Characteristics of *moringa* leaf powder as fortification and consumer acceptance

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**Abstract:** *Moringa Oleifera* is not only rich in nutrients but also has functional properties with efficacies and benefits for human health. Moringa leaf powder as an intermediate product can be used as a fortification to enrich nutrition in food products in an acceptable concentrate for consumers. This study aims to determine the physical and chemical characteristics of Moringa leaf powder and the level of consumer acceptance of the fortification product. The research included the process of making Moringa leaf powder until the preeminent temperature and drying time were obtained and the use of Moringa leaf powder as a fortification in ice cream.

Fortification of ice cream used four treatments of the powder concentration in 0.5%, 1%, 1.5% and 2%. The results showed the yield of the powder was 25%, with a 7.80% water content at a temperature of 47 – 50 \(^\circ\)C for five hours. The level of consumer acceptance of fortified ice cream shows the same acceptance of color, aroma, texture, except taste. Consumers prefer formulas with a concentration of 1% Moringa powder, 5% creamer, 15% sugar, 0.5 % CMC, and 78.5 % milk. Moringa aroma and taste have an impact on consumer acceptance of Moringa ice cream.

1. **Introduction**

*Moringa oleifera* is a tropical plant that is relatively easy to cultivate in tropical areas, such as Indonesia. The nutrient content is sufficient for Moringa to have functional health properties and to overcome the problem of nutritional deficiencies or malnutrition. Moringa has earned the nicknames “Miracle Tree” and “Mother’s Best Friend” due to its high nutritional value, as well as its properties and benefits. Moringa has begun to be recognized and developed in Indonesia as a product with economic value and industrial potential. Moringa powder, utilized to fortify various food processed products.

Moringa leaves were discovered to contain several essential nutrients, such as beta-carotene, vitamin C, protein, iron, potassium, and large amounts of phenol which is regarded as an antidote to free radical compounds [1]. Moringa leaves appear to contain vitamin C, vitamin A, calcium, potassium, and protein [2]. According to another study, moringa leaves contain 10 times the vitamin A of carrots, 17 times the calcium of milk, 15 times the potassium of bananas, 25 times the iron of spinach, and 9 times the protein of yogurt [3,4]. Moringa also has a high antioxidant content, as well as pharma logical and antimicrobial
goods [5]. This is because ascorbic acid, flavonoids, phenolics, and carotenoids are present in moringa [6, 7, 8, 9].

Most people are aware that moringa is still limited to vegetables, and that the diversification of processed moringa is not yet widely known, so efforts are required to introduce the advantages and benefits of moringa. This type of form appears to be more flexible when applied to food products, in addition to serving as fortification it can also be a food additive (BTP) that serves as a natural dye. As fortifying material, by considering consumer acceptance factors such as taste, color, aroma and other physical properties that influence the level of consumer preference for fortified products. According to the findings of McLellan et al., [10], moringa leaf powder has been added to grits as a nutritious food supplement to meet the protein and micronutrient needs of children. The purpose of this study is to determine the process of producing moringa powder as well as consumer acceptance of ice cream containing moringa powder.

2. Methodology

2.1. Material
Ingredients used are fresh Moringa leaves, Moringa powder, liquid milk, CMC (Carboxymethyl Cellulose) sugar, and vegetable cream. The dryer, ice cream machine, and ice cream packaging are research aids.

2.2. Production of Moringa leaf powder
Moringa leaf drying begins with determining the temperature and drying time maximum moisture content standard of 8%, and the Moringa leaves used are 500 g per shelf. The drying process begins with washing the fresh Moringa leaves and arranging them on a drying machine rack with a thickness of 1 cm. The size of the drying rack is approximately 60 cm x 50 cm. Moringa leaves are dried for five hours at a temperature of 47-50 °C before being powdered with a blender and sieved through an 80 mesh sieve. Figure 1 depicts the process of producing Moringa powder.

![Figure 1](image_url)

**Figure 1.** Flow chart for the production of moringa powder.
2.3. **Formulation of ice cream moringa fortification**

The treatment of Moringa powder to ice cream used the concentration of Moringa powder, namely 1) 0.5% Moringa powder (F1), 2) 1% Moringa powder (F2), 3) 1.5% Moringa powder (F3), and 4) 2% Moringa powder (F4). The ice cream formula with the addition of Moringa powder is presented in Table 1.

| Ingredients                        | F1     | F2     | F3     | F4     |
|------------------------------------|--------|--------|--------|--------|
| **Main Ingredient**                |        |        |        |        |
| Moringa leaf powder (%)            | 0.5    | 1      | 1.5    | 2      |
| Fresh Milk (%)                     | 81.5   | 78.5   | 75.5   | 72.5   |
| **Additives (based on main ingredient volume)** |        |        |        |        |
| CMC (%)                            | 0.5    | 0.5    | 0.5    | 0.5    |
| Sugar (%)                          | 15     | 15     | 15     | 15     |
| Vegetable creamer (%)              | 2.5    | 5      | 7.5    | 10     |

2.4. **Production of ice cream moringa leaf powder**

Ice cream is made by heating milk for 2 minutes, then adding dry ingredients (sugar, CMC, vegetable cream), stirring evenly, and returning to the heat for another 2 minutes. After that, mix the solution for 2 minutes before adding the Moringa powder and mixing for another 2 to 3 minutes. It was determined that the solution had cooled for 6-7 minutes. Finally, pour the Moringa ice cream solution into the ice cream machine and let it run for 60 minutes, or until the ice cream is formed. The process of making Moringa ice cream is depicted in Figure 2.

