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Chemical properties of moringa milk powder used rotary vacuum drying

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Abstract

The objective of this study was to determine the effect of the concentration of Moringa leaf extract and variations in drying temperature on the chemical characteristics of Moringa milk powder. The research design used a randomized block design with repeated 3x3 factorials, followed by Duncan's test; The results showed that the concentration of Moringa extract and variation of drying temperature had a significantly different effect on the chemical and organoleptic characteristics of Moringa milk powder. The best treatment was the treatment with the addition of 7% moringa extract at 70 °C.

Keywords: moringa extract; rotary vacuum drying; milk powder.

Practical Application: Concentration of natural dyes used in the manufacture of moringa milk.

1 Introduction

Indonesia is one of the most famous countries because it has the largest and most unique biodiversity in the world. The abundance of Indonesia's natural wealth makes it a warehouse for medicinal plants or ornamental plants. One of the medicinal plants that grows and develops in Indonesia and have many benefits is the Moringa (*Moringa oleifera*) plant. The stems, fruits, flowers, leaves, and seeds of the Moringa plant have many benefits and have been used well by the community, especially on the leaves because it is efficacious as antidiabetic, treating rheumatism, treating herpes, treating internal organ diseases (gastric ulcers, intestinal ulcers, and kidney stones) and treat cancer (Lagawa et al., 2020).

Milk powder quality is complex because it is dependent on a complex combination of physical and functional properties of milk powder (Sharma et al., 2012). For example, the dissolution behaviour of the milk powder is driven by its physical properties, such as particle size distribution and bulk density, and functional properties such as dispersibility (Oldfield & Singh, 2005).

Moringa leaves contain solid nutrients, minerals, and essential amino acids. Moringa leaves also contain quite high antioxidants including vitamin C, beta-carotene, quercetin, and chlorogenic acids (Winarno, 2018). Moringa leaves have antioxidant activity due to their high polyphenol content. Old or young Moringa leaves contain extracts that show antioxidant activity against free radicals. In addition to containing high antioxidants, Moringa leaves can be used to overcome the problem of malnutrition in children and as an effort to boost the immune system (Krisnadi, 2015).

The use of Moringa plants is still not optimally utilized by the people of Indonesia as food. Therefore, Moringa leaves can be used as a source of nutrition in food products by increasing food diversification or diversity of Moringa leaves. One effort that can be done is by adding Moringa leaf extract to milk so that it can increase the nutritional value and provide health benefits for the body. The stabilizer, as well as filler in this Moringa leaf milk product, is trehalose. According to Higashiyama (2002) and Sedijani (2014) trehalose is a simple disaccharide sugar and is a non-reducing sugar that has a sweetness level of about 45% compared to sucrose. In addition to having a stable nature the molecule, trehalose also stabilizes the surrounding molecules.

The addition of Moringa leaf extract to milk which has an ideal nutritional composition and contains substances needed for the body will increase the nutritional value and provide many benefits, especially for the health of the body. Moringa leaves used in the manufacture of moringa milk powder are in powder form because if they are processed into dry or flour forms, the main content of Moringa leaves obtained will be maximized and higher (Zainuddin & Sri Hajriani, 2021). The current study was conducted to determine the effect of the concentration of Moringa leaf extract (*Moringa oleifera*) and variations in drying temperature on the physicochemical characteristics of moringa milk powder.

2 Materials and methods

2.1 Process of making Moringa milk

The ingredients used in the process of making Moringa leaf milk powder drink are Moringa leaves, cow's milk, trehalose sugar. The materials used for analysis in this study were distilled water, dichlorophenol indophenol, HPO_3 solution, 2,2-Diphenyl-1-picrylhydrazyl, pro-analytical ethanol, pro-analytical methanol, quercetin, pigment powder, concentrated H_2SO_4 solution, 30% NaOH solution, Zn granules, 0.1 N HCl standard solution, 0.1 N NaOH solution, phenopthalien indicator, HgO/Na_2SO_4 catalyst, $Na_2S_2O_3$ solution, boiling stone. The tools used to make Moringa

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leaf milk powder drink are rotary vacuum dryer, drying oven, blender, container, spatula, filter, and scale, filter paper, 90 mm funnel, 250 mL Erlenmeyer flask, spoon, 1000 mL and 100 mL measuring cups, vibratory screen, and 80 mesh. The tools used for analysis in the study were analytical balance, Kjedahl flask, 100 mL volumetric flask, burette, clamps and stabilizers, filler, condenser, safety glass ball, long adapter, Erlenmeyer flask, blender, filter paper, dropper, oven, cup porcelain, desiccator, funnel, stirring rod, spatula, crucible pliers, beaker glass, and magnetic stirrer.

