The Development Product of Cascara Moringa (*Moringa oleifera*) Tea

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Abstract. Cascara is a herbal drink made from dried coffee husks. Cascara has a strong sour taste and a brownish red color similar to tea. Cascara contains polyphenol and antioxidant compounds. One effort to improve the quality of cascara products is to combine them with Moringa leaves (*Moringa oleifera* L.). Compounds contained in Moringa leaves are tannins, saponins, alkaloids, and phenols. A product to be developed must have good quality in order to increase the selling value of the product itself. The objective of this research was to produce cascara moringa tea beginning with the manufacture of products with five formulation ratios of cascara : moringa , namely T_0 (100% : 0%), T_1 (90% : 10%), T_2 (80% : 20%), T_3 (70% : 30%), and T_4 (60% : 40%) in three replicates, then the physical, chemical, organoleptic, and microbiological characteristics were analyzed. The best formulation of the cascara moringa product was obtained from the T_2 (80% cascara : 20% moringa) which had the best assessment from the panelists of the color (3.74) and taste (3.49) attributes, as well as the third preferred aroma attribute (3.35). Then, T_2 gave also the L* value of 28.536; pH value of 5.16; water content of 15.835%, total phenol of 26.720 mg GAE/g, antioxidant activity of 51.452%, and total microbes of 9.43 x 10^3 cfu/ml.

Keywords: Cascara, Moringa, Polyphenol, Antioxidant.

1 Introduction

Cascara is a drink made from coffee skins which are processed by drying. Cascara has actually been known for a long time in other countries but is still rarely found in Indonesia. The term cascara comes from Spanish which means skin [1], where cascara is coffee skin that is processed by drying [2]. The characteristics of cascara has a sweet taste, a reddish yellow color, and a distinctive aroma. Cascara has the characteristics of having a strong taste, strong aroma and containing polyphenol compounds [3]. Cascara has the opportunity to be developed into a herbal drink product, but cascara still has a lack, namely a sour smell. One way to improve the quality of cascara is by combining it with other herbal ingredients such as Moringa (*Moringa oleifera* L.) leaves which can cover the sour smell of cascara. Moringa leaves are rich in nutrients including calcium, iron, phosphorus, potassium, zinc, protein, vitamin A, vitamin B, vitamin C, vitamin D, vitamin E, vitamin K, folic acid, and biotin [4]. The addition of Moringa leaves with cascara was carried out as an effort to diversify products because so far Moringa leaves are still limited to be

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consumed as a drink. Apart from that, it can also economically increase the added value of Moringa plants. The aim of this research was to produce a functional drink made from cascara and moringa leaf.

2 Materials and Methods

2.1 Materials

The main equipments used in this research were blender (made by Philips ind.), hand sealer (made by Willman ind.), analytical balance (Ohaus eq. ind.), pH meter (Martini Mi 151), UV-VIS spectro-photometer (Genesys 10 USA), colorimeter CS-10, vortex (VM-300 Taiwan), incubator (Memmert), laminar air flow (Crumair), autoclave (Hirayama HI, Japan), 40 mesh sieve, colony counter, and some glass equipments. The materials used were cascara, moringa leaves, gallic acid, Follin-ciocalteu reagent, 7% Na_2CO_3, DPPH solution, 0.85% NaCl, and Plate Count Agar (PCA) media, and tea bag.

2.2 Cascara Moringa Tea Production

The process of making Moringa powder started with the washing process of leaves before being drained and dried under the sun. The dried Moringa leaves were then crushed with a blender before sieving using a 40 mesh sieve until Moringa leaf powder was obtained. Cascara as a main raw material is from Java Arabica coffee skins obtained from Ijen Estate – East Java. The initial stage of making cascara moringa products is to crush the cascara using a grinder to produce powdered cascara. Next, cascara sieving was carried out using a 40 mesh sieve. Cascara powder is then mixed with Moringa powder with certained ratios, then packaged using tea bags weighing 2 g each before being put into a standing pouch packaging containing 10 bags.

