

Comparison of Powdered Active Compounds Made from Tender Coconut Water Fortified with Vitamin E, Processed by Spray Drying and Freeze Drying

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ABSTRACT

Background: Tender coconut water contains antioxidants vitamin C, amino acids, L-arginine, polyphenols, selenium, and minerals that prevent oxidative stress, anemia, and inflammation. It also lowers lipid profiles, increases enzyme antioxidant status, and controls lipid peroxidation. Previous investigations have shown that tender coconut water provides health benefits but is difficult to store. This is due to its short shelf life, which can be extended by drying to obtain a dry or powdered form. A special drying method to acquire dry materials and maintain the characteristics of the raw materials is spray or freeze drying. **Objective:** This study aims to develop tender coconut water into a powder fortified with vitamin E and to differentiate the active compound content of the powder processed by spray and freeze drying. **Method:** This study used a randomized block design and the sample used was green tender coconut water (Viridis variety) aged about 5-7 months from the Bogor area. The procedures include the purchase of tender coconut water, followed by spray and freeze drying, while the content of active compounds that are beneficial to health was also analyzed. Drying was carried out at the Seafast Center Laboratory of Research and Community Service Institute, Bogor Agricultural Institute (IPB), while the active compound content was analyzed at the Integrated Research and Testing Laboratory, Gadjah Mada University (UGM), Yogyakarta. **Result:** The active compounds analyzed from powder made from tender coconut water fortified with vitamin E were vitamin C, phenol, L-Arginine, L-Histidine, L-Lycine, L-Phenylalanine, L-Isoleucine, L-Leucine, L-Valine, and minerals consisting of Cu (Copper), Fe (Iron), Mg (Magnesium), Zn (Zinc), Na (Sodium), K (Potassium), and P (Phosphor). **Conclusion:** There are differences in the content of active compounds in tender coconut water powder fortified with vitamin E between freeze and spray-drying methods.

Key words: Tender coconut water, Spray drying, Freeze drying.

INTRODUCTION

Tender coconut water contains antioxidant vitamin C, amino acids, L-arginine, polyphenols, selenium, and minerals that prevent oxidative stress,¹ anemia,² inflammations,³ lowers lipid profile,⁴ improves enzyme antioxidant status, and controls lipid peroxidation.⁵ Since ancient times, its properties have been used by many people for various health reasons. During World War II, it was widely used as an alternative treatment in cases of cholera. Regardless of myth or fact, many people still use tender coconut water to maintain their fitness and endurance.

Based on previous investigations, tender coconut water can reduce the levels of TNF- α , IL-1, and IL-6 in DM rats,³ glucoses, as well as MDA, and also increases plasma insulin levels in pregnant rats with DM (random blood sugar).⁶ It also prevents oxidative stress due to DM, exposure to heavy metals and cigarette smoke,^{7,8} and reduces urea levels in rats exposed to Pb.⁹ The nutritional content is very beneficial for the health of the body, but the processing of tender coconut water into the powder and retesting in preventing oxidative stress is still limited. Efforts are needed to develop this raw material into powder products enriched with vitamin E. This is because when more diverse products are produced from tender coconut water, it will provide added value and be more practical. Previous investigations have shown that tender

coconut water provides health benefits, but it is difficult to store. This is due to its short shelf life, which can be extended by drying to obtain a dry or powdered form. A special method to become the dry materials and maintain the raw material characteristics is by spray or freeze drying.

A spray dryer is used to evaporate and dry the material in form of solution and slurry by using heat, therefore, the result is a dry solid granule. In a spray dryer, the solution or slurry is dispersed into the hot gas stream in form of mist or fine droplets. This method uses liquid atomization to form droplets, which are dried using dry air at high temperatures and pressure. Evaporation from the droplet surface causes the deposition of solutes on the surface.¹⁰

Freeze dryers are included in the Conduction/ Indirect Dryer because the transfer process occurs indirectly. It is called indirect drying because between the material to be dried and the heating medium there is a barrier wall, therefore, the water in the vaporized wet/moist material is not carried along with the heating medium. This indicates that heat transfer occurs by conduction. The principle of freeze drying involves freezing the solution and granulating it under ultra-high vacuum at moderate heating conditions, which causes the water in the food to sublimate and produce a solid product. According to Pujihastuti, the advantages of freeze-dried products include maintaining product stability, material structure stability, and increasing

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rehydration power. Therefore, this study aims to develop tender coconut water into a powder fortified with vitamin E and to distinguish the active compound content of the powder. The most effective powder formulation will be obtained to prevent oxidative stress, especially due to type 2 diabetes.