2.2 Statistical analysis

The research design used a randomized block design with repeated 3x3 factorials, followed by Duncan's test. The concentration of Moringa leaf extract (3%, 5%, and 7%), and the variation of drying temperature which consists (50 °C, 60 °C, and 70 °C) comprised the experimental variables. Moringa leaf powder is weighed and then dissolved by adding warm water in a ratio of 1:5. Next, the first filtering process is carried out by filtering the powdered Moringa leaves that have been dissolved using a filter and then the second filtering process by filtering the results of the first filtering using filter paper so that the Moringa leaf extract is free from the residue (Halimah et al., 2019).

2.3 Chemical analysis

The analysis used in this research are water content gravimetric method, antioxidant activity DPPH method, pH value using a pH-meter, protein content Kjeldahl semi-micro method, vitamin C content using UV-Vis Spectrophotometry.

3 Results and discussion

3.1 Analysis of moisture content

The effect of the concentration of Moringa leaf extract and variations in drying temperature on the moisture content is shown in Table 1 and 2. The moisture content decreases with increasing variations in drying temperature and Moringa Extract. Drying using a higher temperature can produce a lower product moisture content so the higher the temperature used, the faster the transpiration process (Winangsih et al., 2013). According to Winarno (2018), high drying temperatures can cause the moisture content in the material to be low because the water evaporation process occurs quickly. In addition, this decrease in moisture content is caused by more dissolved components or compounds (Astawan, 2019).

3.2 Antioxidant activity test

The results of the analysis of antioxidant activity using the DPPH method on moringa milk powder with selected samples with a concentration of 5% Moringa leaf extract and a drying temperature of 60 °C, the results showed that moringa milk powder had antioxidant activity with an IC_{50} value of 2188,2650 ppm. While the results of research by Rizkayanti et al. (2017), that the IC_{50} value of Moringa leaf extract using ethanol solvent is 22,1818 ppm. The decrease in IC_{50} value is thought to be due to a decrease in antioxidant activity caused by the drying process. The graph of the antioxidant activity of the selected sample is shown in Figure 1.

If the IC_{50} value is below 50 ppm then the antioxidant activity is very strong, the IC_{50} value is between 50-100 ppm then the antioxidant activity is strong, the IC_{50} value is between 101-150 ppm, the antioxidant activity is moderate, the IC_{50} value is between 151-200 ppm, the antioxidant activity weak, while if the IC_{50} value is above 200 ppm, the antioxidant activity is very weak (Salim & Eliyarti. 2019).

Analysis of antioxidant activity has the regression equation y = bx + a and the value of r2. In the regression equation, the y coefficient is the IC_{50} value, the x coefficient in this equation is an extract that is tested for antioxidant activity and is the concentration value needed to reduce 50% of DPPH activity. Meanwhile, the value of R^2 which is close to +1 means that as the concentration of the extract increases, the antioxidant activity increases (Novatama & Kusomo, 2016).

3.3 Analysis of protein content

The effect of the concentration of Moringa leaf extract and variations in drying temperature on protein content is shown in Table 3 and Table 4. The protein content decreases with increasing

Table 1. The effect of concentration of Moringa leaf on the moisture content of moringa milk powder.

Moringa Extract	Moisture Content (%)
3%	3.81 ± 0.01^c
5%	3.58 ± 0.02^b
7%	3.22 ± 0.04^a

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 2. The effect of variations in drying temperature on the moisture content of moringa milk powder.

Variation of Drying Temperature	Moisture Content (%)
50 °C	4.62 ± 0.31^c
60 °C	3.50 ± 0.27^b
70 °C	2.49 ± 0.35^a

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 3. The effect of concentration of Moringa leaf on the protein content of moringa milk powder.

Moringa Extract	Protein Content (%)
3%	32.57 ± 0.06^a
5%	32.63 ± 0.00^b
7%	32.65 ± 0.01^b

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 4. The effect of variations in drying temperature on the protein content of moringa milk powder.

Variation of Drying Temperature	Protein Content (%)
50 °C	32.66 ± 0.03^b
60 °C	32.63 ± 0.04^b
70 °C	32.60 ± 0.06^a

Different letter in each column indicates a significant difference ($p < 0.05$).