2.3 Experimental Design

The experimental design used in this research was a Completely Randomized Design (CRD) with a single factor experiment, namely the ratio of cascara and moringa with 5 treatments. Each treatment was repeated 3 times to obtain 15 experimental units. The ratio used in making the product is as follows:

T_0 = Cascara 100% : Moringa Leaves 0%
T_1 = Cascara 90% : Moringa Leaves 10%
T_2 = Cascara 80% : Moringa Leaves 20%
T_3 = Cascara 70% : Moringa Leaves 30%
T_4 = Cascara 60% : Moringa Leaves 40%

2.4 Color Lightness (L)

The color testing procedure (L*) begins with brewing cascara moringa. The test sample is then put into a clear plastic bag and tested for brightness using a color

reader. The color of the sample was measured by attaching the tip of the color reader lens to a clear plastic surface containing cascara moringa brew.

2.5 pH Values

The brew is made by placing a test sample bag (± 2 g) in a glass and added with 200 ml of boiling water. A volume of 50 mL cascara moringa infusion was placed in a glass, and the pH meter was then immersed in it for a few seconds until it showed a constant pH value.

2.6 Water Content

The amount of 2 g of cascara moringa tea was weighed and put on a glass plate known its weight before (A). The plate was then heated in the oven for 5 hours at 105^{O}C, before being cooled in a desiccator for 15 minutes. After cooling, the plate including the sample was weighed (B). This stage was repeated until the weight of the sample was constant with a weighing difference of ± 0.2 mg respectively. Water content is calculated using the formula:

$$Water\ Content\ = \frac{(A)-(B)}{Sample} x100\%$$

2.7 Total Phenol

Total polyphenol analysis was carried out using the Follin-ciocalteau reagent. Analysis of total phenols in the material was calculated based on the gallic acid standard curve (*C*). The process began with weighing 1.5 g of cascara moringa sample and diluted in 50 ml of distilled water. A volume of 0.05 ml was taken (*V*) and diluted again using distilled water until a volume of 5 ml (*d*) before being added with Folin-Ciocalteu reagent. After mixing, the sample was then added with Na_2CO_3 solution. The sample solution was wrapped in aluminum foil and then left for 60 min. The absorbance was measured at λ 765 nm using a spectrophotometer. Total phenol can be calculated using the formula:

$$Total\ Phenol\ (mg\ GAE/g) = \frac{C\ x\ V\ x\ d}{Extract\ g}$$

Explanation :
C = equivalent concentration from the standard curve
V = volume of analysis
d = dilution factor

2.8 Antioxidant Activity

The antioxidant activity was measured based on the method of Kekuda [5]. The cascara moringa tea (1.5 g) was diluted in 50 ml of distilled water. A certain volume of cascara moringa solution was then diluted in distilled water until a volume of 5 ml. The sample solution was added with 3.5 ml of 400 µM DPPH solution and left for 30 minutes. The sample solution was then measured for absorbance at λ 765 nm using a spectrophotometer. Antioxidant activity can be calculated using the formula:

$$\%\ inhibition\ = \frac{Abs\ Blank\ x\ Abs\ Sample}{Abs\ Sampel} x100\%$$

2.9 Hedonic Test

The hedonic test was carried out by 100 persons filling in the questionnaire provided. The panelists used were untrained panelists with an age range of 17 years - over. The attributes assessed in this hedonic test include color, taste, and aroma with the value scale of 1 (dislike very much), 2 (dislike), 3 (rather like), 4 (like), 5 (like very much).

2.10 Total Microbes

The number of microbes was calculated using total plate count [6]. About 5 g of cascara moringa sample was weighed and dissolved in 45 ml of 0.85% NaCl solution. Then, some dilutions were developed and 1 ml of each dilution was placed in a petri dish before being covered by the addition of 15 ml PCA media. All petri dishes were then incubated at a temperature of 35ºC for 48 h. Microbial numbers were examined using a colony counter and were calculated using the following formula:

$$N = \frac{\sum C}{((1\ x\ n1)+(0{,}1\ x\ n2)+(0{,}01\ x\ n3))xd}$$

Explanation :
N = total colonies
$\sum C$ = total colonies counted
$n1$ = total plates at dilution 1
$n2$ = total plates at dilution 2
$n3$ = total plates at dilution 3
d = dilution level

2.11 Effectivity Test

Determination of the best treatment is based on the effectiveness index method [7], started with assigning a weight value to each parameter with numbers 0-1 based on the level of importance of each parameter. The higher the importance level of the parameter, the higher the value given. The result values for each parameter were added up to find out the total result value. The highest total result value indicated the best treatment results.

$$Weight\ Value\ Parameter = \frac{Weight\ Value\ (WV)}{Total\ Weight\ Value\ (TWV)}$$

$$Effectivity\ Value\ (EV) = \frac{Treatment\ \ Value - Bad\ Value}{Good\ Value - Bad\ Value}$$

$$Result\ Value\ (RS) = Effectivity\ Value\ x\ Weight\ Value\ Parameter$$

3 Results and Discussion

3.1 Color Lightness

A lower clarity value indicates an increasingly cloudy clarity quality, while a higher clarity value indicates the clarity quality of the brewed water is transparent [8]. The results of the brightness analysis (see Fig. 1).

