

Physicochemical and Sensory Characteristics of Noni (*Morinda citrifolia*) Juice Drink with the Addition of Ginger and Lemongrass

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ABSTRACT

Noni (Morinda citrifolia) contains bioactive compounds, but it has an unpleasant odor caused by caproic acid. Due to essential oil compounds, ginger and lemongrass can be used to reduce the unpleasant aroma of noni fruit. This research aims to evaluate the effect of ginger and lemongrass with varying concentrations of noni juice on physicochemical and sensory characteristics noni drink. The study employed a completely randomized design with six treatments and four replications. Physicochemical data were analyzed using ANOVA and Duncan's post hoc test, while sensory data were analyzed using the Chi-Square test. Results indicated that the type of ginger and concentration of noni juice significantly influenced the chemical characteristics. A concentration of 10 ml of noni juice affected the physical and sensory properties of noni juice beverage, but this was not observed at a concentration of 20 ml. The best formula resulted from treatment with a concentration of 10 ml of noni juice and the addition of 10 ml of lemongrass, with an overall score of 4.13 (liked). This was attributed to the flavonoid content of 0.290 mgQE/ml, polyphenol content of 0.3500 mgGAE/ml, vitamin C content of 0.114 mg/ml, antioxidant activity of 17.65ml, as well as satisfactory scores for taste, aroma, and aftertaste.

1. INTRODUCTION

Noni fruit easy to find in Indonesia. According to the Central Bureau of Biopharmaceutical Crop Production Statistics in 2021, noni fruit production in East Java province amounted to 2,652,373 kg (BPS, 2021). The high production of noni in East Java has the potential to be used as a beverage product. This fruit also has several bioactive compounds in it such as vitamin C, flavonoids, polyphenols, routine, scopoletin, coumarin, anthraquinones, and saponins (Pandy *et al.*, 2014; Luján *et al.*, 2014; Assi *et al.*, 2017; Sogandi & Rabima, 2019). The weakness of noni fruit is that it has an unpleasant aroma, so it is not liked by the public. This aroma comes from the caproic acid compound (hexanoic acid) contained in noni fruit (Bangun & Sarwono, 2002).

Generally, noni fruit is processed into extract/juice which is used as a health drink (Zackiyah *et al.*, 2014; Garnida & Hasnelly, 2018; Safitri & Ismawati, 2018) or extracted in powder form (Rosida *et al.*, 2021). The resulting extract/juice drink has undesirable characteristics because the aroma and taste are unpleasant. In research by Wang *et al.* (2021), noni fermentation can reduce hexanoic and octanoic acid compounds so that the aroma and taste are more acceptable. The characteristics produced in the noni juice fermentation process are still not accepted by the public, so it is necessary to add other ingredients to increase public acceptance.

Ginger and lemongrass are spices that have active compounds in the form of essential oils that produce a distinctive taste and aroma that people like. Hakim *et al.* (2021) used ginger to remove the prengus aroma in goat's milk, and Indriani *et al.* (2021) added ginger to cover the bitter taste in sweet orange peel herbal tea drinks, while

lemongrass can be used to covering the unpleasant smell of red dragon fruit skin herbal drinks. The distinctive aroma and taste of ginger comes from the compounds zingiberen, zingeron, gingerol, shogaol, oleoresin and resin (Srikandi *et al.*, 2020), while the characteristic aroma of lemongrass is produced from the compounds citronellal, geraniol, and citronellol (Hasugian *et al.*, 2019).

Ginger and lemongrass are commonly consumed as herbal drinks in Indonesia. The essential oil compounds in both ingredients contribute to the taste and aroma and have antioxidant properties. According to research by Tri & Minarsih (2022), the antioxidant activity of ginger is 21.86% inhibition and according to Sangi & Katja, (2011), the antioxidant activity of lemongrass is 64.85% inhibition. The addition of ginger and lemongrass juice to noni juice drinks is expected to improve the unpleasant aroma of noni. This study aims to evaluate the effect of adding ginger and lemongrass with varying concentrations of noni juice on physicochemical and sensory characteristics, as well as to determine the best treatment.

