Apple Cider Drink with Additional Sugarcane Juice (*Saccaharum Officinarum*) as Anti-Diabetes and Obesity

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Abstract. Instant or trendy beverages are increasing in popularity and distribution in Indonesia. However, they use white crystal sugar that loses its nutrition during crystallization, which is assumed to cause diabetes and obesity. On the other hand, various beverages cannot be avoided in the culinary world since consumers prefer them. Apple cider on the market is known as Malang's traditional drink. Its primary materials are white crystal sugar, apple-flavored cider, and preservatives, which are unsafe to consume. Therefore, this research aimed to chemically analyze the apple cider drink made from local apple and sugarcane juice that replaced white crystal sugar with no preservatives or other chemicals. This laboratory study used the $AlCl_3$ to determine the flavonoid level, the Folin–Ciocâlteu method to determine total phenols, and the spectrophotometer for testing potassium, calcium, tannins, and saponins. The results showed an antioxidant activity of 263.34 µg/mL. The total flavonoid on the apple cider was 1.676 mg QE/g, and the total phenol was 4.5 mg GAE/g. During the phytochemical test, the apple cider had a potassium content of 73.6554 mg/L, and a calcium content of 7.5963 mg/L. Qualitatively, the results identified tannin content but not saponins. Thus, the apple cider with additional sugarcane juice met the healthy drink requirements.

1 Introduction

In the Indonesian economy, sugarcane is the fourth most strategic commodity after grain. According to the data from the East Java Regional Development Planning Agency (*Badan Perencanaan Pembangunan Daerah*/BAPPEDA), an increase in sugarcane production can be an asset for sugar self-sufficiency. However, sugarcane is not optimally managed in the community. According to some research, sugarcane is better processed and consumed directly through the pressing process due to some beneficial ingredients. Sugarcane juice is a sweet liquid produced from the mentioned pressing process of the cane. The research of [1] proved that sugarcane juice contains high levels of as much as 0.475 ppm chromium. Chromium helps the body bind insulin to control the body's sugar levels as normal [2]**.** Also, sugarcane

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juice contains phenolic and flavonoid compounds, which act as antioxidants that benefit diabetes patients. According to several studies, sugarcane juice has proven that sugarcane has various benefits for the body. According to Megawati (2018), consuming sugarcane juice regularly can maintain the body's metabolism from lack of fluids caused by the many activities to avoid stroke attacks. Besides maintaining heart health, sugarcane juice can also maintain eye, kidney, and brain health. Besides, the antidiabetic content, such as flavonoids and phenols in the juice, has antidiabetic properties to be consumed by people with diabetes. The flavonoid compounds in sugarcane juice reaches a total of 175.87%, which means a very large antioxidant content (Megawati, 2018). There are active compounds in sugarcane juice which are thought to play a role in inhibiting alpha amylase, such as ferulic acid that binds alpha amylase and inhibit its breakdown process. This content is excellent for diabetes patients; therefore, unprocessed sugarcane juice is very helpful in preventing and controlling sugar in the body. On the opposite, the processed sugarcane juice into sugar cubes lost some substances and cannot be consumed by diabetics. However, due to the short shelf life and perishability of sugarcane juice, people prefer granulated sugar as a sweetener in food and drinks.

Granulated sugar is a sweetener made from refining the sugarcane juice. Nowadays, there are many good packageddrinks to attract consumer interest. Almost all use granulated sugar as a sweetener, for example, apple cider, which has been circulating on the market, especially in Malang, East Java. Apple cider is a soft drink from apple cider with granulated sugar and permitted food additives, including sodium cyclamate as a preservative, malic acid, and ascorbic acid. Granulated sugar contains sucrose. During the sucrose refining process, the sucrose content is optimized. At the same time, other substances, including the mineral chromium, are removed, including substances beneficial for health, such as vitamins, minerals, flavonoids, phenolics, and potassium. Excessive sugar consumption is predicted to causea high prevalence of type 2 diabetes.