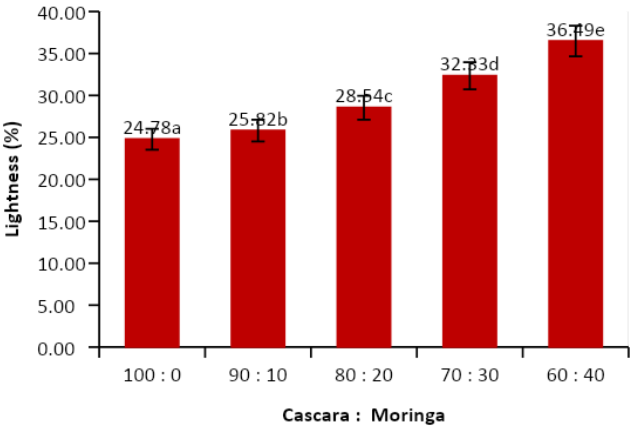

Fig. 1. The lightness of cascara moringa tea

The results of analysis of variance (Anova) with a confidence level of 95% ($\alpha = 0.05$) show that the difference in the ratio of cascara : moringa leaves has a significant effect on the brightness of the brew in all samples. The brightness value increases with the higher the ratio of Moringa leaves. Coffee skin contains pigment-forming compounds, namely anthocyanins. Arabica coffee skin has anthocyanin of 12.48 mg/L [9]. The color change of cascara is formed due to the degradation of anthocyanins during the drying process of the coffee skins. Alteration of anthocyanin structure caused by increasing temperature happens with releasing of sugar molecules attached to anthocyanin structure, and transformation into an aglycon named anthocyanidin. High temperatures during the drying process will damage the anthocyanins in the coffee skin. Based on research, anthocyanin pigments occured degradation at temperatures above 70°C [10]. The use of a higher ratio of Moringa leaves can have an effect on increasing the clarity value of the cascara brew. This is because the color of Moringa leaf tea is green due to chlorophyll availability and drying does not change the color of the leaves [11].

3.2 The pH Value

The power of hydrogen (pH) , usually called the degree of acidity, is a parameter used to determine the acidity or alkaline level of a food or drink [12]. The results of the analysis of the pH value of cascara moringa can be seen in Fig. 2.

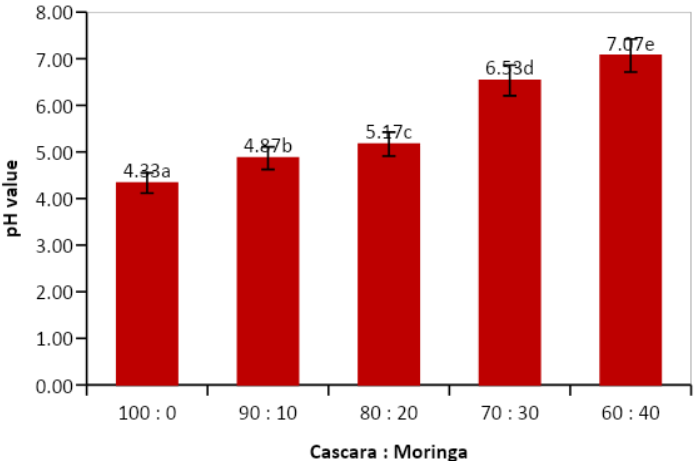

Fig. 2. The pH value of cascara moringa tea

The results of analysis of variance with a confidence level of 95% (α = 0.05) showed that the difference in the ratio of cascara : moringa leaves had a significant effect on the pH value in all samples. The pH value increases with the higher the ratio of Moringa leaves. The decrease in the pH value is accompanied by an increase in the cascara ratio, because the pH value of the cascara raw material is more acidic, namely 4.3, compared to the pH value of moringa which is neutral, namely between 5.8 - 6.0 [13].