2. MATERIALS AND METHODS

2.1. Material

The ingredients used in making noni juice with the addition of ginger and lemongrass include fermented noni juice obtained from UD Zam, Jember, emprit ginger, fresh lemongrass, white sugar, and distilled water. The ingredients used in testing noni juice drinks with the addition of ginger and lemongrass include ethanol p.a, NaOH p.a, methanol 99%, DPPH (2,2-diphenyl-1-picrylhydrazyl), distilled water, ethanol 96%, folin-ciocalteu reagent, Na₂CO₃, NaNO₂, AlCl₃, starch, iodine, labels, aluminum foil and tissue.

2.2. Tool

Equipment included cutting boards, filters, 100 and 50 ml dark bottles. The equipment used for analysis was a Konica Minolta CR 10 plus color reader, Pyrex Iwaki measuring cup, Ohaus Pioneer analytical balance, Shimadzu UV-Vis spectrophotometer, bulb pipette, vortex, tube Pyrex Iwaki brand reaction, Pyrex Iwaki brand Erlenmeyer, Pyrex brand measuring flask, micropipette, Pyrex Iwaki brand glass beaker, filter cloth, funnel, measuring pipette, pi pump, dropper pipette, burette, clamps and stand.

2.3. Research Design

The experimental design used in this research was a completely randomized design (CRD) with a single factor with different treatment formulations. The formula for making noni juice drinks with the addition of ginger and lemongrass is F1 (10 ginger: 10 noni), F2 (10 lemongrass: 10 noni), F3 (5 ginger: 5 lemongrass: 10 noni), F4 (10 ginger: 20 noni), F5 (10 lemongrass: 20 noni), and F6 (5 ginger: 5 lemongrass: 20 noni). The research was carried out with 4 times.

2.4. Research Stages

This research began with making ginger juice and lemongrass juice. The next stage is making noni juice according to a predetermined formula. Based on this formulation, it will be mixed with 10 g of sugar which will then be mixed using distilled water until a volume of 100 ml is reached. The mixed ingredients are stirred until homogeneous and pasteurized at 80°C for 15 min. Pasteurized drinks are cooled to room temperature and packaged in glass bottles.

2.5. Analysis

The analyzes carried out included physicochemical analysis in the form of flavonoids (Mabry *et al.*, 2012), polyphenols using the Folin-Ciocalteu method (Diouf *et al.*, 2009), vitamin C using the iodine titration method (Sudarmadji *et al.*, 1997), antioxidant activity using the DPPH method (Sirivibulkovit *et al.*, 2018), color using a color reader (Minolta), sensory analysis using the hedonic method (Civille & Carr, 2016), and effectiveness testing (De Garmo *et al.*, 1994). Data resulting from physicochemical analysis were processed using ANOVA ($\alpha \leq 0.05$) and if significantly different, continued with the DMRT (Duncan's Multiple Range Test). Data resulting from sensory analysis were processed using the Chi-square method at a significant level ($\alpha \leq 0.05$).

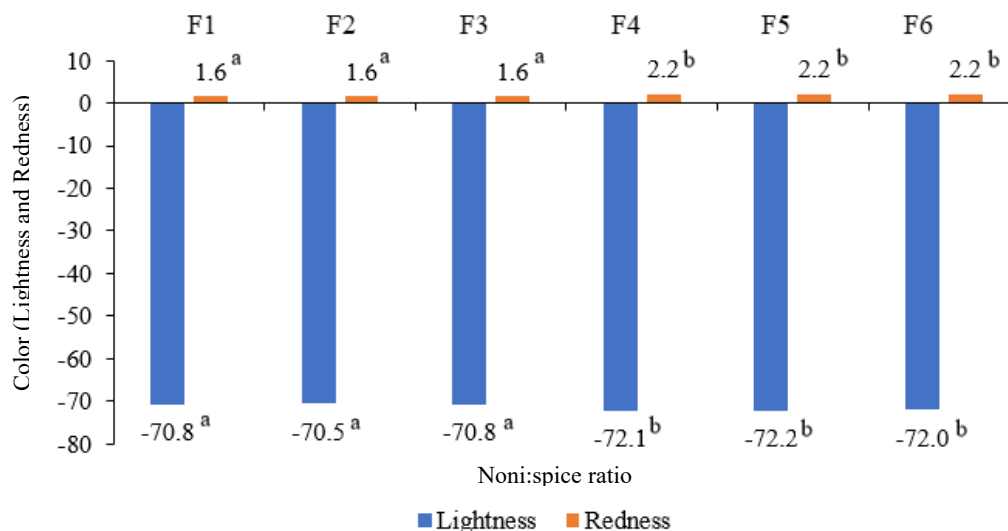


Figure 1. Color value of noni juice drink with the addition of ginger and lemongrass. (Note: Different notations indicate significant differences in each treatment)

3. RESULTS AND DISCUSSION

3.1. Physicochemical Characteristics

The physical and chemical properties of noni juice drinks with the addition of ginger and lemongrass are presented in Figure 1.

