

Article

Is instant porridge with a high calcium content based on *Moringa oleifera* as an alternative baby food to prevent stunting in Indonesia?

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Abstract

Background: According to WHO, stunting is a state of height-for-age index below minus two standard deviation. However, the condition could be prevented by giving suitable complementary food to babies and toddlers. Moringa leaves are rich in vitamins A, C, B6, as well as calcium, potassium, iron, as well as protein, and are therefore used as complementary foods for breast milk, in baby feeding.

Design and Methods: Instant porridge was developed using three formulas. Each formula comprised Moringa leaf flour (5, 6 and 7 grams each) combined with 30 grams of oatmeal powder, 40 grams of powdered formula, 10 grams of refined sugar, and 5 grams of banana flour.

Results: Based on the organoleptic test, Formula 3 (created with 5 grams of Moringa leaf flour) was discovered to be the best. The organoleptic evaluation panel consisted of 3 trained and 30 untrained participants, while the statistical results showed the parameters of colour, texture, and taste, have no significant effect on panellists' acceptance.

Conclusions: The flavour parameter has a significant effect on panellists' acceptance, with a p-value <0.05.

Introduction

Indonesia has the fifth highest prevalence of stunting in the entire world. Stunting is a state of malnutrition so that individuals will be short below the average growth chart. This condition is one of the contributors that cause an increase in early childhood death due to malnutrition which continues into the terminal phase.¹ Furthermore, the 2018 Basic Health Research (Indonesian Ministry of Health) recorded a 30.8% national stunting prevalenc.² However, stunting can be prevented by providing suitable complementary foods. Fresh Moringa leaves contain vitamin A, vitamin C, Vitamin B6, calcium, potassium, iron, and protein, and have a high nutritional content, compared to other foods.³⁻⁵ The leaves have a higher vitamin A content, 6.8 mg/100 g, com-

pared to the 1.8 mg/100 g contained in carrots, and a calcium content of 440 mg/100 g, compared to the 6.49 mg/100 g present in milk.⁶⁻⁸ Meanwhile, Moringa leaves have a potassium content of 259 mg/100 and banana has a counterpart of 88 mg/100 g. Similarly, the leaves have quite a high protein content of 6.7 g/100 g, compared to the 3.1 g/100 g contained in yoghurt, as well as a vitamin C content of 220 mg/100 g, compared to the 30 mg/100 g present in oranges.⁹ As a result, the leaves have been used for to combat malnutrition, especially in African countries.^{10,11} This study therefore aims to develop complementary foods for breast-feeding in the form of instant baby porridge, with the addition of Moringa leaf flour, to ensure complete nutritional content.

Design and Methods

This design of this study is based on the research and development model of Borg and Gall,¹² consisting of 8 steps. These include, identifying and determining potential and problem, conducting preliminary studies and requirement analysis, establishing product specifications, developing initial product models, expert trials, field trials and product validation, product revision, suggestions for utilization, dissemination, and further product development. This study met the Brawijaya University's ethical clearance requirements and all the respondents consented to participation. In addition, this study has been approved by the health research ethics committee of the Faculty of Medicine, University of Brawijaya, with research ID 104/EC/KEPK-S1/03/2019.

The equipment used in this study include, oven, blender, 80 mesh sieves, bowls, and measuring scale. Meanwhile, the main ingredient used is Moringa leaf flour. The other ingredients for instant porridge include, oatmeal powder, powdered formula milk, fine granulated sugar, and banana flour, all obtained from mini-markets within Malang City. All formulations were carried out in accordance with the SNI 01-7111.4-2005 standard for instant complementary foods, and met the protein, fat, carbohydrate, as well as total calorie requirements. Also, complementary foods met the nutritional adequacy for infants aged 6-12 months. Table 1 shows the formula for complementary feeding (MP ASI).

Significance for public health

The problem of stunting in toddlers not only interferes with physical growth and development, but also with brain growth, thus, weakening the cognitive abilities of toddlers. Therefore, the condition must be resolved immediately. Furthermore, stunting affects productivity during adult stage, and is often prevented in public health by providing nutritious food intake for toddlers, through proper complementary feeding. Currently, the choice of complementary foods is solely commercial. Hence, there is a need for research and development with regard to the manufacture of complementary foods with practical, highly nutritious natural ingredients.