3.3 Water Content

Water content is one of the factors that influences the shelf life of food products, which a high water content in food products will cause a higher potential for microbiological damage [14]. The results of water content of cascara moringa tea can be seen in Fig. 3.

The results of analysis of variance with a confidence level of 95% (α = 0.05) show that the difference in cascara moringa ratio has a significant effect on the water content values. The average water content of cascara moringa was in a range of 9.34 - 12.06%. Based on the Indonesian National Standard for green tea (SNI 4324:2014) and for black tea (SNI 3753:2014), the maximum standard of water content value for tea products is 10%. The water content of dried Moringa leaves is 6.64% [15]. Meanwhile, the water content of dried cascara in this study was 9.34%. The water content increased with the lower of cascara and the higher of Moringa leaves. One factor that influences the percentage of water content is the drying time. Cascara is dried for 30 days in the sun, while Moringa leaves are dried for 4 days. The longer the drying time, the lower the water content obtained. The longer the drying time applied, the more heat the material will receive so that the amount of water that is evaporated in the food increases resulting in a lower water content [16].

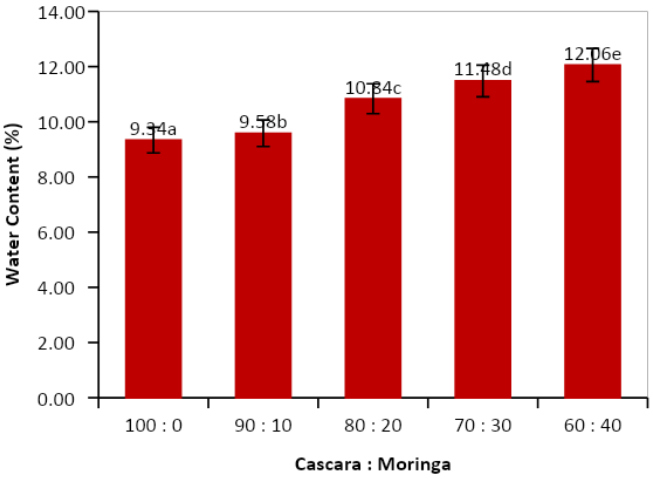

Fig. 3. The water content of cascara moringa tea

3.4 Total Polyphenol

Phenol is a secondary metabolite and a class of bioactive compounds that are beneficial for health and non-toxic originating from plants [17]. The total polyphenol content is expressed as gallic acid equivalent (GAE). The results of the total phenolic analysis of cascara moringa tea can be seen in Fig. 4.

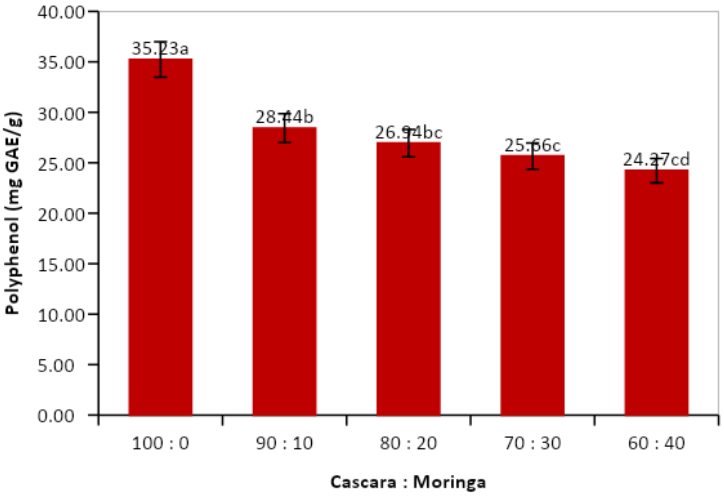

Fig. 4. Total polyphenol of cascara moringa tea

The results of analysis of variance at a 95% confidence level (α = 0.5) showed that total polyphenols at the various ratio of cascara and Moringa leaves were significantly different. Based on the average total polyphenols of cascara and Moringa leaves, it ranges from 24.27 mg GAE/g to 35.23 mg GAE/g. The decrease in total polyphenol in cascara moringa tea was due to the total polyphenol in Moringa leaves being lower than the total polyphenol in cascara. The total polyphenol in dried Moringa leaves is 17.12 mg GAE/g [18], while the total polyphenol in dried cascara is 26.12 mg GAE/g [19]. Based on this value, the decrease of cascara in the mixture resulted in the decrease of polyphenol content. The addition of Moringa leaves was not significantly able to maintain the total polyphenol in tea.