3.1.1. Lightness

Figure 1 shows the lightness value of the noni juice drink with the addition of ginger and lemongrass which has an average L value ranging from -72.2 to -70.5, indicating a dark color because the lightness value is negative. Lightness is a color level based on brightness with a value of 0-100, where the smaller the resulting value indicates the darker the color and vice versa. The ANOVA statistical test showed that the difference in formulation had a significant effect on the lightness value of the noni juice drink with the addition of ginger and lemongrass ($p \leq 0.05$). The addition of different types of ginger and lemongrass did not affect the lightness value of the noni juice drink. So, the addition of ginger and lemongrass spices did not affect the brightness of the color of the noni juice drink at various noni concentrations.

The lightness value of noni juice drinks is influenced by the concentration of noni juice. The higher the concentration of noni juice, the less water is added, so the color of the drink becomes darker. Fresh noni juice has a brighter color than fermented noni juice. Fermented noni juice produces a dark brown color, browning occurs due to enzymatic reactions during the fermentation process (Konsue *et al.*, 2018).

3.1.2. Redness

The redness value of the noni juice drink with the addition of ginger and lemongrass is shown in Figure 1. The average a^* value for this noni juice drink ranges from 1.6 to 2.2, indicating a reddish color due to the positive redness value ($+a^*$). Redness (a^*) is indicating of red and green color, with positive ($+a^*$) values ranging from 0 to 100 indicating a red color, while negative ($-a^*$) values ranging from 0 to -80 indicates a green color.

The ANOVA test showed that the difference in formulation had a significant effect on the redness value of the noni juice drink with the addition of ginger and lemongrass ($p \leq 0.05$). The addition of ginger and lemongrass with concentrations of 5 and 10% did not affect the redness value of the noni juice drink. The redness value is related to the

lightness value of the noni juice drink with the addition of ginger and lemongrass (Figure 1). The addition of noni concentration can increase the redness value of noni juice drinks with the addition of spices. This is because the contribution of the red color comes from noni juice. The redness can be produced from the brownish color resulting from fermentation of noni juice. According to [Konsue *et al.* \(2018\)](#), microbial activity during the noni fermentation process can trigger enzymatic reactions resulting in a dark brown color.

3.1.3. Total Flavonoids

The Anova statistical test showed that differences in formulation had a significant effect on the total flavonoids in noni juice drinks ($P \leq 0.05$). Different variations in adding ginger and lemongrass also affect the flavonoid content. Based on Table 1, the flavonoid content in noni juice drinks with the addition of ginger and lemongrass ranges from 0.062 to 0.349 mgQE/ml. The combination of 20 ml noni and 10 ml lemongrass (F5) produces the highest flavonoid content of 0.349 mgQE/ml, while the combination of 10 ml noni and 10 ml ginger (F1) has the lowest flavonoid content of 0.062 mgQE/ml. The addition of ginger juice concentration produces lower flavonoid levels compared to the addition of lemongrass juice concentration, because the flavonoid content in lemongrass is higher (0.363 mgQE/ml) compared to ginger (0.011 mgQE/ml). Increasing the concentration of noni juice can also increase the flavonoid levels in noni juice drinks with the addition of ginger and lemongrass. However, the addition of lemongrass was more effective in increasing the flavonoid content of noni juice drinks compared to the addition of ginger at various concentrations of noni juice.

Noni, ginger and lemongrass contain flavonoid compounds. The main flavonoid compound in noni is Rutin. The main components of lemongrass flavonoid compounds are isoquercetin, catechin, and quercetin ([Somporn *et al.*, 2018](#)). Ginger contains flavonoid compounds in the form of quercetin, routine, catechin, epicatechin, and naringenin ([Ghasemzadeh *et al.*, 2010](#)).

