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Halal status and chemical quality of *Nirapresso* from several coffee shops in Banda Aceh

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Abstract. The increase in the number of coffee shops in Banda Aceh is accompanied by various product innovations that attract consumers, one of which is the *nirapresso* drink. *Nirapresso* is an innovative drink that combines espresso coffee with palm (*Arenga pinnata* Merr) sap, resulting in a blend of sweet, slightly acidic, and coffee flavors. This research aims to evaluate the halal status and quality of *nirapresso* beverage products in several coffee shops in the city of Banda Aceh, including analyzing the sap used. The result showed that alcohol content of palm sap and *nirapresso* is still within the limits allowed by the MUI Fatwa. Other chemical characteristics indicate that the palm sap used by coffee shops in Banda Aceh is fresh sap with a very low alcohol content, averaging 0.140%, as is the case with *nirapresso*, averaging 0.137%, thus remaining below the limit set by the Indonesian Ulema Council Fatwa of <0.5%.

1. Introduction

Coffee is one of the most popular beverages in the world, including in Indonesia. The coffee-drinking culture has become a tradition in the daily lives of people, especially in Aceh. Aceh, particularly the city of Banda Aceh, is even nicknamed the 'city of 1000 coffee shops' due to the many coffee shops that serve delicious and quality coffee [1]. The increase in the number of coffee shops in Banda Aceh is accompanied by various product innovations that attract consumers, one of which is the *nirapresso* drink. *Nirapresso* is a beverage made by combining espresso coffee and palm sap, resulting in a unique flavor that is a blend of the sweetness of palm sap and the bitterness of espresso coffee [2]. Palm sap is a sweet liquid obtained from tapping the flower clusters of the *arenga* tree (*Arenga pinnata* Merr), which contains natural sugars such as sucrose, glucose, and fructose. Fresh palm sap has a sweet taste, is clear in color, and has a fragrant aroma [2,3].





Figure 1. *Nirapresso*

Essentially, *nirapresso* is an innovative drink that combines espresso coffee with palm sap, resulting in a blend of sweet, slightly acidic, and coffee flavors. The process of making *nirapresso* involves three stages: brewing espresso as the base ingredient, preparing the palm sap as a mixing ingredient, and combining both ingredients to create the *nirapresso* drink [4]. However, it is important to note that palm sap is highly susceptible to natural fermentation after tapping, converting the sugars in the juice into alcohol and acetic acid, which can impact the safety and halal status of the drink [5].

According to Hotijah et al [6], the storage duration of pure palm sap kept at a cold temperature can last for approximately 4 hours after the tapping process. Based on the research results of Raihan [7], the analysis of alcohol content in palm sap from Montasik district, Aceh Besar, varied with fermentation time at room temperature for 0, 4, 8, and 24 hours after distribution, showing a sequential increase of 0%, 0.12%, 0.17%, and 0.27%. Furthermore, according to Ilyas [8], palm sap stored at a cold temperature (5°C) produced the lowest alcohol content of 0.29% on the first day and the highest alcohol content of 0.72% on the 18th day, whereas palm sap stored at room temperature ($\pm 29^{\circ}\text{C}$) produced the lowest alcohol content of 0.31% on the first day and the highest alcohol content of 0.73% on the 14th day. Palm sap that changes may not meet the halal standards as a beverage product. The aspects of halal and product safety are a concern, given the potential for alcohol formation during the fermentation process. Aceh, as a province that implements Islamic law, has strict regulations regarding food and beverage products. The fatwa from the Indonesian Ulema Council No. 10 of 2018 sets the maximum limit for fermented food and beverage products containing 0.5% of alcohol.

The Indonesian Ulema Council standards serve as an important reference for coffee shop entrepreneurs to maintain the safety and halal status of their products. This research aims to evaluate the halal status and quality of *nirapresso* beverage products in several coffee shops in the city of Banda Aceh, including analyzing the sap used. The results of this study are expected to provide benefits for coffee shop entrepreneurs in maintaining product quality, as well as to inform the public about the safety and halal status of *nirapresso* drinks based on the applicable standards, according to the Indonesian Ulema Council No. 10 of 2018.