3.5 Antioxidant Activity

Antioxidants are compounds that occur naturally in food. This compound functions to protect food from damage caused by the oxidation reaction of fats and oils, so that the food has a rancid aroma [20]. The results of analysis of variance with a confidence level of 95% (α = 0.5) showed that the difference in the ratio of cascara : moringa leaves had no significant effect on the antioxidant activity obtained, but it had different values in each sample. Based on the average antioxidant activity of cascara moringa, it ranges from 49.547% to 53.285% (see Fig. 5).

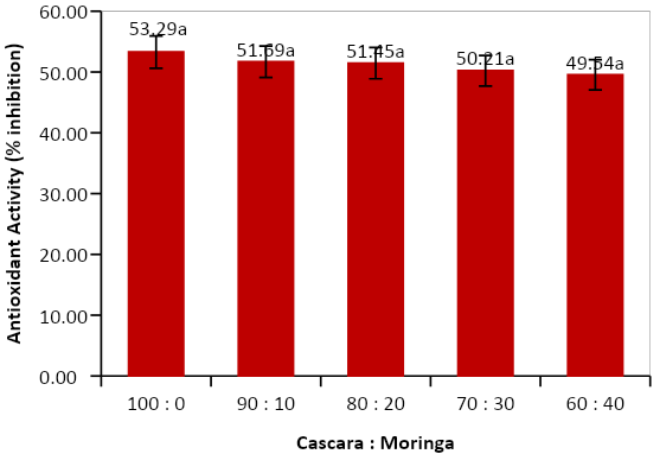

Fig. 5. The antioxidant activity of cascara moringa tea

Factors that influence antioxidant activity are the type of material and processing method [21]. The antioxidant compounds contained in cascara include flavan-3-ol, hydroxamic acid, catechin, and ferulic acid [22]. Cascara has the most dominant phenolic content, namely protocatechuic acids 85 mg/L and chlorogenic acid 69.9 mg/L. These two compounds have good heat stability up to a temperature of 85°C so that the antioxidant activity of phenolic compounds is still relatively large [22]. The main chemical components found in Moringa leaves are polyphenols and flavonoids which have antioxidant activity. The main polyphenol content in Moringa leaves is gallic acid, quercetin, and kaempferol [23].

3.6 Organoleptic Test

Color Preference. Color is one of the parameters assessed by consumers to increase the interest of buying a product. The level of preference for the color of cascara moringa tea can be seen in Fig. 6.

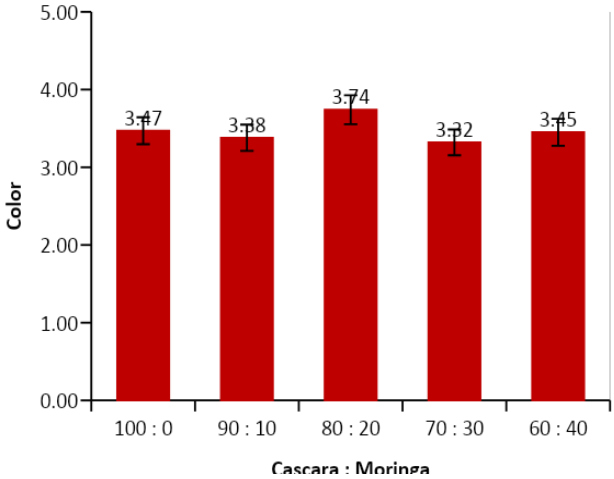

Fig. 6. The color preference of cascara moringa tea

Based on the chi square test ($\alpha \leq 0.05$), the ratio of cascara : moringa leaves influences the level of color preference. Differences in the level of panelist's preference for the color of cascara moringa tea drink can be influenced by differences in color value (L*). Based on the results of the hedonic test for color parameters, it is known that the panelists preferred the tea drink of cascara : moringa at a ratio of 80 : 20. This shows that the panelists prefer the color of the cascara moringa tea drink which tends to be dark in color. When the moringa was increased, the tea color changed to be brighter which was related to the higher of the brightness value (L*) indicating that the cascara moringa drink is lighter.