Moringa leaf flour production

Green, fresh *Moringa oleifera* leaves were washed with water, de-stalked, spread on a dry container, then oven-dried for 120 min at 55°C. Subsequently, the leaves were milled with a dry blender and sieved using an 80 mesh sieve, to remove any small uncrushed stalks present.^{13,14}

The instant porridge mix was then created using a modification of the dry mixing method, as described by Yustiyani.¹⁵ This was performed by mixing all the ingredients, including Moringa leaf flour, oatmeal powder (Quaker Instant Oatmeal), powdered formula milk (Morinaga Chil Kid), and sugar, in a plastic bag, followed by manual shaking for 5 min, until all the ingredients were completely blended. The Instant porridge mix was then served to the panel comprising of both trained and untrained sensory evaluators in a serving of 45 grams or 6 tablespoons for each.

The organoleptic test was performed by three trained panelists, 2 UM culinary art education lecturers and 1 UM Food Chemistry lecturer. Meanwhile, the untrained panellists comprised 30 mothers of babies or toddlers in Batu City. The test was designed to evaluate 4 parameters, colour, flavour, texture, and taste, using 6 hedonic scales, Very much like, Very like, Like, Rather like, Neutral, and Dislike. Also, the product's nutritional

Table 1. Instant porridge formula.

Ingredients	Instant baby porridge formula (g)		
	F1	F2	F3
Moringa leaf flour	7	6	5
Oatmeal powder	30	30	30
Powdered formula	40	40	40
Fine granulated sugar	10	10	10
Banana flour	5	5	5

Table 2. Product nutritional content.

Parameter	F1	F2	F3	Commercial porridge
Serving size	6 tablespoons = 45 grams	6 tablespoons = 45 grams	6 tablespoons = 45 grams	6 tablespoons = 40 grams
Number of servings per package	2	2	2	3
Amount per serving				
Total energy	200 kcal	198 kcal	196 kcal	160 kcal
Protein (g)	8	8	7	4
Fat (g)	7	7	7	2.5
Carbohydrate (g)	26	25	24	31
Dietary fibre (g)	1	1	1	3
Potassium (mg)	390	384	378	100
% RDA	% RDA	% RDA	% RDA	
Protein	45	44	43	20
Vitamin A	45	44	44	40
Vitamin C	37	33	29	50
Vitamin B1	60	56	56	30
Vitamin B2	68	68	53	30
Calcium	104	100	96	35
Phosphor	83	82	82	35
Iron	26	26	24	50
Zinc	28	28	28	25

Source: Indonesian Food Composition Table,⁹ and Winarno.⁹

content was determined based on the overall calculation of nutritional content for the ingredients, according to Winarno reference¹⁶ for Moringa leaf flour, as well as the 2017 Indonesian Food Composition Table (TKPI), with the linear nutrition survey program. Subsequently, all quantitative data obtained were tabulated and statistically analysed with the Friedman Test to investigate the differences between the three formulas.

Results and Discussions

Nutritional contents

Table 2 shows the product's nutritional content. The energy value indicates the difference in the concentration of Moringa leaf influences the results obtained. Furthermore, the lowest energy value, 196 kcal, was attained in third formula, with a concentration of 5 grams of Moringa leaf flour, while the highest, 200 kcal, was obtained in the first, with a concentration of 7 grams of Moringa leaf flour. The energy value is as a result of the carbohydrates, fats and proteins in the porridge. This corresponds with the statement by Hardinsyah,¹⁷ stating energy is only obtainable from carbohydrates, proteins and fats contained in food and stored in the human body, to be utilized for growth and development.

The Moringa leaf powder instant porridge mix with the lowest protein content of 7 grams per serving was the third formula (F3), while the highest was the first formula (F1), with 8 grams per serving. This shows an increase in Moringa leaf flour content is likely to cause an increase in the protein content of the porridge, and is in accordance with the report by Farooq,¹⁸ stating Moringa leaf flour has a very high protein content, of 27.1 grams/100 grams. Therefore, the flour meets the protein standard of instant complementary powder in SNI 01-7111.1-2005, ranging from 8-22

grams/100 grams.

According to Table 2, the difference in the concentration of Moringa leaf flour has no effect on the product's fat content, as the three formulas all contained 7 grams of fat, in each serving. This is in accordance with the fat content requirement for instant powdered complementary food, 6-15 grams/100 grams, as stated in SNI 01-7111.1-2005.

