 2015. Pengaruh Perbandingan Sari Batang Sereh Dengan Sari Jahe Dan Konsentrasi Serbuk Gula Aren Terhadap Mutu Serbuk Minuman Penyegar Sereh. *Jurnal Rekayasa Pangan dan Pertanian*, 3(2), pp. 157-163.

Zulfadhli, Z., F. Andila, Diana and R. Rinawati. 2017. Pengaruh Ekstrak Batang Serai (*Cymbopogon citratus*) Terhadap Pertumbuhan Bakteri *Edwardsiella* Tarda Secara In Vitro. *Jurnal Akuakultura*, 1(1), pp. 44-47.