Taste Preference. Taste is one of the main factors in determining a product's acceptability to consumers. The level of preference for the taste of cascara moringa brew can be seen in Fig. 7. Based on the chi square test ($\alpha \leq 0.05$), the ratio of cascara : moringa leaves influences the level of taste preference. The results show that the average level of taste preference of cascara moringa tea is between 2.40 to 3.49. The causal factor that influences the panelist's taste preferences parameters brew is the difference in ingredient ratios The higher the ratio of cascara used, the more sour the resulting taste. While the higher the ratio of Moringa leaves, the taste of cascara moringa tea drink was more astringent. The predominant acid compound in cascara is chlorogenic acid which is about 42% [21].

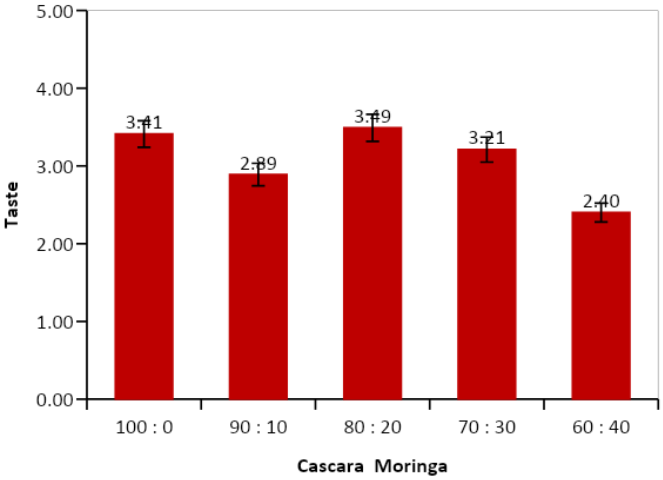

Fig. 7. The taste preference of cascara moringa tea

The addition of Moringa leaves can cause an astringent taste in the tea drink. This is due to the presence of saponin and tannin compounds in Moringa leaves. Saponin compounds have a bitter and foamy taste when dissolved in water, while tannin compounds cause an astringent taste when it is consumed. This astringent is due to the formation of cross-links between tannin and protein in the oral cavity [24].

Aroma Preference. Analysis of aroma preferences is a parameter that is difficult to measure by the sense of smell because each individual has different odor preference sensitivities. The level of preference for the aroma of cascara moringa brew can be seen in Fig. 8.

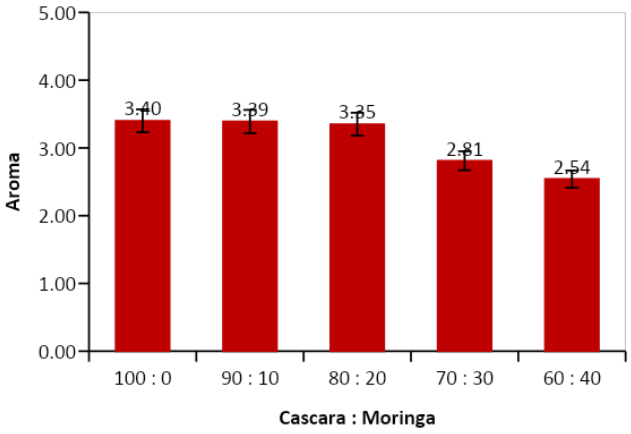

Fig. 8. The aroma preference of cascara moringa tea

Based on the chi square test ($\alpha \leq 0.05$), the ratio of cascara : Moringa leaves influences the level of aroma preference. The results show that the average level of panelist's preference for the aroma of cascara moringa tea brewing is in a range of 2.54 - 3.40. Several factors that influence the aroma preference are the differences in ingredient ratios and pH. The higher the ratio of cascara, the tea drink aroma will be more sour. The aroma of cascara tends to smell sour [25]. Meanwhile, the addition of Moringa leaves cause the aroma of the tea drink to be more unpleasant, typical of Moringa leaves. The unpleasant aroma produced is due to the saponin and tannin compounds in Moringa leaves. Fresh Moringa leaves contain 5% saponin and 1.4% tannin [24].

3.7 Total Microbes

Total microbial analysis aims to determine the number of microbes in food ingredients so that it can safely be ensured that the product is suitable for marketing and consumption. The results of the total microbial analysis of cascara moringa can be seen in Table 1.