In addition, the carbohydrate content of the Moringa leaf powder was discovered to be influenced by the Moringa leaf flour content. The lowest carbohydrate content, 24 grams, was obtained in was in the third formula, while the highest, 26 grams, was observed in the first formula. Carbohydrates are the main source of calories and play a role in determining the properties of food, including colour, taste, and texture.¹⁶ Also, these results are in accordance with the carbohydrate standards of instant powdered complementary foods, not more than 7.5 grams/100 kcal or 30 grams/100 grams, as stated in SNI 01-7111.1-2005. The difference in the concentration of Moringa leaf flour was also found to have no effect on fibre content, as all three formulas had a fibre content of 1 gram in each serving. This is in accordance with the instant powdered complementary food standard for fibre, not more than 5 grams/100 grams, as stated by SNI 01-7111.1-2005. Table 2 also shows the Moringa leaf instant porridge mix fulfils up to 45% of the vitamin A, 37% of the vitamin C, 60% of the vitamin B1, 68% of the vitamin B2, 26% of the iron, 28% of the zinc, 83% of the phosphorus, and 100% of the calcium recommended dietary allowance (RDA) per serving, for infants aged 6-12 months. The last two minerals are very crucial in preventing stunting.

Calcium is an essential micronutrient for linear growth during early.¹⁹ Furthermore, 70% of bone weight consists of calcium phosphate crystals, and this shows the mineral's significance for optimal bone growth.²⁰ Calcium deficiency has detrimental effects on immunity and bone health, and is mainly caused by inadequate intake and or suboptimal absorption. Therefore, inadequate calcium consumption in toddlers affects the basic structure of the bones, resulting in stunting or other growth impairments.^{21,22}

Trained panellists' organoleptic test

Table 3 shows the organoleptic test performed by trained panellists. This was the first step to obtain criticism and suggestions regarding the development of instant baby porridge with Moringa leaf flour. In this step, 3 samples of instant porridge were made with a difference in the concentration of 2 grams of moringa leaf flour in each formula. The first, second and third formulas had concentrations of 10, 8 and 6 grams of Moringa leaf flour, respectively. The trained panellists, culinary art education lecturers at the Faculty of Engineering, State University of Malang, evaluated the results of the development, through an organoleptic test questionnaire based on 4 assessment parameters: colour, flavour, texture, and taste, using 6 levels of preference, very much like, very like, really like, like, rather like, neutral, and dislike. According to the organoleptic evaluation, the third instant porridge formula was most preferred by the panellists. Meanwhile, the highest average value for the colour, flavour, texture and parameters (Formula 3)

Table 3. Trained panellist organoleptic test results.

Parameter	F1	F2	F3
Colour	3	3.33	4.33
Flavour	1.33	2	3.33
Texture	3.33	3.66	4.33
Taste	1	1.33	3.33

were 4.33, 3.33, 4.33, and 3.33, respectively. These values are all within the range of like. Subsequently, data from the nutritional evaluation of the instant porridge developed with Moringa leaf powder generated some suggestions. These include the need to perform pre-treatment of the leaves to reduce the smell's intensity, and to reduce the levels of Moringa leaf flour by formulating the porridges with a difference of 1 gram of leaf flour.

The development's results were also justified by a lecturer in the Department of Chemistry, Faculty of Mathematics and Natural Sciences, State University of Malang, through an organoleptic test questionnaire based on 4 assessment parameters, colour, flavour, texture, and taste, using 6 scale of preference levels, very much like, very like, really like, rather like, neutral, and dislike. The data from this evaluation generated the same suggestion as the other trained panellists.

Untrained panellists' organoleptic test

Figure 1 shows the results of colour assessment. Based on this evaluation increase in moringa leaf flour content was discovered to produce a darker green colour in the product, while a reduction in flour content was found to cause a light or even pale coloration. In addition to raw materials, the production process is also regarded to affect the colour of instant baby porridge.²³ The colour assessment showed the panellists tend to prefer light green, as increase in Moringa leaf flour content lead to a decrease in the preference value for colour. Subsequently, the differences between the panellists' preference for F1, F2, and F3 were tested using the Friedman test. The results had a p-value of 0.856 (>0.05), indicating the three formulations have no significant difference in panellist acceptance. Meanwhile, Figure 2 shows the result of flavour assessments. Based on this evaluation, the third formulation with a concentra-