2. Materials and methods

2.1 Sample collection and preparation

The raw material samples in the form of palm sap and the resulting drink, *nirapresso*, were obtained directly from 5 coffee shops in Banda Aceh city (A= Moorden Coffee, B= Horas Kopi Gayo, C= Oen Kupa, D= Benu Coffee Roaster, E= BMK), with sampling carried out on the same day. The samples of palm sap and *nirapresso* drinks were placed in a cool box that was filled with ice blocks to prevent fermentation during transport to the laboratory.

Samples of palm sap and *nirapresso* drinks collected from five coffee shops in Banda Aceh were homogenized by stirring evenly to ensure the components were well mixed. Each sample was then taken in amounts of 30 mL and placed into coded erlenmeyer flasks, and then ready for analysis.

2.2 Physicochemical analysis

The analyses performed included alcohol content analysis using the dichromate method with UV-Vis spectroscopy [9], pH analysis using a pH meter with AOAC modifications, total acid analysis using AOAC titration methods, total dissolved solids analysis using a refractometer [10], total sugar analysis using the Luff-Schoorl method [11], total phenol analysis, and antioxidant analysis using the DPPH method according to Huang et al [12].

2.3 Data analysis

Analysis for all samples and parameters was performed with 3 repetitions. Data is presented in tabular form and analyzed descriptively.

3. Results and discussion

3.1 Alcohol content

The palm sap from each coffee shop has a low alcohol content ranging from 0.119-0.183% with an average of 0.140%. This result is not much different from the alcohol content of *nirapresso* as shown in Table 1.

Table 1. Alcohol content of palm sap and *nirapresso*

Producers	Alcohol content (%)	
	Palm sap	<i>Nirapresso</i>
A	0.131	0.171
B	0.133	0.152
C	0.183	0.116
D	0.133	0.129
E	0.119	0.116
Average	0.140	0,137

Table 1 shows that the alcohol content in palm sap and *nirapresso* ranges from 0.1% to 0.2% with an average of 0.1%. This value is still well below the maximum limit of 0.5% set by the Indonesian Ulema Council Fatwa No. 10 of 2018; thus, *nirapresso* can be categorized as halal. The alcohol content in palm sap is formed naturally due to fermentation activities by yeasts such as *Saccharomyces cerevisiae*, which ferment sugars into alcohol. Environmental factors such as storage temperature, duration of storage, and microbial contamination can accelerate the fermentation process and increase alcohol levels. Nevertheless, the low alcohol content in this study indicates that the palm sap used is still fresh and has been handled quite well. This result is in line with Sinaga et al [13], who state that higher storage temperatures (29–30°C) can accelerate fermentation and increase alcohol production in palm sap. Therefore, storing palm sap at low temperatures, such as in a refrigerator, can slow down the fermentation activity of microbes like *Saccharomyces cerevisiae*. This condition causes the process of breaking down sugar into alcohol to proceed much more slowly than at room temperature. In addition to keeping the alcohol content low, cold storage also helps maintain the freshness of the sap by preventing changes in taste and aroma. Thus, the use of sap stored at low temperatures not only maintains the quality of the raw material but also ensures that the alcohol content remains below the specified threshold, thereby complying with halal standards according to the Indonesian Ulema Council Fatwa No. 10 of 2018.

3.2 pH value

The pH value of palm sap from each coffee shop ranged from 3.91 to 4.23, with an average of 4.04. This result is not much different from the pH value of *nirapresso* produced, as shown in Table 2.

Table 2. pH value of palm sap and *nirapresso*

Producers	pH value	
	Palm sap	<i>Nirapresso</i>
A	3.96	4.17
B	3.91	4.21
C	4.23	4.01
D	4.14	4.17
E	3.94	4.05
Average	4.04	4.12

Table 2 shows that the low pH values in the treatments are caused by the natural fermentation process of palm sap, resulting in acetic acid. This result is in line with research [2], which states that palm sap is highly susceptible to fermentation by microorganisms such as *Acetobacter aceti*, which can convert alcohol into acetic acid, thereby increasing acidity. Espresso coffee, although acidic, has a higher pH than palm sap that has undergone fermentation. Research by Ahmy et al [14] indicates that the higher the sugar concentration, the pH of the resulting product tends to be higher. This result occurs because sugar acts as a compound that can reduce acidity. The addition of sugar in the process of making *nirapresso* can mitigate the acidic effects of palm sap, resulting in a higher pH. Additionally, the differences in grinding and brewing methods of coffee also affect the pH value. Budiyanto et al. [15] state that higher brewing temperatures can increase the extraction of chlorogenic acid from coffee, which affects the final acidity of the product. Thus, the difference in pH between the palm sap and *nirapresso* is not only influenced by the fermentation process but also by the interactions between the components present in the mixture, as well as the brewing methods used.