As explained above, sugarcane juice is easily damaged by microbes and the decomposing process; hence, there needs to be severe treatment to improve the juice image into a functional drink (health drink), including changing the granulated sugar in apple cider to replace it with sugarcane juice as a sweetener. Apple cider with sugarcane juice sweetener is very different from apple cider. Also, adding other natural ingredients to strengthen the taste is necessary, such as lemon as a sour taste or a substitute for citric acid and mint leaves as an additional flavor ingredient for a fresh taste. Although Food Additives (*Bahan Tambahan Pangan*/BTP), such as citric acid, can be added to drinks, ascorbic acid is also permitted as a preservative. However, efforts are made not to use chemicals to process healthy drinks.

Sugarcane juice apple cider as a functional drink (providing beneficial effects on health) was thought to be very beneficial for the body, especially for diabetes patients. The flavonoids, phenols and antioxidants in sugarcane juice greatly influence the absorption of sugar in the body to prevent diabetes. Sugarcane juice apple cider also contains lemon as a sour taste. If apple cider generally uses citric acid or citric acid, sugarcane juice apple cider uses lemon as a sour taste to avoid instant food additives. The lemon content in apple cider also has the potential to be antidiabetic and anti-free radical because it contains flavonoids and reduces sugar levels [3]. Following the requirements of the Indonesian National Standards Agency (*Badan Standar Nasional Indonesia*/SNI) number 01-3719-1995, apple cider suitable for consumption does not contain dangerous or excessive food additives. Thus, it was hoped that this product would be able to enrich the culinary treasures in Indonesia, as well as provide benefits to consumers for their health. This will significantly benefit sugarcane farmers and reduce our dependence on imported sugar, which continues to increase yearly.

2 Method

2.1 Product Test of Apple Cider with Sugarcane Juice

Manalagi apples were processed using the infusion extraction method, a boiling process at a specific temperature to extract their juice. The fruits underwent a process of sorting ingredients, weighing, washing, cutting, boiling, grinding, and filtering. Product tests were carried out three times with different formulas. The procedure was as follows: sorting the apples with fresh green color, weighing and washing them, cutting the fruits into cubes to speed the mesh when boiled, boiling with 250 litres of water at a temperature of 80° to 90 °C for 45 minutes, adding other ingredients such as sugarcane juice, lemon water, and mint leaves, stirring the product while crushing the apples. The boiled apple cider was then filtered to extract only the juice before being cooled to be packaged and ready to be consumed. Hedonic test analysis in this study used 30 semi-trained panelists with two repetitions and a liking level scale from 1 to 5.

2.2 Laboratory Test

After knowing the most preferred formula for the hedonic test, the next step was a laboratory test, which included an antioxidant activity test, flavonoid test, phenol test, tannin test, anthocyanin test, saponin test, potassium test, calcium test, and shelf life test via anti-bacteria test.

2.3 Tools

In this research, measuring cups, Erlenmeyer, test tubes, analytical balances, micropipettes, spatulas, tube racks, UV-vis spectrophotometry, measuring pipettes, chemical beakers, stirring rods, vortex mixers, hotplates, funnels, and tissue were used.

2.4 Material

The materials were 250 ml of sugarcane juice apple cider, DPPH, $AlCl_3$, Folin Ciocalteu, HNO_3, Aquades, NaOH, and *Escherichia Coli* solutions.

2.5 Antioxidant Activity Test of Apple Cider with Sugarcane Juice

Determining the antioxidant activity of sugarcane juice apple cider drinks began with determining the wavelength of the 0.1 mM DPPH solution. The absorbance of the 0.1 mM DPPH solution was measured in the wavelength range 500–530 nm. Next, samples with concentrations of 20 ppm, 40 ppm, 60 ppm, 80 ppm, and 100 ppm were taken 1 mL each and put into each bottle wrapped in aluminum foil. After, 1 mL of DPPH solution was added to each and incubated for 30 minutes. Then, the absorbance was measured at a wavelength of 515 nm. The absorbance data obtained was used to determine the IC50 value [4].

2.6 Flavonoid Test of Apple Cider with Sugarcane Juice

0.5 samples of 10,000 ppm sugarcane juice apple cider drink were added with 1.5 mL of ethanol p.a. and 0.1 mL of 1% $AICI_3$ solution. Then, 0.1 mL of CH_3COONa 1M was added before an additional 2.8 mL Aquades. The solution was shaken and left for 30 minutes. Next, the absorbance was measured at a wavelength of 425 nm using UV-Vis spectrophotometry [5].