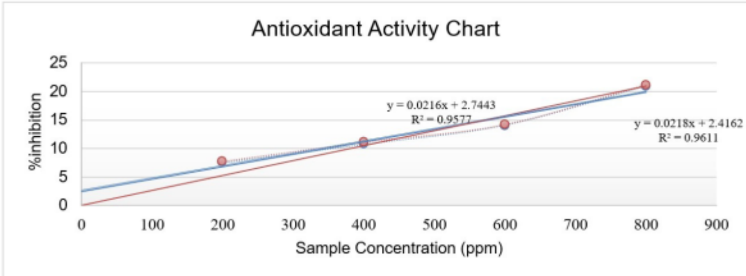

Figure 1. Antioxidant Activity Graph of Selected Samples with Two Replications.

variations in drying temperature due to protein denaturation, this is in line with the opinion of Winarno (2018), which states that protein denaturation can occur due to changes in heat, pH, and the addition of chemicals.

Meanwhile, the addition of higher concentrations of Moringa leaf extract used can increase protein levels, this is in line with the opinion of Malibun et al. (2019), that Moringa leaves have a protein content of 3 times that of egg protein, 25 times the iron and 3 times the vitamin C in spinach where the protein content of Moringa leaf powder is 26.03% (Augustyn et al., 2017).

Moringa leaves also contain 18 amino acids consisting of 8 types of essential amino acids and 10 types of non-essential amino acids. The essential amino acids include isoleucine, leucine, lysine, methionine, phenylalaine, threonine, tryptophan, and valine. Non-essential amino acids include alanine, arginine, aspartic acid, cystine, glutamic acid, glycine, histidine, serine, proline, and tyrosine (Suhartini et al., 2018).

3.4 Analysis of vitamin C content

The effect of the concentration of Moringa leaf extract and variations in drying temperature on protein content is shown in Table 5 and 6. The addition of Moringa leaf extract affects the vitamin C content of moringa milk powder. The higher the drying temperature, the lower the vitamin C content. This happens because of the unstable nature of vitamin C and is easily degraded, especially by temperature (Evi & Budhihastuti, 2016). Vitamin C is a compound that is easily damaged if it is treated with high temperatures, in accordance with (Winarno, 2018) statement which states that the content of ascorbic acid will be easily damaged due to heat and light.

The higher the concentration of Moringa leaf extract, the higher the level of vitamin C contained in Moringa leaf milk. This is because fresh Moringa leaves contain 220 mg of high vitamin C and 17.3 mg of dried Moringa leaves (United States Department of Agriculture, 2015).

3.5 pH value measurement

The effect of the concentration of Moringa leaf extract and variations in drying temperature on pH value measurement are shown in Table 7 and Table 8. The pH value of Moringa leaf milk can be influenced by the concentration of Moringa leaf extract used, the higher the concentration of Moringa leaf extract used, the pH value will decrease. This can be caused because Moringa leaf extract has a pH that leads to neutral as stated by Fatmawati et al. (2020), that extracts from Moringa leaves have a pH that leads to a neutral pH ranging from 5.8 to 6.0.

Table 5. The effect of concentration of Moringa leaf on the vitamin C content of moringa milk powder.

Moringa Extract	Vitamin C Content (ppm)
3%	9.00 ± 0.12^a
5%	13.33 ± 0.60^b
7%	17.18 ± 0.08^c

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 6. The effect of variations in drying temperature on the vitamin C content of moringa milk powder.

Variation of Drying Temperature	Vitamin C Content (ppm)
50 °C	14.03 ± 0.47^c
60 °C	13.27 ± 0.41^b
70 °C	12.19 ± 0.37^a

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 7. The effect of concentration of Moringa leaf on the pH Value Measurement of moringa milk powder.

Moringa Extract	pH Value
3%	6.59 ± 0.06^c
5%	6.48 ± 0.04^b
7%	6.31 ± 0.01^a

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 8. The effect of variations in drying temperature on the pH Value Measurement of moringa milk powder.

Variation of Drying Temperature	pH Value
50 °C	6.53 ± 0.18^b
60 °C	6.48 ± 0.15^b
70 °C	6.37 ± 0.11^a

Different letter in each column indicates a significant difference ($p < 0.05$).

While the higher the drying temperature used, the lower the pH of the Moringa leaf extract, this is in accordance with the results of research by Lagawa et al. (2020), that the higher the drying temperature used, the lower the resulting pH value due to the results of research that the content of phenolic compounds and flavonoids increases at high temperatures. This is also in line with the results of research by Rismawati & Ismiyati (2017), which states that flavonoid levels increase in line with the increasing pH value.