Table 1. Total Microbes of Cascara Moringa Tea

Rasio (Cascara : Moringa)	Total Microbes (cfu/g)
T_0 (100 : 0)	1,91 x 10^4
T_1 (90 : 10)	1,42 x 10^4
T_2 (80 : 20)	9,43 x 10^3
T_3 (70 : 30)	4,17 x 10^3
T_4 (60 : 40)	8,98 x 10^2

Based on SNI for green tea (SNI 4324:2014) and black tea (SNI 3753:2014), the maximum limit for total plate number is 3 x 10^3 cfu/g. The highest total microbe was from sample T_0 with a total microbial value of 1.91 x 10^4 cfu/g. This sample was cascara tea without the addition of Moringa leaves. The high total number of microbes in cascara is thought to be due to the drying process which is carried out under open sunlight. The drying process using sunlight has the disadvantage that it takes a long time and is very dependent on the weather, besides that it is also less hygienic [26]. The lowest total microbial value was from sample T_4 with a total of 8.98 x 10^2 cfu/g. This is because Moringa leaves contain antibacterial compounds such as alkaloids, saponins, flavonoids and terpenoids that play an important role in curing disease [27].

3.8 Effectiveness Analysis

The effectiveness analysis was carried out to determine the best treatment of all the samples of cascara moringa products. The samples with the best treatment were selected based on the analysis of color, taste, aroma preferences, followed by water content, total phenol, antioxidant activity, and total microbes. The results of the cascara moringa effectiveness analysis can be seen in Table 2.

Table 2. Effectiveness Value of Cascara Moringa

Rasio (Cascara : Moringa)	Effectiveness Value
T_0 (100 : 0)	0.661
T_1 (90 : 10)	0.578
T_2 (80 : 20)	0.729
T_3 (70 : 30)	0.454
T_4 (60 : 40)	0.343

Based on the values of the effectiveness analysis, the best treatment for cascara moringa products was T_2 treatment (80% cascara : 20% moringa leaves) with the highest value of 0.729. The T_2-treated cascara moringa product had a water content of 10.84%, total phenols of 26.94 mg GAE/g, antioxidant activity of 51.45%, and total microbes of 9.43 x 10^3 cfu/g. It is possible for consumers to accept the T_2-treated cascara moringa product based on the results of the assessment of the panelist's most preferred color and taste attributes, and the number three preferred aroma attribute.

4 Conclusion

The best formulation of the cascara moringa product was obtained from the T_2 treatment (80% cascara : 20% moringa leaves) which had the best assessment from the panelists for the color (3.74) and taste (3.49) attributes, as well as the number three preferred aroma attributes (3.35). The T_2 product had also the L* value of 28.54; pH value of 5.17; water content was 10.84%, total phenols were 26.94 mg GAE/g, antioxidant activity was 51.45%, and total microbes were 9.43 x 10^3 cfu/g. The cascara moringa tea will be a potential natural and safe drink.

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References

[1] Bondesson, E. : A nutritional analysis on the by- product coffee husk and its potential utilization in food production. Uppsala: Swedish University of Agricultural Sciences (2015)
[2] Esquivel, P. and Jiménez, V. M.: Functional properties of coffee and coffee by-products. Food Research International **46**(2), 488-496 (2012)
[3] Rahayu, T. B., Nurindahsari, Y. A. W.: Peningkatan status gizi balita melalui pemberian daun kelor (*Moringa oleifera*). Jurnal Kesehatan Madani Medika **9**(2), 87-91 (2019)
[4] Aminah, S., Ramdhan, T., and Yanis, M.: Kandungan nutrisi dan sifat fungsional tanaman kelor (*Moringa oleifera*). Buletin Pertanian Perkotaan **5**(2), 35-44 (2015)
[5] Kekuda, T. R. P., Vinaylaka, K. S., Kumar, S. V. P., and Sudharshan, S. J.: Antioxidant and antibacterial activity of lichen extract, honey and their combination. Journal of Pharmacy Research **12**(2), 1875-1878 (2009)