2.7 Phenol Test of Apple Cider with Sugarcane Juice

A 0.5 mL of 10,000 ppm sugarcane juice apple cider drink sample was added with 2.5 mL of Folin-Ciocalteu 7.5% and incubated for 8 minutes. Next, 2 mL of 1% NaOH solution was added. The solution was incubated for 1 hour at room temperature. Then, the absorbance was measured at a wavelength of 735 nm using UV-Vis spectrophotometry [6].

2.8 Saponins Test of Apple Cider with Sugarcane Juice

The aquades were poured into a goblet and heated r on a hotplate until it boiled. A sample of 1 mL was taken with 1 ml of hot aquades. Stir vigorously using a Vortex mixer. If permanent foam forms, then the sample contains saponin [7].

2.9 Tannins Test of Apple Cider with Sugarcane Juice

This research took a sample of 1 mL into a test tube. Then four drops of 1% $FeCl_3$ were taken, mixed with the sample, shaken until it changed color, and waited for the results [7].

2.10 Anthocyanins Test of Apple Cider with Sugarcane Juice

A 0.5 gram/0.5 mL sample of apple cider from sugarcane juice was taken. Then, 2 mL of NaOH was addedand dripped slowly while observing the color change.

2.11 Potassium and Calcium Test of Apple Cider with Sugarcane Juice

The samples were poured with added HNO_3 and macerated for 24 hours. After it was filtered, and if there were solids in the sample, then the solids would be tested using an Ass spectrophotometer [8]

3 Results and Discussion

3.1 Hedonic Test

Based on the hedonic test on sugarcane juice apple cider, including texture, color, and taste, the results were: themost preferred hedonic texture average was formula 3 with a result of 3.83 (like). The most preferred color hedonic test average was the thir^{d} formula with a result of 3.68 (like) due to the colors of apple cider and sugarcane juice being almost similar and not attracting attention, so the panelists were neutral in choosing the color hedonic test. The average for the most preferred taste of the hedonic test is the third formula, with a result of 4.15 (like). Thus, the third formulacould be used for further laboratory tests.

3.2 Laboratory Test

3.2.1 Antioxidant Activity Test of Apple Cider with Sugarcane Juice

Antioxidants protect the body from free radicals' effects on cells, which are determined through their IC50. IC50is the sample solution concentration needed to inhibit 50% DPPH free radicals. If the IC50 value is smaller, the antioxidant activity is stronger; if the IC50 is greater, the antioxidant activity is weaker.

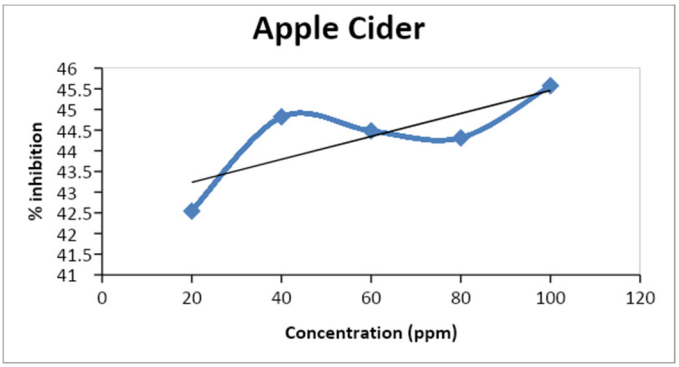

Fig. 1. Simple Linear Regression Analysis of Antioxidant Activity Test of Apple Cider with ugarcane Juice.

Based on the Figure 1, the curve is obtained from the equation y = 0.0278x + 42.679 with a correlation coefficient 0.6177. The sample absorbance experienced a significant increase from 100ppm to 20ppm with a control absorbance of 1.187. The Table 1 proves this.

Table 1. Sample Absorbance Concentration Results

Concentration (ppm)	Abs. sample
20	0.682
40	0.655
60	0.659
80	0.661
100	0.646

A compound is strong if the IC50 value is less than 50, with a ratio of strong (50-100), medium (100-150), and weak (150-200) according to Table 2.