![Flow chart of the processing moringa ice cream.](image-url)
2.5. Chemical and Physical Analysis
Physical and chemical characteristics were carried out on moisture content, yield, chroma color (L *, a *, b * values) and proximate analysis of moringa powder. Overrun analysis was performed on Moringa ice cream.

2.6. Preference Test
A consumer preference test for moringa ice cream was conducted based on liking and hedonic quality. The color, aroma, taste, and texture level of preference tests were performed using 1-5 hedonic scales, whereas the hedonic quality of moringa ice cream was performed using 1 to 5 on the hedonic quality scale.

2.7. Statistical Analysis
The study design used a completely randomized design with three replications. The data from the observations were then analyzed using ANOVA with further tests using Duncan with a significance <0.05.

3. Result and discussion
Table 2 shows the results of the yield and chemical characteristics measurements of fresh moringa leaves and moringa powder. The yield of fresh moringa leaves after they have been separated from the stems and are ready to be dried is 50%. After the drying process, a 25% yield of moringa powder was obtained with a depreciation of 50%. According to the standard, drying for 5 hours at a temperature of 50 °C can produce moringa powder with a moisture content of 7.80 %.

3.1. Physicochemical Analysis of Moringa leaf powder

| Parameters       | Moringa leaves | Moringa leaf powder |
|------------------|----------------|---------------------|
| Rendement (%)    | 50             | 25                  |
| Moisture content | 80.37          | 7.80                |
| Colour           |                |                     |
| - L* value       | 39.23          | 60.48               |
| - a* value       | -5.71          | -14.69              |
| - b* value       | 10.07          | 26.20               |

The drying process changed the brightness level, increasing the L* value from 39.23 to 60.48. Although the color of moringa powder lightens, the color remains green, as indicated by the value of a* (negative), which is -14.69.

3.2. Proximate composition of Moringa leaf powder
The proximate analysis results are shown in Table 3, which shows that the proximate content of moringa powder changes after drying. Moringa powder has a moisture content of 7.80%, which is in accordance with the standard for powder moisture content in order to extend the shelf life of Moringa powder and prevent the growth of mold and mildew. According to another study, the moisture content of Moringa powder was 7.55-8.65 percent [11]. According to Salma Sultana [11], the crude fiber content of Moringa powder ranged from 6.00 to 9.60 percent and could potentially be used as a dietary ingredient for humans and animals.
Table 3. Moringa leaf powder proximate composition.

| Parameters       | Moringa leaf powder |
|------------------|---------------------|
| Moisture (%)     | 7.80                |
| Ash (%)          | 9.32                |
| Protein (%)      | 29.6                |
| Fat (%)          | 6.98                |
| Carbohydrate (%) | 39.4                |
| Crude fibre (%)  | 6.91                |

3.3. Mineral, β-Carotene and Vitamin C contents of Moringa leaf powder

Table 4. Mineral, β-Carotene and Vitamin C contents of moringa leaf powder.

| Parameters         | Moringa leaf powder |
|--------------------|---------------------|
| Potassium (%)      | 1,860               |
| Calcium (%)        | 2.210               |
| Iron (mg/kg)       | 91.2                |
| B-carotene (mg/kg) | 271                 |
| Vitamin C (%)      | 498                 |

Similarly, the vitamin C content of Moringa powder is 498 mg/100g, which is higher than the vitamin C content of other plant sources of vitamin C.

3.4. Overrun of ice cream with moringa leaf powder

Table 5 displays the results of overrun measurements of an ice cream formulation treatment with Moringa powder added. The greater the amount of Moringa powder added, the lower the overrun value. Overrun is a degree of development or increase in the volume of ice cream dough caused by trapped air in the ice cream formula as a result of the agitation process. Because it affects texture and density level, overrun becomes one of the determining parameters of ice cream quality.

Table 5. Overrun of moringa leaf powder ice cream.

| Sample code | Overrun (%) |
|-------------|-------------|
| F1          | 70°C        |
| F2          | 68.57°C     |
| F3          | 63.46b      |
| F4          | 53.85a      |

Formula F1 has the highest overrun value, which is 70%, and the value is decreasing as more Moringa powder is used. This is most likely due to the ice cream formula thickening, making it difficult to expand. The value of the overrun will be reduced if the formula or solution has a higher viscosity.