METHOD

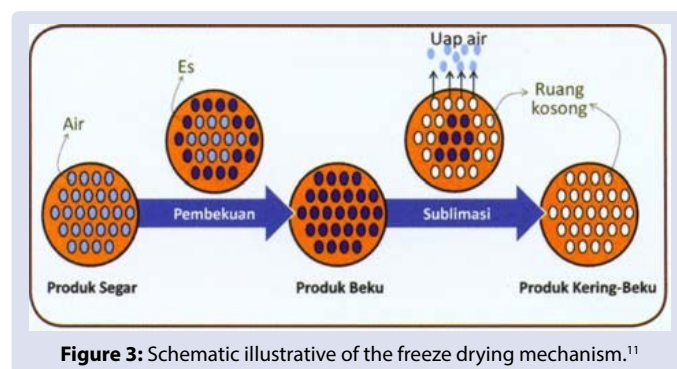
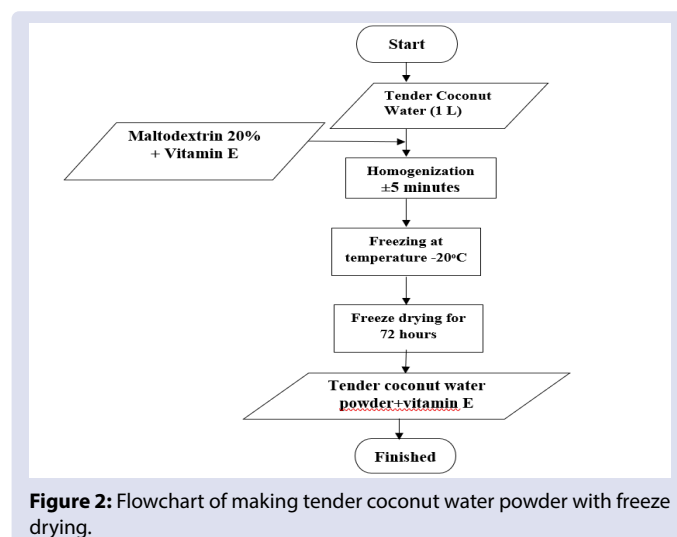
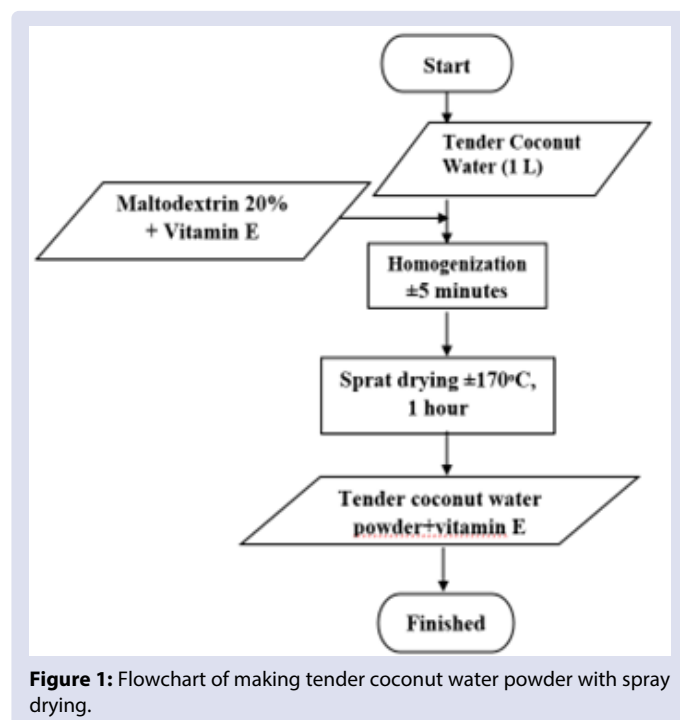
The method used was to compare the content of active compounds between powder made from tender coconut water which is processed by freeze and spray dryer methods. This study used a randomized block design and the sample was green tender coconut water (Viridis variety) aged about 5-7 months, obtained from the Bogor area. This area was selected to ease the process of making the powder at the Bogor Agricultural Institute (IPB). The procedures include the purchase of tender coconut water, followed by spray as well as freeze drying, and the content of active compounds that are beneficial to health was also analyzed. The drying technique was carried out at the Seafast Center Laboratory of Research and Community Service Institute, Bogor Agricultural Institute (IPB), while the active compound content was analyzed at the Integrated Research and Testing Laboratory, Gadjah Mada University, Yogyakarta. The manufacturing of powder made from tender coconut water fortified with vitamin E started from June 6 to August 5, 2022. The content of active compounds such as vitamin C, phenol, L-Arginine, L-Histidine, L-Lycine, L-Phenylalanine, L-Isoleucine, L-Leucine, L-Valine, and minerals consisting of Cu (Copper), Fe (Iron), Mg (Magnesium), Zn (Zinc), Na (Sodium), K (Potassium), and P (Phosphor) was examined starting from 11 August to 5 October 2022.