Table 2. Antioxidant Properties Based on IC50 Values

IC50 Value	Antioxidant Properties
<50	Very strong
50ppm – 100ppm	Strong
100ppm – 150ppm	Adequate
150ppm – 200ppm	weak

Source: [9]

The IC50 antioxidant capacity test results on sugarcane juice apple cider were 263.34 ppm and were classified as weak. The lower the antioxidant activity value, the higher its capacity content. There was a reasonably drastic decline compared with sugarcane juice's antioxidant capacity. Based on research [10]. Sugarcane juice contains strong antioxidants of 72.65 ppm.

Meanwhile, the antioxidant capacity of *Manalagi* apples is 52.36 ppm [11]. The antioxidant capacity should be better after the apple cider was added sugarcane juice, even through the processing (boiling). The weak antioxidant activity in sugarcane juice apple cider was thought to be due to the heating process at more than 80 ℃. Antioxidant activity can persist at temperatures of 60°–70 ℃. The DPPH method was chosen in this study because it has an easy and fast procedure. In addition, the DPPH method has a stable and maximum absorption with a wavelength of 517nm. Boiling above 90℃ also considers organoleptic quality, which concerns taste, color, texture and aroma. Suppose heating is carried out to a temperature of 60℃. In that case, the antioxidant activity of sugarcane juice syrup will undoubtedly be stronger. However, despite this, the antioxidant capacity of sugarcane juice

apple cider is still beneficial for health, especially for diabetes patients, to control glucose levels in the body. It can maintain and control blood pressure in the body [12].

3.2.2 Flavonoid Content of Apple Cider with Sugarcane Juice

Flavonoids are a metabolic compound and a group of polyphenols that act as antioxidants and scavengers of free radicals [5]. The antioxidant content of flavonoids is a type of exogenous antioxidant which is believed to control blood sugar and regulate blood pressure in the body [13]. In addition, the flavonoid content in plants is believed to be an anti-inflammatory drug for the skin [14].

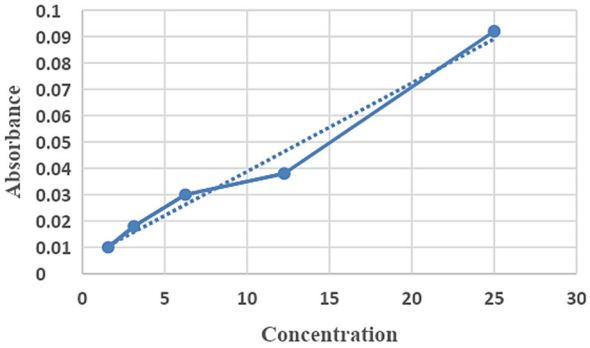

Fig. 2. Simple Linear Regression Analysis of Flavonoid Content of Apple Cider with Sugarcane Juice

Figure 2 shows that the total flavonoid content obtained from apple cider from sugarcane juice is 1.676 mg QE/g. Meanwhile, according to [15], the flavonoid content in sugarcane juice is 3,403.83 mg QE/g. This means that there is a decrease in the flavonoid content in it. The low flavonoid content is thought to be due to the heating process at very high temperatures. For a long time, the flavonoid content is reduced more. As explained by [16], flavonoids and antioxidant compounds will decrease due to the influence of temperature variations during the drying process because these compounds are sensitive to light and heat. This reduction occurs due to the breaking of the molecular chain and an oxidation reaction, which causes the oxidation of the hydroxyl group and will form other compounds that evaporate quickly. Therefore, handling raw materials as sources of antioxidants must be good and avoid various factors that can reduce their content. Although the flavonoid content in sugarcane juiceapple cider is relatively low, it still provides benefits for body health. Because the flavonoid content in plants/fruits is believed to be an anti-inflammatory drug for the skin [17].

3.2.3 Phenol Content of Apple Cider with Sugarcane Juice

Phenolic compounds are found in plants and are generally related to sugars as glycosides [18]. Phenolic compounds have hypoglycemia and antioxidant effects. The following is a graph of the Phenol Content of Sugarcane Juice Apple Cider based on Simple Linear Regression Analysis.

Based on the Figure 3, the curve is obtained from the equation y= 0.0044x + 0.0232 with a correlationcoefficient of 0.9914. The results of the phenol content analysis were obtained from curve calculations with the equation above, namely y = 0.0044x + 0.0232; the y value obtained was 0.043.