Table 1. Sample bioactive compound content

No	Sample	Flavonoid (mgQE/ml)	Polyphenol (mgGAE/ml)	Vitamin C (mg/ml)	Antioxidant Activity (%inhibition)
1	F1	0.062 ^d ±0.007	0.2215 ^a ±0.009	0.062 ^a ±0.003	11.48 ^a ±0.027
2	F2	0.290 ^b ±0.008	0.3500 ^c ±0.004	0.114 ^c ±0.003	17.65 ^b ±0.276
3	F3	0.159 ^a ±0.008	0.2767 ^b ±0.010	0.126 ^b ±0.003	17.38 ^b ±0.708
4	F4	0.229 ^c ±0.007	0.4141 ^d ±0.004	0.097 ^b ±0.003	21.39 ^c ±0.628
5	F5	0.349 ^e ±0.005	0.4815 ^e ±0.003	0.109 ^c ±0.003	30.58 ^d ±0.515
6	F6	0.337 ^c ±0.006	0.4921 ^{ef} ±0.003	0.138 ^e ±0.003	28.83 ^d ±0.106

Note: Different notations indicate significant differences in each treatment

3.1.4. Total Polyphenol

The results from ANOVA test showed that differences in formulation had a significant effect on the total polyphenols in noni juice drinks ($P \leq 0.05$). The results of the total polyphenol analysis of the noni juice drink with the addition of ginger and lemongrass are shown in Table 1. The average total polyphenols of the samples ranged from 0.2215 to 0.4921 mgGAE/ml. The highest total polyphenol content of 0.4921 mgGAE/ml was produced from a combination of 20 ml of noni with the addition of 5 ml of ginger and 5 ml of lemongrass (F6), while the lowest content of 0.2215 mgGAE/ml was produced from a combination of 10 ml of noni with the addition of 10 ml. ginger (F1).

Increasing the concentration of ginger juice produces lower polyphenol levels compared to increasing the concentration of lemongrass juice, because the polyphenol content in lemongrass is higher (0.4152 mgGAE/ml) compared to ginger (0.1588 mgGAE/ml). Increasing the concentration of noni juice can also increase the polyphenol content in noni juice drinks with the addition of ginger and lemongrass, because the polyphenol content of noni (0.2789 mgGAE/ml) is higher than ginger but lower than lemongrass. The addition of lemongrass was more effective in increasing the polyphenol content of noni juice drinks compared to the addition of ginger at various concentrations of noni juice. Polyphenol content was positively correlated with flavonoid content; The higher the flavonoid content in the noni juice drink with the addition of ginger and lemongrass, the higher the polyphenol content.

Noni, ginger, and lemongrass contain polyphenolic compounds. The main polyphenolic compounds in noni are artepilin C, biokanin A, narigenin, eriodictyol, kaempferol, isorhamnetin, pinocembrin, kaempferide, and flavonoids. The main components of ginger polyphenol are shogaol, gingerol, and paradol (Mao *et al.*, 2019). Lemongrass contains polyphenolic compounds in the form of gallic acid, flavonoids and tannic acid (Sompam *et al.*, 2018).

3.1.5. Vitamin C

The Anova statistical test showed that differences in formulation had a significant effect on the vitamin C levels of noni juice drinks ($P \leq 0.05$). Based on table 1, vitamin C levels are higher as the concentration of noni juice is increased, as well as the addition of ginger and lemongrass juice. The highest vitamin C level of 0.138 mg/ml was produced from the 20 ml noni formulation with the addition of 5 ml ginger and 5 ml lemongrass (F6), while the lowest value of 0.062 mg/ml was produced from the 10 ml noni formulation with the addition of 10 ml ginger (F1).

The addition of a mixture of ginger and lemongrass juice produces lower levels of vitamin C than adding ginger and lemongrass juice separately. However, increasing the concentration of lemongrass juice produces higher levels of vitamin C due to its higher content. The vitamin C content test shows that ginger has 0.062 mg/ml, while lemongrass has 0.255 mg/ml. The vitamin C content in noni juice drinks with the addition of ginger and lemongrass is less stable because of the pasteurization process carried out during the manufacture of the drink, which can cause damage to vitamin C due to heating or storage. According to Sartika (2020), vitamin C is easily damaged by prolonged heating, air (oxygen), and enzymes. Vitamin C is easily oxidized because it has a very reactive hydroxyl group (-OH), when the hydroxyl group is oxidized, it will change to a carbonyl group (Rahayuningsih *et al.*, 2022).