The flowchart of making tender coconut water powder with spray and freeze drying can be observed in Figure 1 and 2.

RESULTS AND DISCUSSION

This study includes 2 stages as follows:

The manufacturing of powder made from tender coconut water by spray and freeze drying at the Seafast Center Laboratory of the Research and Community Service Institute, Bogor Agricultural Institute (IPB).



Examination or analysis of the active compound content was carried out at the Integrated Research and Testing Laboratory, Universitas Gadjah Mada, Yogyakarta.

The process of making powder made from tender coconut water is divided into 5 groups, namely:

- A: Tender coconut water dried with spray drying
- B: Tender coconut water dried with spray drying + vitamin E 400 IU
- C: Tender coconut water dried with spray drying + vitamin E 200 IU
- D: Tender coconut water dried with freeze drying
- E: Tender coconut water dried with freeze drying + vitamin E 400 IU
- F: Tender coconut water dried with freeze drying + vitamin E 200 IU

The principle of freeze drying technology starts with the freezing process, and continues with drying, namely removing/separating most of the water in the material that occurs through the mechanism of sublimation. The process occurs through the mechanism of sublimation at cold temperatures. Therefore, the process of gelatinization, caramelization, and denaturation does not occur, which prevents change in crust formation on the dry part of the food. This makes the water vapor diffuse well from the wet part to the ambient air to obtain an efficient dry product. The freeze-drying process is described in Figure 3.

Freeze-drying technology is a special method that allows for obtaining dry materials and maintains the characteristics of the raw materials. Freeze-drying coconut water powder has the same nutritional content and taste as fresh raw material.¹² Spray dryer drying includes direct drying and in the process, the water from the wet material is evaporated

Table 1: The analysis results of the active compound content of powder made from tender coconut water processed by spray and freeze drying. Source: Integrated Research and Testing Laboratory-Universitas Gadjah Mada-Yogyakarta.