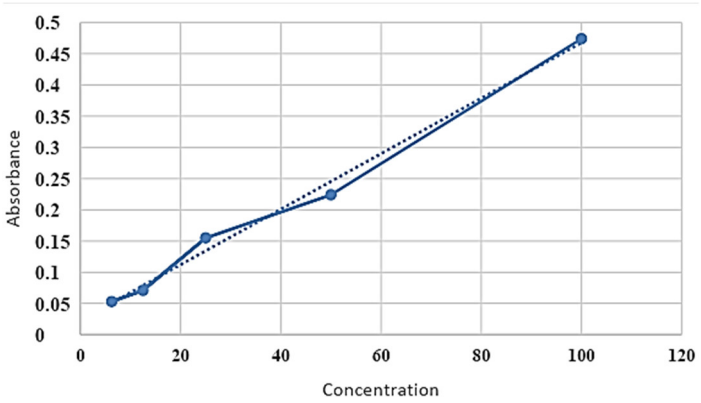

Fig. 3. Simple Linear Regression Analysis of Phenol Content of Apple Cider with Sugarcane Juice

The phenol content obtained from apple cider from sugarcane juice was 4.5 mg GAE/g. Meanwhile, according to [15], the phenol content in unprocessed sugarcane juice is 11.31 mg GAE/g. The reduction in phenol content is also thought to be due to the heating process at a reasonably high temperature (> 80°C) and over a long period, so the phenol content decreases more. As explained by [19], the phenolic content will be damaged/reduced if exposed to hot temperatures, including drying from sunlight. Even though the phenol content in sugarcane juice apple cider is not strong, it is much better than fruit juice that uses granulated sugar, according to [20]. Granulated sugar has lost nutritional/antioxidant capacity except for glucose, sucrose, and calcium.

3.2.4 Anthocyanin

Anthocyanins are secondary metabolites found in large quantities in fruits and vegetables. Anthocyanin functions as an antioxidant in the body. There are various health benefits of anthocyanins, such as antioxidants that can improve eye health and prevent diabetes by increasing insulin sensitivity [21]. According to [22], anthocyanin is a polyphenolic compound that colours orange to black. Meanwhile, the anthocyanins in sugarcane juice apple cider are proven by changing the color to orange.

3.2.5 Tannins

Tannins are phenolic compounds found in plants. Tannin is a compound that is considered antidiabetic. The antidiabetic effect of tannins can inhibit alpha-amylase and alpha glucoside and act as insulin receptors [23]. Based on the results of tannin identification using $FeCL_3$ solution, sugarcane juice apple cider contains positive tannins, marked with a blackish-green color. These tannins are not in apple cider, sweetened with granulated sugar (0).

3.2.6 Saponins

Saponin is a compound that can be found in plants [24]. Sugarcane juice is one of the plants that contains saponins. The benefit of saponin for diabetes patients is that it works like insulin. The mechanism of action of insulin is that it can inhibit the alpha-glucosidase enzyme, an enzyme whose job is to convert carbohydrates into glucose [25]. The screening test results were negative, meaning sugarcane juice apple cider does not contain saponin. The saponin content in sugarcane juice apple cider is lost due to the boiling process because saponin easily dissolves in water [26] [24].

3.2.7 Potassium and Calcium Content of Apple Cider with Sugarcane Juice

Potassium and calcium are essential macro minerals in maintaining body health, including cells and tissues. Potassium and calcium are enzymes that help maintain muscle health [27]. The spectrophotometric method is the most accurate for expressing potassium and calcium results. In DKBM data by the Ministry of Health, it is known that apples' potassium and potassium content are 130 mg calcium and 6 mg potassium. This study aimed to determine the calcium (Ca) and potassium (K) levels in apple cider samples from sugarcane juice, which were analyzed using Spectrophotometry Ass. The results show that the calcium content was 73.6554 mg/L, and the potassium content was 11.0518 mg/L.

4 Conclusion

Based on organoleptic tests, the sugarcane juice apple cider formula was preferred over apple cider on the market. Although weak antioxidant content (263.34 ppm), is still much better than granulated sugar (0). The flavonoid content (1.675 mg QE/g) and phenol (4.5 mg GAE/g). However, it is not included in the high category, is still better than apple cider sweetened with granulated sugar (0). The calcium content was high (73.6554 mg/L), and potassium was 11.0518 mg/L. Next, the results of tannins and anthocyanins were also qualitatively positive; only saponins were not identified because they dissolved in water.