Vitamin C is a vitamin that helps the body's metabolism. Vitamin C deficiency can cause various health problems such as cancer, stroke, impaired sense of taste, and heart disease (Ashor *et al.*, 2019). According to the Ministry of Health (2019), adults' daily need for vitamin C is around 75 - 90 mg. In noni juice drinks with the addition of lemongrass ginger, the highest vitamin C is 0.138 mg/ml or the same as 13.8 mg/100ml, so to meet daily needs, 5-7 bottles/day of noni juice drinks with the addition of ginger and lemongrass are needed.

3.1.6. Antioxidant Activity

The ANOVA statistical test showed that differences in formulation had a significant effect on the antioxidant activity of noni juice drinks ($p \leq 0.05$). The results of the analysis of the antioxidant activity levels of noni juice drinks with the addition of ginger and lemongrass are presented in Table 1. The highest average value of antioxidant activity levels of 30.58% was produced from the 20 ml noni formulation with the addition of 10 ml lemongrass (F5), while the lowest value was 11, 84% inhibition was produced from 10 ml noni formulation with the addition of 10 ml ginger (F1). The addition of ginger juice concentration resulted in a lower antioxidant content than the addition of lemongrass juice concentration. This can happen because the antioxidant content of lemongrass juice is higher than ginger juice. Tests for the antioxidant content of ginger and lemongrass were 5.513% inhibition and 18.627% inhibition respectively. Increasing the concentration of noni juice can also increase the antioxidant content of noni juice drinks with the addition of lemongrass ginger. This can happen because the antioxidant content of noni is higher than ginger but lower than lemongrass, namely 12.041% inhibition, so if the concentration is increased it can affect the antioxidant content.

The antioxidant activity of the noni juice drink with the addition of ginger and lemongrass is positively correlated with the levels of flavonoids, polyphenols and vitamin C. The higher the levels of flavonoids, polyphenols and vitamin C, the higher the antioxidant activity of the noni juice drink with the addition of ginger and lemongrass. According to Sholehah (2010), the antioxidant activity of noni juice is produced by the scopelotin content which is a coumarin of 52.94 ppm. Lemongrass is high in citrate compounds which function as antioxidants with 75-85% inhibition (Balakrishnan *et al.*, 2015). Ginger contains polyphenols in the form of gingerol and its derivatives which act as antioxidants (Mao *et al.*, 2019).

3.2. Sensory Characteristics

The results of the hedonek method sensory characteristics test with parameters including aroma, taste, aftertaste, and overall noni juice drink with the addition of ginger and lemongrass are presented in Figure 2.

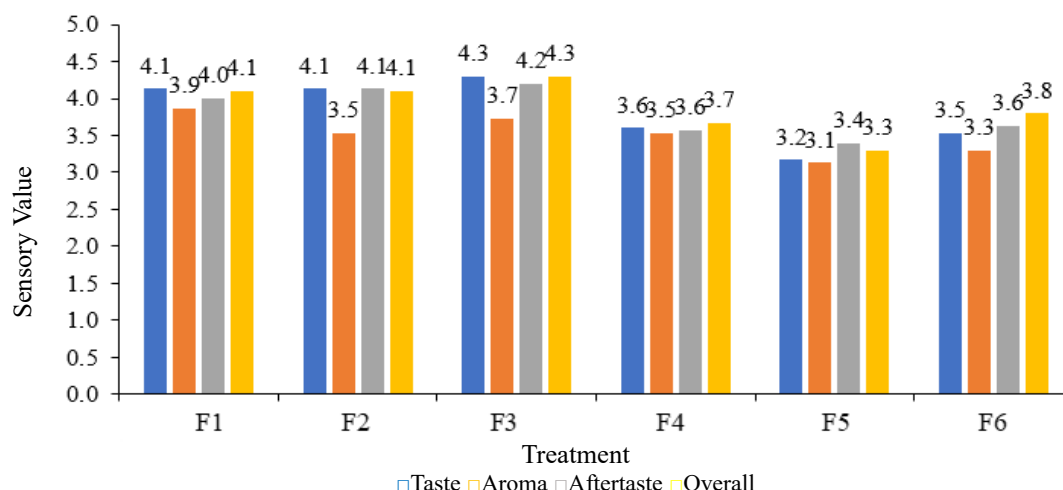


Figure 2. Sensory value of noni juice drink with addition of ginger and lemongrass