3.5. Sensory characteristics of moringa leaf powder ice cream

Table 6 shows the results of an organoleptic test of ice cream fortified with Moringa powder against the level of preference and hedonic quality. The addition of different moringa powders to an ice cream formula has no effect on consumer acceptance. The addition of Moringa powder in concentrations ranging from 0.5 to 2% has no effect on consumer preference for color, aroma, or texture. Colors 4.04 – 4.57 (liked moderately), aroma 3.70 – 3.90 (liked moderately), texture 3.96 – 4.35 (liked moderately). The use of Moringa powder above 1.5 percent demonstrates consumer acceptance of different flavors.
Table 6. Sensory properties of moringa leaf powder ice cream.

| Sample code | Colour | Flavour | Taste | Texture |
|-------------|--------|---------|-------|---------|
| F1          | 4.57a  | 3.96a   | 4.70b | 4.35a   |
| F2          | 4.48a  | 3.83a   | 4.26ab| 4.17a   |
| F3          | 4.35a  | 3.70a   | 3.96a | 4.13a   |
| F4          | 4.04a  | 3.70a   | 3.61a | 3.96a   |

Table 7 displays the results of the consumer assessment of hedonic quality tests of Moringa aroma and taste. The results of hedonic quality tests revealed that different concentrations of the powder had an effect on consumer acceptance. The higher level of Moringa leaf powder concentration, the lower consumer acceptance on Moringa powder.

Table 7. Sensory evaluation of Moringa leave powder ice cream.

| Sample code | Aroma | Taste |
|-------------|-------|-------|
| F1          | 4.17c | 3.65c |
| F2          | 3.39c | 2.87b |
| F3          | 2.57b | 1.96a |
| F4          | 2.26a | 1.65a |

Consumers prefer the aroma and taste of the ice cream formula with 1% Moringa, with aroma on a hedonic scale of 4.17 (liked moderately) and taste on a hedonic scale of 3.65 (liked moderately).

4. Conclusion
Making Moringa powder at a drying temperature of 47 - 50 °C for 5 hours yields a 25% yield and a moisture content of 7.80% - 8.14% with a green color. Except for taste, the application of Moringa powder to ice cream yielded the same consumer preference test results for color, aroma, and texture. Consumers prefer formulas with a concentration of 1% Moringa powder, 5% creamer, 15% sugar, 0.5 percent CMC, and 78.5 percent milk. Moringa aroma and taste have an impact on consumer acceptance of Moringa ice cream.

5. References
[1] A. Verma, M. Vijayakumar, C. Mathela, Chandra S, Rao, Chandana V. 2009 In vitro and in vivo antioxidant properties of different fractions of Moringa oleifera leaves. Food and Chemical Toxicology, 47 2196-22-1
[2] Mahmood KT, Tahira Mugal, Ikram Ul Haq. 2011 Moringa oleifera: a natural gift-A review. Journal of Pharmaceutical Sciences and Research 2 11 pp 775-781
[3] Fuglie, Lowell J., ed. 2001 The Miracle Tree: The multiple attributes of moringa. Dakar, Senegal: Church World Service.
[4] Hekmat, S., Morgan K., Soltani M., Gough R. 2015 Sensory evaluation of locally-grown fruit purees and inulin fibre on probiotic yogurt in Mwanza, Tanzania and the microbial analysis of probiotic yogurt fortified with Moringa oleifera. J Healt Popul Nutr. 33 1 pp 60-67
[5] Das, A. K., Rajkumar, V., Verma, A. K., & Swarup, D. 2012 Moringa oleifera leaves extract: A natural antioxidant for retarding lipid peroxidation in cooked goat meat patties. International Journal of Food Science and Technology 47 pp 585–591
[6] Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. 2007b. Moringa oleifera: A food plant with multiple medicinal uses. Phytotherapy Research 21 pp 17–25
[7] Makkar, H. P. S., and K. Becker. 1997 “Nutrients and antiquality factors in different morphological parts of the Moringa oleifera tree.” *Journal of Agricultural Science* **128** pp 311-322.

[8] Moyo, B. 2012 Antimicrobial activities of Moringa oleifera Lam leaf extracts. *African Journal of Biotechnology* **11**(11) pp 2797-2802.

[9] Dahot, M.U. 1998 Vitamin contents of flowers and seeds of moringa oleifera *Biochemistry* pp 2122 – 2124

[10] McLellan, L., Mckenzie, J. and Clapham, M.E. 2010 A study to determine if dried moringa leaf powder is an acceptable supplement to combine with maize meal for Malawian children. *Proceedings of the Nutrition Society*, 28 June–1 July 2010. Health Sciences, Queen Margaret University, Edinburgh EH21 6UU, UK.

[11] Salma Sultana. 2020 Nutritional and functional properties of Moringa oleifera. Departement of Biochemistry and Moleculer Biology. Bangladesh Agriculture University, Bangladesh. *Metabolisme Open* **8** pp 1-6