[6] Maturin, L., and James, T.P.: Chapter 3: Aerobic Plate Count. Food and Drug Administration (FDA) Bacteriological Analytical Manual Online. Berlin : Silver Spring (2001)
[7] De Garmo, E. P., Sullivan, W. G., and Candra, C. R.: Engineering Economi. 7th edition. New York: Mc Millan Publ.Co (1984)
[8] Nasir, A., Sari,L., and Hidayat, F.: Pemanfaatan kulit buah naga (*Hylocereus polyrhizus*) sebagai bahan baku pembuatan teh herbal dengan penambahan kayu manis (*Cinnamons lumbini* L). Serambi Saintia Jurnal Sains dan Aplikasi **8**(1), 1-14 (2020)
[9] Ariadi, H. P., Sukatiningsih, Windrati, S. W.: Ekstraksi senyawa antioksidan kulit buah kopi: kajian jenis kopi dan lama maserasi. Berkala Ilmiah Pertanian **10** (1) (2015)
[10] Harbone: Encyclopedia of Food and Color Additives. New York: CRC Press (2005)
[11] Fatima, S., Masriani, and Idrus: Pengaruh penambahan bubuk jahe merah terhadap organoleptik teh daun kelor (*Moringa oleifera*). STI Pertanian Mujahidin : Toli-Toli (2020)
[12] Purwadi,I.: Milenial Nusantara Jakarta: Gramedia Pustaka Utama (2016)
[13] Yulianti, R.: Pembuatan minuman jeli daun kelor (*Moringa oleifera*) sebagai vitamin c dan ßkaroten, Skripsi. Fakultas Pertanian Institut Pertanian : Bogor (2008)
[14] Luthfiyanti, R., Irwansyah, A. C., Pamungkas, N. Y., and Triyono, A. Penurunan mutu senyawa antioksidan dan kadar air terhadap masa simpan permen hisap ekstrak daun Ciplukan (*Physalis angulata* Linn.) Jurnal Riset Teknologi Industri **14**(1), 1-12 (2020)
[15] Kurniawati, I., Fitriya, M., and Wijayanti :Karakterisitik tepung daun kelor dengan metode pengeringan sinar matahari. STIKES PKU Muhammadiyah: Surakarta (2018)
[16] Winarno, F. G.: Pangan, Gizi dan Konsumen. Jakarta: Gramedia (2008)
[17] Rasouli, H., Farzaei, M. H., and Khodarahmi, R. Polyphenols and their benefit: a review. International Journal of Food Properties 20(2), 1700-1741 (2017)
[18] Rudiana, T., Indriatmoko, D. D., and Komariah: Aktivitas antioksidan ekstrak etanol daun salam (*Syzygium polyanthum*) dan daun kelor (*Moringa oleifera*). Majalah Farmasi dan Farmakologi **25**(1), 20-22 (2020)
[19] Djannah, A. K. Pengaruh perbedaan teknik penyeduhan dan rasio penambahan jahe (*Zingiber officinale*) terhadap sifat kimia, fisik, dan organoleptik teh cascara. Skripsi. Malang: Universitas Brawijaya (2020)
[20] Sayuti, K, and Yenrina, R.: Antioksidan, alami, dan sintetik. Padang: Andalas University Press (2015)
[21] Heeger, A., Kosinska-Cagnazzo, A., Cantergiani, E., and Andlauer, W.: Bioactives of coffee cherry pulp and its utilisation for production of cascara beverage. Food Chemistry **221**(2), 969-975 (2017)
[22] Sholichah, E., Apriani, R., Desnilasari, D., Karim, M. A., and Harvelly: Produk samping kulit kopi arabika dan robusta sebagai sumber polifenol untuk antioksidan dan antibakteri. Jurnal Industri Hasil Perkebunan **14**(2), 57-66 (2019)

[23] Asisi, N., Uliyah, Amaliyah, N. F., and Hasrawati, A.: Aktivitas antioksidan ekstrak daun kelor (*Moringa oleifera* L.) dan pengembangannya menjadi bentuk seduhan gel. As-Syifaa Jurnal Farmasi **13**(1), 1-6 (2021)
[24] Folid, N., Makkar, H. P. S and Becker: The Potential of *Moringa oleifera* for Agricultural and Industrial Uses. Mesir: Dar Es Salaam (2007)
[25] Umazor, C.: Sensory Characterization and Analysis of Tea Infusion From Dry Coffee Cheery Pulp "Cascara" from Washed and Natural Processed Coffee. Thesis. Handuras: Studiorom Utinensis University (2017)
[26] Thamkaew, G., Sjoholm, I., and Galindo, F. G.: A review of drying methods for improving the quality of dried herbs. Critical Reviews in Food Science and Nutrition **61**(11), 1763-1786 (2021)
[27] Yudistira, F.: Potensi Antimikroba Ekstrak Air Daun Kelor (*Moringa oleifera*) Terhadap *Salmonella enteritidis* (sp-1-pkh) Secara In Vitro. Tesis Universitas Brawijaya : Malang (2013)