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References

1. C. Wijayanti, N. Rizky, P. Hapsari, R. A. Ayuningtyas, B. Fatwa, and P. Sari, “Kadar Kromium Dalam Sediaan Gula Cair Dan Optimasi Daya Simpannya Sebagai Sediaan Gula Anti Diabetes,” *IPTEK Journal of Proceedings Series*, vol. 0, no. 4, pp. 9–12, 2019.
2. A. linda Mutiarani, “Pengaruh Pemberian Kromium, Vitamin C, Dan Vitamin E Terhadap Gula Darah Tikus Wistar Yang Diinduksi Aloksan,” *Jurnal ilmiah kedokteran*, vol. Volume 4, no. September, pp. 39–50, 2017.
3. B. P. Catur, “Penetapan Kadar Flavonoid Total Ekstrak Variasi Kulit Jeruk Dengan Metode Spektrofotometri Uv-Vis,” 2021.
4. F. R. Tulungen, “Biofarmasetikal Tropis Biofarmasetikal Tropis,” *The Tropical Journal of Biopharmaceutical*, vol. 2, no. 2, pp. 158–169, 2019.
5. S. R. Dewi, B. D. Argo, and N. Ulya, "Kandungan Flavonoid dan Aktivitas Antioksidan Ekstrak Pleurotus ostreatus," *Rona Teknik Pertanian*, vol. 11, no. 1, pp. 1–10, 2018, doi: 10.17969/rtp.v11i1.9571.
6. Susanti and F. Bachmid, “Perbandingan Metode Ekstraksi Maserasi dan Refluks terhadap Kadar Fenolik dari Ekstrak Tongkol Jagung (Zea mays L.) (Susanty, Fairus Bachmid),” pp. 87–93.
7. M. Lina, F. Kumalasari, F. Andiarna, F. Psikologi, and U. I. N. Sunan, “UJI FITOKIMIA EKSTRAK ETANOL DAUN KEMANGI (Ocimum basilicum L),” vol. 4, no. 1, pp. 39–44, 2020.
8. S. Khoirunissa, “Perbandingan Kadar Kalsium Dalam Teri Nasi Kering Dan Teri Nasi Basah Dengan Metode Spektrofotometri Serapan Atom,” *Perbandingan Kadar Kalsium Dalam Teri Nasi Kering Dan Teri Nasi Basah Dengan Metode Spektrofotometri Serapan Atom*, Vol. لعددلاحا, no. 3, pp. 1–13, 2018.