3.3 Total acidity value

The palm sap from each coffee shop has a total acidity value ranging from 0.19-0.29% with an average of 0.22%. This result is not much different from the total acidity value in the produced *nirapresso*, as shown in Table 3.

Table 3. Total acidity value of palm sap and *nirapresso*

Producers	Total acidity value (%)	
	Palm sap	<i>Nirapresso</i>
A	0.19	0.19
B	0.27	0.16
C	0.15	0.14
D	0.20	0.15
E	0.29	0.13
Average	0.22	0.16

Table 3 shows that the highest total acid value is found in the palm sap sample, caused by further fermentation that produces acetic acid. The increase in total acid is influenced by the activity of *Acetobacter aceti* bacteria that convert alcohol into acetic acid. This result is in line with the research by Rachmawati et al [16], which states that palm sap is very easily fermented spontaneously by natural microorganisms, especially *Acetobacter aceti* bacteria that convert alcohol into acetic acid. The longer the storage of the sap at room temperature, the higher the total acid that is formed. This result corresponds with the research [13], which states that the total acid value of palm sap tends to increase

along with the length of storage. Conversely, the low total acid occurs due to the preservation of palm sap at low temperatures or the use of very fresh palm sap with a short fermentation time before being mixed with coffee. Palm sap, as a fermentation substrate, will naturally have a higher acid content over time due to microbial activity. However, when this sap is mixed with espresso coffee during the production process of *nirapresso*, a dilution effect occurs that reduces the total acid concentration in the final drink. Espresso coffee itself has a relatively stable pH and does not significantly contribute to the increase of total acid in the fermentation of palm sap.

3.4 Total dissolved solid value

The palm sap from each coffee shop has a total dissolved solids value ranging from 9.83-12.53 °Brix with an average of 11.46 °Brix. This result is not much different from the total dissolved solids value in the produced espresso sap, as shown in Table 4.

Table 4. Total dissolved solids value of palm sap and *nirapresso*

Producers	Total dissolved solids value (°Brix)	
	Palm sap	Nirapresso
A	10.50	8.60
B	11.40	9.90
C	13.03	8.60
D	9.83	8.26
E	12.53	10.00
Average	11.46	9.07

Table 4 shows that palm sap has a higher total dissolved solids value compared to *nirapresso*. This occurs because palm sugar contains natural sugars such as sucrose, glucose, and fructose in significant amounts, which significantly contribute to the total dissolved solids. According to Yunita et al [17], the total sugar in fresh palm sap can reach 10–15%. Variations in sap quality, freshness level, and post-harvest handling methods may cause differences in total dissolved solids values among coffee shops. The total dissolved solids value in *nirapresso* tends to be lower due to dilution by coffee. The fermentation process that occurs in the palm sap can also convert sugars into alcohol and acids, thereby reducing the total dissolved solids. This result is in line with the research by Kurniawan et al [18], which states that fermentation by *Saccharomyces cerevisiae* can convert sugars into alcohol. Therefore, if the sap used in *nirapresso* has already undergone initial fermentation, some of its sugar has already been converted, resulting in a lower total dissolved solids compared to fresh sap.

3.5 Total sugar content

The palm sap from each coffee shop has a total sugar content ranging from 12.07-15.50% with an average of 13.27%. This result is not much different from the total sugar content in the produced *nirapresso*, as shown in Table 5.

Table 5. Total sugar content value of palm sap and *nirapresso*

Producers	Total sugar content (%)	
	Palm sap	Nirapresso
A	15.50	9.90
B	11.20	6.93
C	13.37	9.47
D	12.07	7.35
E	14.20	10.77
Average	13.27	8.88

Table 5 shows that palm sap has a higher sugar content compared to *nirapresso*. This result occurs because fresh palm sap naturally contains high levels of sugar (mainly sucrose, glucose, and fructose) that come from the photosynthesis process of the palm tree. According to [17], the sugar content in fresh palm sap can reach 12-15%. Palm sap is rich in natural sugars, which play an important role in determining fermentation potential and the quality of the final products produced. Variations in sugar content in palm sap among coffee shops may be caused by differences in tapping time, conditions of the palm trees, or the level of initial fermentation before the samples are taken. Conversely, the *nirapresso* drink has a low total sugar value, which is suspected to be caused by the dilution effect of palm sap in espresso coffee, thereby reducing the sugar concentration in the drink. The processing process of *nirapresso* involves the dilution of natural palm sugar by the addition of espresso coffee, which is naturally low in sugar. Espresso coffee itself contains very minimal sugar, so when mixed with palm sap, the total sugar concentration in the final drink will decrease proportionally.