NO	TEST PARAMETERS	UNIT	SAMPLE CODE						METHOD
			A	B	C	D	E	F	
1	L-Arginine	µg/g	39.5	34.4	30.2	51.6	231.1	101.5	LCMS
2	L-Histidine	µg/g	11.7	17.8	11.5	21.9	66.0	39.3	LCMS
3	L-Lycine	µg/g	15.7	22.3	20.3	16.2	97.1	38.7	LCMS
4	L-Phenylalanine	µg/g	3.5	3.0	2.0	9.4	8.7	4.8	LCMS
5	L-Isoleucine	µg/g	3.0	0.9	0.5	4.5	2.6	3.2	LCMS
6	L-Leucine	µg/g	10.9	9.1	8.0	15.9	15.7	12.3	LCMS
7	L-Valine	µg/g	3.2	2.5	2.0	4.1	2.7	3.2	LCMS
8	Cu (Copper)	mg/kg	1.55	0.33	0.30	0.94	0.75	0.57	Flame-AAS
9	Fe (Iron)	mg/kg	4.27	0.69	0.65	3.5	6.40	3.16	Flame-AAS
10	Mg (Magnesium)	mg/kg	386.33	368.87	356.70	271.88	377.31	324.43	Flame-AAS
11	Zn (Zinc)	mg/kg	1.51	1.29	1.10	2.11	1.00	2.20	Flame-AAS
12	Na (Sodium)	mg/kg	1080.30	1046.13	1040.50	810.28	1052.86	1155.44	Flame-AAS
13	K (Potassium)	mg/kg	5354.20	5572.74	5435.45	6873.30	7260.42	6409.42	Flame-AAS
14	P (Phosphor)	mg/kg	250.71	111.29	110.30	276.87	163.37	164.79	UV-vis spectrophotometry
15	Vitamin C	µg/g	Not detected						TLC
16	Phenol	mg/kg	Not detected						Gas Chromatography

Description:

- LCMS: Liquid Chromatography Mass Spectrometry
- AAS: Atomic Absorption Spectrometry
- TLC: Thin Layer Chromatography
- UV-vis: Ultra Violet-visible

with hot air media. The heat carried by air will heat the surface of the wet material, increasing the temperature, and leading to the evaporation of the water. Freeze dryers are included in the Conduction/Indirect Dryer because the transfer process occurs indirectly. It is called indirect drying because there is a barrier wall between the material to be dried and the heating media. Therefore, the water in the vaporized wet/moist material is not carried along with the heating medium and this shows that heat transfer occurs by conduction.¹¹

Spray drying is suitable for drying liquid materials. In the spray dryer, the liquid is passed through a nozzle (pressure filter), which functions to convert the sample into very fine liquid droplets. Reducing the size will increase the surface area of the material, thereby speeding up the process of removing water. The drying process with a spray dryer can produce results in form of a fine powder. This is because of the nozzle in the spray dryer that changes the shape of the slurry into very fine liquid droplets. Drying with a freeze-dryer requires a powdering process, which is performed after the drying process is ground. The powdering process cannot yet become a product since the mesh size is not uniform, therefore, meshing is carried out for uniform flour size.¹⁰

The results indicated that group E, which is a powder made from tender coconut water processed by freeze drying and fortified with vitamin E 400 IU has the highest L-arginine content, Mg, and K with values 231.1 µg/g, 377.31 mg/kg, and 7,260.42 mg/kg, respectively. This content is higher compared to group B, where the powder was processed by spray drying and fortified with vitamin E 400 IU.

Previous studies have stated that active compounds such as L-arginine contained in coconut water are healthy, can reduce the risk of type 2 diabetes mellitus (DMT2),³ and prevent free radicals caused by mercury exposure.^{13,14} L-arginine can prevent and/or alleviate type 2 diabetes through the restoration of insulin sensitivity. The results of a meta-analysis showed that plasma L-arginine levels were associated with an increased risk of T2DM.¹⁵ In diabetes, potassium is very useful for increasing insulin sensitivity, therefore, the process of lowering blood sugar takes place effectively. It also lowers the risk of hypertension and heart disease in diabetics. Moreover, potassium is useful for

increasing insulin sensitivity and its intake is very important because insulin requires a lot of potassium. Mineral content such as Mg is also needed by the body, however Mg deficiency is found to be significantly common in patients with type 2 diabetes, especially in those with an uncontrolled glycemic profile. A previous study also reported that type 2 diabetes is often associated with extracellular and intracellular magnesium (Mg) deficiency.¹⁶ In this study, freeze drying method is better than the spray drying, especially for powder from tender coconut water, which is characterized by higher levels of L-arginine, magnesium and potassium when compared to the spray drying. Freeze-drying technology is a special method that allows for obtaining dry materials and maintains the characteristics of the raw materials. Freeze-drying coconut water powder has the same nutritional content and taste as fresh raw material.¹²

CONCLUSION

The active compound content such as L-arginine, magnesium (Mg), and potassium (K) in a powder made from tender coconut water processed by freeze drying and fortified with vitamin E 400 IU is higher than the product obtained through spray-drying method.