3.2.1. Aroma

The results of the Chi square statistical test showed that formula variations had an effect on the hedonic value of the aroma of the noni juice drink with the addition of ginger and lemongrass ($p \leq 0.05$). Based on Figure 2, the highest value was produced by the 10 ml noni juice formulation with the addition of 10 ml ginger juice (F1) of 3.87 (neutral close to liking), and the lowest value was produced by the 20 ml noni juice formulation with the addition of 10 ml lemongrass juice (F5) of 3.13 (neutral). This is in accordance with [Garnida & Hasnelly \(2018\)](#), who stated that the more noni added, the less the panelists liked the aroma of the functional drink. The addition of lemongrass and ginger spices increased the aroma preference at a concentration of 10 ml noni juice with a preference value of 3.73 and 3.87 (neutral close to liking). However, at a noni concentration of 20%, the favorability value dropped to 3.5 - 3.1 (neutral). This is caused by the aroma of caproic acid from noni juice.

Noni has an unpleasant aroma, but after fermentation, noni juice is produced with an aroma that is slightly more liked by the public. According to [Putri *et al.*, 2020](#), the anaerobic fermentation process of noni fruit can break down chemical compounds that cause odor. The addition of ginger can increase people's preference for noni juice drinks. This can happen because ginger contains the distinctive aromatic aroma of zingiberene and zingiberone which gives a fragrant aroma ([Amir, 2014](#)). In [Pramitasari's \(2010\)](#) research, the addition of ginger can increase consumer preferences because it can reduce the unpleasant aroma of soy milk.

3.2.2. Taste

The results of the Chi square statistical test showed that formula variations had an effect on the hedonic value of the taste of the noni juice drink with the addition of ginger and lemongrass ($p \leq 0.05$). Based on Figure 2, the addition of 10 ml of noni juice resulted in a higher taste rating than 20 ml. The highest value of 4.3 (like) was produced by the 10 ml noni formulation with 5 ml ginger and 5 ml lemongrass (F3), while the lowest value of 3.17 (neutral) was produced by the 20 ml noni formulation with 10 ml lemongrass (F6). This is in accordance with [Garnida & Hasnelly, 2018](#) which states that the more noni is added, the taste of the functional drink is not liked by the panelists. The addition of lemongrass and ginger spices increases the taste preference of 10 ml noni juice with a favorability value of 4 (like). However, when the noni concentration was increased to 20 ml, the favorability value dropped to 3 (neutral). This is caused by the bitter taste of noni juice which gets stronger as the concentration increases.

Fresh noni has a slightly bitter taste, but after fermentation it produces noni juice with a sour taste which is still not liked by the public. According to [Hui & Evranuz \(2012\)](#), fermentation can reduce pH levels and increase acidity levels. The addition of ginger and lemongrass can increase people's preference for noni juice drinks, because ginger and lemongrass provide a slightly spicy taste. Ginger contains oleoresin compounds and lemongrass contains lemongrass which produces a spicy taste ([Chasparinda *et al.*, 2014](#); [Arisanti & Mutsyahidan, 2018](#)).

3.2.3. Aftertaste

The results of the Chi square statistical test showed that formula variations had an effect on the hedonic value of the aftertaste of the noni juice drink with the addition of ginger and lemongrass ($p \leq 0.05$). Figure 2 shows that the lowest value of 3.40 (neutral) was produced by the 20 ml noni formulation with the addition of 10 ml lemongrass (F6), while the highest value of 4.20 was produced by the 10 ml noni formulation with the addition of 5 ml ginger and 5 ml lemongrass. (F3). This is in accordance with [Astutik \(2004\)](#), the addition of noni concentration reduces the aftertaste value of noni tea soft drinks. The addition of lemongrass and ginger increased the aftertaste favorability at a concentration of 10 ml with a value of 4 - 4.2 likes, but at a concentration of 20 ml, the favorability value dropped to 3.7 - 3.5 neutral. Due to the stronger bitter and sour taste at high concentrations.

Noni juice has a sour taste due to the fermentation process, while ginger and lemongrass provide a slightly spicy taste. Too high a concentration of noni, ginger, and lemongrass can produce a tart or slightly bitter taste. This is in accordance with [Dusun *et al.*, \(2020\)](#) as the addition of lemongrass concentration to the instant ginger, nutmeg and lemongrass drink leaves a slightly bitter taste so the panelists don't like it. Ginger contains oleoresin compounds (non-volatile oil) which gives a spicy and bitter aftertaste ([Chasparinda *et al.*, 2014](#)).