3.6 Organoleptic test (color, flavor, and taste)

The effect of the concentration of Moringa leaf extract and variations in drying temperature on organoleptic test are shown in Table 9 and Table 10. According to Husain et al. (2020), that the more addition of Moringa leaf extract, the darker the resulting color will be. According to Zainuddin & Sri Hajriani (2021), in Moringa leaves there is a green pigment or chlorophyll content and this pigment is also found in green vegetables, this can affect the assessment of color attributes by panelists.

The pigment is chlorophyll which has non-polar properties, that is, it is insoluble in water but soluble in organic solvents, but if the phytol group in chlorophyll is released, it can be due to heat, acid, alkali, or enzymes, the chlorophyll will turn into chlorophyll which is water soluble (Astawan, 2019).

Variations in drying temperature can also affect the color of the moringa milk powder to become darker, the material undergoes oxidation and can cause the material to burn (brown). This causes the color to be less attractive so it is not liked by the panelists.

Variations in drying temperature can affect the panelists' preference for aroma because the higher the drying temperature used, the lower the aroma of Moringa leaf milk due to the destruction of volatile compounds in the drying process. This is in accordance with the opinion of Anjarsari (2015), that the aroma in foodstuffs can be caused by several volatile components, but these volatile components can be lost during the processing, especially heating.

Table 9. The effect of the concentration of Moringa leaf extract on the organoleptic test of moringa milk powder.

Moringa Extract	Color	Flavor	Taste
3%	5.54 ± 0.10^{b}	5.95 ± 0.03^{b}	5.75 ± 0.20^{c}
5%	5.65 ± 0.02^{b}	5.50 ± 0.03^{a}	5.12 ± 0.07^{a}
7%	5.30 ± 0.20^{a}	5.89 ± 0.07^{b}	5.56 ± 0.07^{b}

Different letter in each column indicates a significant difference ($p < 0.05$).

Table 10. The effect of variations in drying temperature on the organoleptic test of moringa milk powder.

Variation of Drying Temperature	Color	Flavor	Taste
50 °C	5.28 ± 0.35^{a}	5.90 ± 0.57^{b}	5.30 ± 0.66^{a}
60 °C	5.60 ± 0.66^{b}	5.82 ± 0.27^{a}	5.67 ± 0.53^{c}
70 °C	5.61 ± 0.24^{b}	5.62 ± 0.42^{b}	5.46 ± 0.76^{b}

Different letter in each column indicates a significant difference ($p < 0.05$).

The concentration of Moringa leaf extract affects the aroma because the higher the addition of the concentration of the extract, the aroma of Moringa leaf milk is less favored by the panelists, this is because Moringa leaves contain lipoxidase enzymes that cause an unpleasant aroma. Green vegetables contain lipoxidase enzymes which, if the cooking process is not perfect, can cause an unpleasant odor. The aroma can be reduced by boiling the vegetables with salt, or soaking the vegetables in ice water just before the vegetables are cooked (Letlora et al., 2020).

In addition, in Moringa leaves there are catechin compounds which according to Friskilla & Rahmawati (2018), that catechin compounds have the property of being able to dissolve in water and can bring bitter, astringent properties and a distinctive aroma to steeping tea. The unpleasant aroma appears besides being caused by catechin compounds, it is also caused by the content of the lipoxidase enzyme present in Moringa leaves, causing the panelists to dislike the aroma. This is supported by the opinion of Abidah et al. (2020), which states that the lipoxidase enzyme works by hydrolyzing (decomposing) the fat in green vegetables into hexanal group 7 and hexanol compounds that cause the distinctive odor of Moringa leaves.

In addition, the addition of the concentration of Moringa leaf extract can affect the taste attributes where the astringent taste in Moringa leaves is caused by the presence of catechin and tannin compounds in Moringa leaves, causing a taste that is not liked by the panelists. This is supported by the opinion of Sulistiani et al. (2019), which states that catechins are tannins that do not have tanning properties and agglomerate proteins so that they can produce astringent taste in a product.

4 Conclusion

The concentration of Moringa extract and variation of drying temperature had a significantly different effect on the chemical and organoleptic characteristics of Moringa milk powder. The best treatment was the treatment with the addition of 7% moringa extract at 70 °C, with these results it was concluded that the higher the addition of moringa extract and the drying temperature, the better the quality of moringa milk powder. Presented method In this paper it can be proposed as an alternative to milk making by using local natural dyes, which potentially implementable for milk powder products at scale production units.

Conflict of interest

this article has no conflicts interest

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