ACKNOWLEDGMENTS

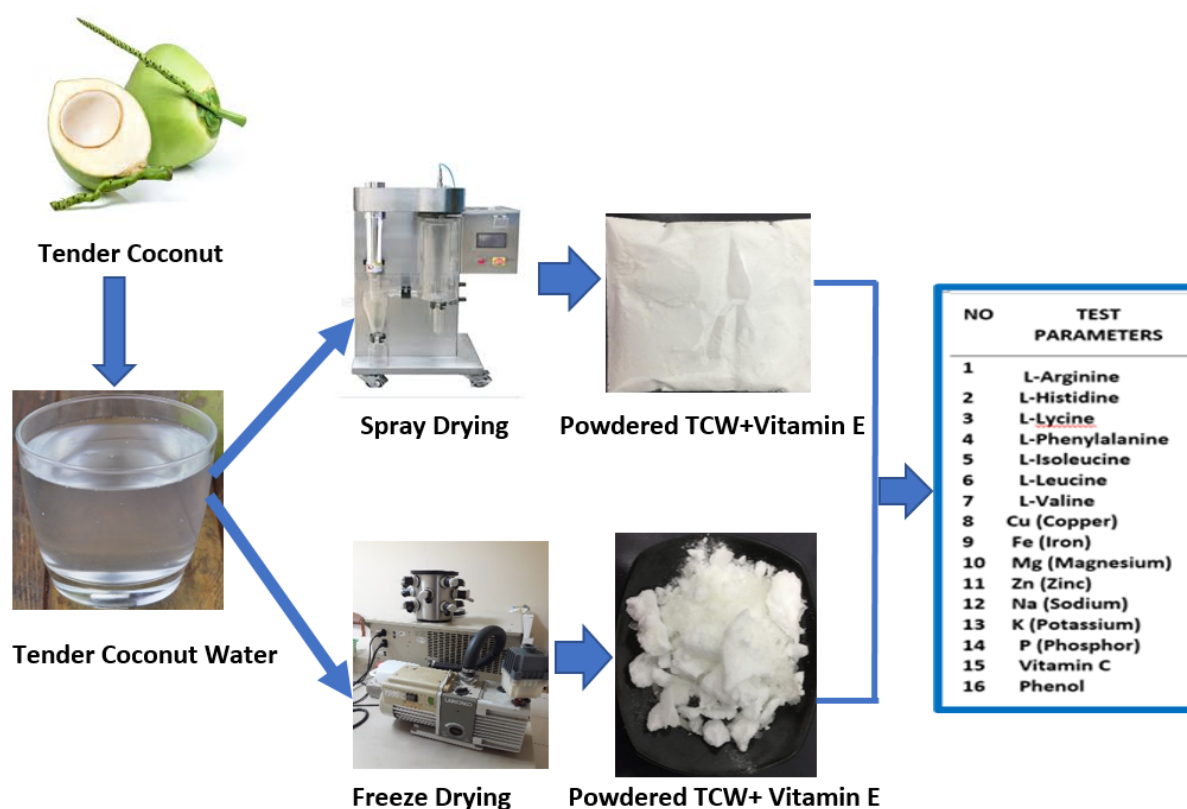
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REFERENCES