3.2.4. Overall

The results of the Chi square statistical test showed that formula variations had an effect on the overall value of the noni juice drink with the addition of lemongrass ginger ($p \leq 0.05$). Figure 2. The average panelists' preference score for all noni juice drinks ranges from neutral to like. The panelists gave the highest score (4.30), which means they liked the sample with 10 ml of noni, 5 ml of ginger, and 5 ml of lemongrass (F3), while the lowest score (3.30), which means neutral, was given to the sample with 20 ml of noni and 10 ml lemongrass (F6). A sample with a concentration of 10 ml of noni was preferred over 20 ml, perhaps because it had a better taste, aroma and aftertaste. The addition of lemongrass and ginger spices can increase liking at a concentration of 10 ml, but with a concentration of 20 ml the liking rating drops to neutral.

3.3. Effectiveness Value

Effectiveness testing is a test carried out to determine the best formulation. Determination of the best formulation of noni-based functional drink with the addition of ginger and lemongrass was carried out using the method of [De Garmo *et al.*, \(1994\)](#). The parameters used include levels of antioxidant activity, taste, aroma, aftertaste, overall, total polyphenols, total flavonoids, and vitamin C levels. In Figure 3, the highest effectiveness index value was produced by 10 ml noni treatment with the addition of 10 ml lemongrass (F2) of 0.66. This can happen because the F2 formulation has the following overall test results: antioxidant activity levels of 17.65% inhibition; total polyphenol content 0.3500 mgGAE/ml; total flavonoid levels 0.290 mgQE/ml; vitamin C level 0.114 mg/ml; taste score 4.1; aroma score 3.52; aftertaste score 4.16; overall score 4.13.

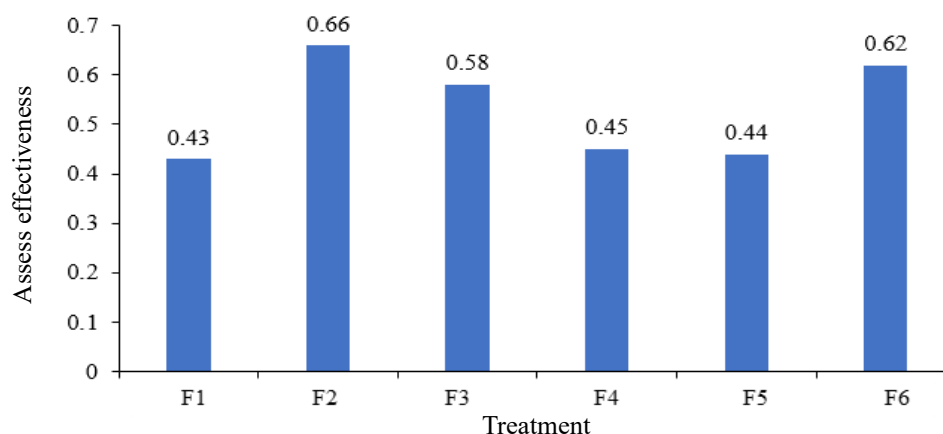


Figure 3. Effectiveness value of noni juice drink with the addition of ginger and lemongrass

4. CONCLUSION

The physicochemical and sensory characteristics of noni juice drinks with the addition of ginger and lemongrass are influenced by differences in the concentration of noni juice, ginger and lemongrass. Formula F6 (20% noni, 5% ginger and 5% lemongrass) produces a drink with polyphenol and vitamin C content, namely 0.4921 mgGAE/ml and 0.138 mg/ml. Meanwhile, F5 (20% noni and 10% lemongrass) produces a drink with the highest antioxidant activity and flavonoid content, namely 30.58% inhibition and 0.349 mgQE/ml. The addition of ginger and lemongrass affected the sensory characteristics of noni juice drinks at a concentration of 10%, but not at a concentration of 20%. Formula F3 (noni 10%, lemongrass 5%, ginger 5%) produces a drink with the highest hedonic value for taste, aftertaste and overall with an average score of 4 (like). Formula F1 (noni 10% and ginger 10%) got the highest hedonic value for aroma with a value of 3.87 (neutral close to liking). The best formula obtained in this research was F2 (10% noni and 10% lemongrass) with an effectiveness value of 0.66. Based on these results, it is known that the addition of ginger and lemongrass juice to noni juice drinks can improve the unpleasant aroma and can also increase the functional activity of noni juice drinks.

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