3.6 Total phenol value

The sap from each coffee shop has a total phenol value ranging from 11.38-19.84 mg GAE/100g with an average of 15.35 mg GAE/100g. This result is not much different from the total phenol value in *nirapresso* as shown in Table 6.

Table 6. Total phenol value of palm sap and *nirapresso*

Producers	Total phenol value (mg GAE/100g)	
	Nira Aren	<i>Nirapresso</i>
A	15.22	19.81
B	16.21	15.82
C	11.38	17.20
D	19.84	22.66
E	14.09	19.52
Average	15.35	19.00

Nirapresso contains higher phenolic compounds compared to palm sap (Table 6). Coffee, as the main component of *nirapresso*, is rich in phenolic compounds, particularly chlorogenic acid, which reaches 60–120 mg/100g, thus increasing the total phenolic value in *nirapresso* beverages (Alara et al [19]). The coffee roasting process can also enhance phenolic compounds through the formation of new compounds. Conversely, the low total phenolic value in palm sap is suspected to be caused by natural fermentation by microorganisms like *Saccharomyces cerevisiae*. Although fresh palm sap contains some phenolic compounds, fermentation can lead to degradation or structural changes of phenolic compounds, thereby reducing their total concentration. Research by Mahardani and Yuanita [20] shows that the fermentation process can affect the levels of phenolic compounds in food products. Espresso coffee added to palm sap brings a significant amount of phenolic compounds that substantially increase the total phenolic content in *nirapresso*.

3.7 Antioxidant value

The sap from each coffee shop has antioxidant values ranging from 36.23-68.80% with an average of 54.41%. This result is not much different from the antioxidant value of *nirapresso* produced, as shown in Table 7.

Table 7. Antioxidant values of palm sap and *nirapresso*

Producers	Antioxidant value (%)	
	Palm sap	<i>Nirapresso</i>
A	36.23	74.45
B	68.80	61.37
C	58.61	75.08
D	48.38	72.85
E	60.04	55.32
Average	54.41	67.81

The antioxidant activity value of *nirapresso* is higher than that of palm sap (Table 7). The high antioxidant activity is suspected to come from the phenolic compounds in espresso coffee. Coffee is rich in antioxidant compounds such as chlorogenic acid, caffeine, and melanoidins that are formed during the roasting process. In contrast, the low antioxidant activity occurs due to the degradation of antioxidant compounds during the fermentation of aren sap. Although fresh palm sap contains several antioxidants, the fermentation process can lead to the degradation of phenolic compounds by microorganisms. This proves that coffee contains chlorogenic acid and polyphenols that have antioxidant properties. The addition of espresso coffee to palm sap significantly increases the total antioxidant content in the *nirapresso* drink. Coffee is one of the largest sources of antioxidants, and its contribution far exceeds that of palm sap. According to research. According to Hastuti [21], the antioxidant activity in robusta coffee (*Coffea canephora*) is generally higher compared to arabica coffee (*Coffea arabica*). This is due to the higher content of bioactive compounds in arabica coffee, particularly chlorogenic acid, which is more abundant in robusta coffee. Chlorogenic acid is the main phenolic compound that acts as an effective antioxidant in preventing the formation of free radicals.

4. Conclusion

The alcohol content of palm sap and *nirapresso* is still within the limits allowed by the MUI Fatwa. Other chemical characteristics indicate that the palm sap used by coffee shops in Banda Aceh is fresh sap with a very low alcohol content, averaging 0.140%, as is the case with *nirapresso*, averaging 0.137%, thus remaining below the limit set by the Indonesian Ulema Council Fatwa of <0.5%. It is necessary to ensure that all coffee shops continue to use fresh sap, considering that the relatively low pH makes the sap very susceptible to further fermentation. Storage at cold temperatures or immediate use after tapping is an important step to maintain quality and prevent increases in alcohol content. With good quality control of raw materials, *nirapresso* can not only maintain its freshness but also consistently meet halal standards and food safety.

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