9. D. Tristantini, A. Ismawati, B. T. Pradana, and J. Gabriel, “Pengujian Aktivitas Antioksidan Menggunakan Metode DPPH pada Daun Tanjung (Mimusops elengi L),” *Universitas Indonesia*, p. 2, 2016.
10. P. PhilRice, "Rice that Filipinos Grow and Eat," 2005, Accessed: Sep. 24, 2023. [Online]. Available: https://eaber.org/wp-content/uploads/2011/05/PIDS_Leon_2005.pdf
11. Y. D. Rusita and R. Purwasih, “Perbandingan Aktivitas Antioksidan Ekstrak Apel Hijau (Malus Domestica) Segar Dan Kering Dengan Metode Spektrofotometri,” *Jurnal Kebidanan dan Kesehatan Tradisional*, vol. 4, no. 1, pp. 39–44, 2019.
12. A. B. Purnamasari, "Effect of Brotowali Extract Fortification of Papaya Leaves And Sugarcane Caries on Diabetes Mellitus Type II," in *Journal of Physics: Conference Series*, IOP Publishing, 2021, p. 012051. Accessed: Sep. 24, 2023. [Online]. Available: https://iopscience.iop.org/article/10.1088/1742- 6596/1752/1/012051/meta
13. D. S. Prawitasari, “Diabetes Melitus dan Antioksidan,” *KELUWIH: Jurnal Kesehatan dan Kedokteran*, vol. 1, no. 1, pp. 48–52, 2019, doi: 10.24123/kesdok.v1i1.2496.
14. P. A. U. Husna, C. F. Kairupan, and P. M. Lintong, “Tinjauan Mengenai Manfaat Flavonoid pada Tumbuhan Obat Sebagai Antioksidan dan Antiinflamasi,” *eBiomedik*, vol. 10, no. 1, pp. 76–83, 2022.
15. O. P. Wening, S. Yuliatun, M. M. Artin, and S. B. Agatha, “Karakterisasi Fitokimia Enkapsulasi Nira Tebu Powder dengan Menggunakan Varietas BL, PSDK-923, dan PSBM-901,” *Indonesian Sugar Research Journal*, vol. 2, no. 1, pp. 22–34, Jun. 2022, doi: 10.54256/isrj.v2i1.72.
16. Z. Ai *et al.*, "Effect of hot air impingement drying on drying behavior, volatile components profile, shell burst ratio, flavonoid contents, microstructure of Amomum villosum fruits," *Drying Technology*, vol. 41, no. 1, pp. 107–121, Jan. 2023, doi: 10.1080/07373937.2022.2087184.
17. N. Bibi *et al.*, "Variations in total phenolic, total flavonoid contents, and free radicals' scavenging potential of onion varieties planted under diverse environmental conditions," *Plants*, vol. 11, no. 7, p. 950, 2022.
18. O. T. Mahardani and L. Yuanita, "Efek Metode Pengolahan Dan Penyimpanan Terhadap Kadar Senyawa Fenolik Dan Aktivitas Antioksidan," *Unesa Journal of Chemistry*, vol. 10, no. 1, pp. 64–78, 2021, doi: 10.26740/ujc.v10n1.p64-78.
19. A. Mega, A. Tritisari, and R. Fertiasari, “Analisis Kandungan Vitamin C Pada Jeruk Nambong Sebagai Hasil Olahan Jeruk Limau (Lat. Citrus Amblycarpa) Dengan Metode Iodimetri,” *Agrofood*, vol. 3, no. 1, pp. 29–32, 2021.
20. L.-Q. Chen *et al.*, "Sugar transporters for intercellular exchange and nutrition of pathogens," *Nature*, vol. 468, no. 7323, pp. 527–532, 2010.
21. R. A. Ifadah, P. Rizkia, W. Wiratara, and C. Anam, “Ulasan Ilmiah : Antosianin dan Manfaatnya untuk Kesehatan,” vol. 3, no. 2, pp. 11–21, 2021.
22. M. Priska, N. Peni, L. Carvallo, and Y. D. Ngapa, “Antosianin dan pemanfaatannya,” *Cakra Kimia (Indonesian E-Journal of Applied Chemistry)*, vol. 6, no. 2, pp. 79–97, 2018.
23. R. E. Budianto *et al.*, “Jurnal Sains dan Kesehatan,” vol. 4, no. 5, pp. 548–556, 2021.
24. D. Hendra Gunawan, P. Negeri Pontianak, J. Teknologi Pertanian dan Administrasi Bisnis, J. Jenderal Ahmad Yani Pontianak, and K. Barat, “PENURUNAN SENYAWA SAPONIN PADA GEL LIDAH BUAYA DENGAN PEREBUSAN DAN PENGUKUSAN Decreasing Saponin Compounds on Aloe Vera Gelwith Boiling and Steaming,” *Jurnal Teknologi Pangan*, vol. 9, no. 1, pp. 2597–436, 2018.

25. S. Sudirman and A. C. Kusumastuti, "Pengaruh Pemberian Rebusan Daun Binahong (Anredera Cordifolia)terhadap Kadar Glukosa Darah pada Wanita Dewasa," *Journal of Nutrition College*, vol. 7, no. 3, p. 114, 2018, doi: 10.14710/jnc.v7i3.22270.
26. D. H. Gunawan, "Penurunan Senyawa saponin pada gel lidah buaya dengan perebusan dan pengukusan,"
Jurnal Teknologi Pangan, vol. 9, no. 1, pp. 41–44, 2018.
27. I. Musfiroh, N. N. Susanti, and Y. Sukmawardani, "Analisis Kalium dan Kalsium pada Ikan Kembung dan Ikan Gabus," *Ijpst*, vol. 3, no. 1, pp. 26–30, 2016.