1. Zulaikhah ST. Health Benefits of Tender Coconut Water (TCW). Int J Pharm Sci Res. 2019;10(2):474-80.

2. Zulaikhah ST, Wahyuwibowo J, Rakha DA, Rizky PD, Fauzi NA. Effect of Tender Coconut Water to Prevent Anemia on Wistar Rats Induced by Lead (Plumbum). *Pharmacogn J.* 2019;11(6):1325-30.
3. Zulaikhah ST, Wahyuwibowo J, Suharto MN, Enggartiasto BH, Ortanto MIR, Pratama AA. Effect of tender coconut water (TCW) on TNF- α , IL-1 and IL-6 in streptozotocin (STZ) and nicotinamid (NA) induced diabetic rats. *Pharmacogn J.* 2021;13(2):500-5.
4. Zulaikhah ST, Pertiwi D, Bagus SA, Nuri S, Alfiza NS. Effect of Tender Coconut Water on Blood Lipid Levels in Hight Fat Diet Fed Male Rats. *J Krishna Inst Med Sci Univ.* 2017;6(2):63-8.
5. Zulaikhah ST, Ari SA. Effects of Tender Coconut Water on Antioxidant Enzymatic Superoxida Dismutase (SOD), Catalase (CAT), Glutathione Peroxidase (GPx) and Lipid Peroxidation In Mercury Exposure Workers. *Int J Sci Res.* 2015;4(12):517-24.
6. Nova FS, Chasani S, Hussanna A, Zulaikhah ST. Tender coconut water Inhibits the process of lipid peroxidation, reduce glucose levels, and increase plasma insulin in pregnant diabetic rats. *Pharmacogn J.* 2020;12(1):24.
7. Zulaikhah ST, Wibowo JW, Fitri H, Aini N, Pratama A. Tender Coconut Water Can Inhibit Inflammation Caused by Cigarette Smoke. *J Hunan Univ Sci.* 2021;48(12):28-35.
8. Zulaikhah ST, Wahyu WJ, Muhammad S. Pengaruh Air Kelapa Muda Terhadap Kadar Antioksidan Endogen Akibat Paparan Asap Rokok Pada Tikus Jantan Galur Wistar. *Suara Forikes.* 2021;12(6):290-3.
9. Zulaikhah ST, Wayhuwibowo J. Pengaruh Pemberian Air Kelapa Muda Terhadap Kadar Ureum Pada Tikus Galur Wistar Yang Terpapar Plumbum (Pb) Siti Thomas Zulaikhah. *J Penelit Kesehatan Suara Forikes.* 2021;11(1):198-201.
10. Lestari Y. Perbandingan kerja pengeringan tipe Spray dryer dan Freeze dryer dalam proses pengeringan bahan berbentuk cair. *J Ilm Kohesi.* 2019;3(3):96-9.
11. Hariyadi P. Freeze Drying Technology : for Better Quality & Flavor of Dried Products. *Food Rev Indones.* 2013;7(2):52-7.
12. Boonnumma S, Chaisawadi S, Suwanyuen. Freeze-dried coconut water powder processing for natural health drink. *Acta Horti.* 2014;1023:91-4.
13. Zulaikhah ST. The Role of Antioxidant to Prevent Free Radicals in The Body. *Sains Med J Med Heal.* 2017;8(1):39.
14. Zulaikhah ST, Wayhuwibowo J. The Effect of Tender Coconut Water on Free Radical Due to Mercury Exposure. *IJPHS Int J Public Heal Sci.* 2018;7(2):102-6.
15. Mirmiran P, Bahadoran Z, Gaeini Z, Azizi F. Habitual intake of dietary L-arginine in relation to risk of type 2 diabetes: a prospective study. *BMC Endocr Disord.* 2021;21(1):1-7.
16. Barbagallo M. Magnesium and type 2 diabetes. *World J Diabetes.* 2015;6(10):1152.

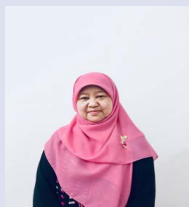
GRAPHICAL ABSTRACT



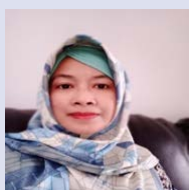
SUMMARY

The active compound content such as L-arginine, magnesium (Mg), and potassium (K) in a powder made from tender coconut water processed by freeze drying and fortified with vitamin E 400 IU is higher than the product obtained through spray-drying method.

ABOUT AUTHORS



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