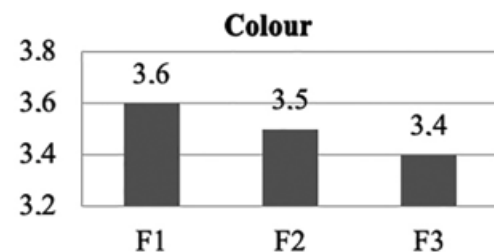


Figure 1. Organoleptic test for colour parameters

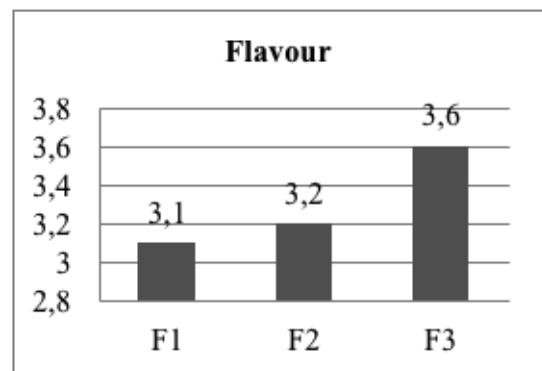


Figure 2. Organoleptic Test for Flavour Parameters.

tion of 5 grams of Moringa leaf flour was most preferred formula for the 30 untrained panellists, with an average value of 3.6 or within the range of likes. An increase in Moringa leaf flour content was found to produce an unpleasant aroma. Hence, panellists preferred the formula with less leaf flour. Moringa leaves have a distinctly unpleasant aroma due to the presence of lipoxidase enzymes.²⁴ Subsequently, the differences between the panellists' preference for F1, F2, and F3 were tested using the Friedman test. This resulted in a p-value of 0.034 (<0.05), indicating the three formulations had significant differences in panellist acceptance. Figure 3 shows the results of texture evaluation. Instant porridge with Moringa leaf flour has a creamy, not too liquid texture, and this is thought to be as a result of the raw materials used. In addition, the process of sieving instant baby porridge mix helped to prevent the occurrence of gritty texture.²⁵ The differences between the panellists' preference for F1, F2, and F3 were then tested using the Friedman test. This resulted in a p-value of 0.2 (>0.05), indicating the three formulations had no significant difference in panellist acceptance.

Figure 4 shows the results of taste assessment. The taste of the third formulation was found to be most preferred by the 30 panellists, with an average value of 3.6 or within the range of really like and like. This is because an increase in Moringa leaf flour will increase the bitter taste as Moringa leaves contain alkaloid compounds.²⁶ Therefore, the panellists preferred the porridge with the least Moringa leaf flour content. The differences between the panellists' preference for F1, F2, and F3 were tested using the Friedman test. This resulted in a p-value of 0.074 (>0.05), indicating the three formulations have no significant difference in panellist acceptance.

Moringa leaf flour instant porridge has a higher nutritional value compared to commercial instant porridge. A single serving of

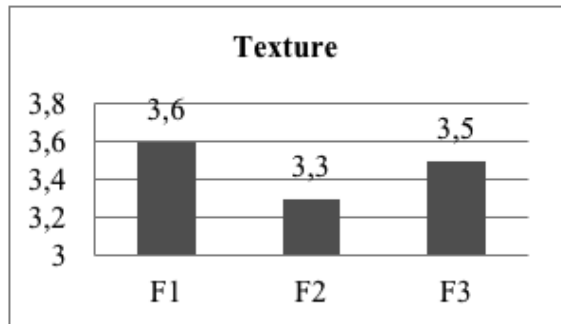


Figure 3. Organoleptic Test for Texture Parameters.

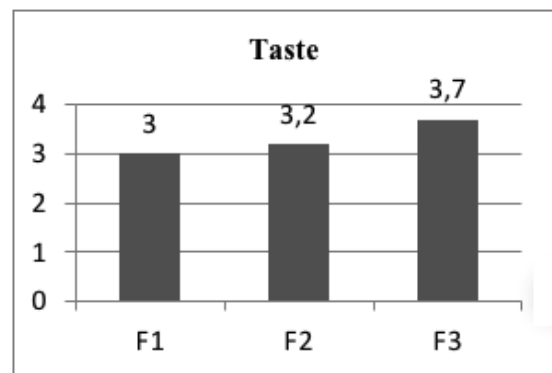


Figure 4. Organoleptic Test for Taste Parameters.

the Moringa leaf flour instant porridge has twice the protein content as the commercial counterpart, as well as higher vitamins and mineral, content, with the exception of vitamin C, as a result of the drying process. Long drying time causes a decrease in the vitamin levels of the ingredients. According to Mukaromah,²⁷ reduction in vitamin C is due to high temperature treatment for a long time. In this study, drying was carried out at a temperature of 55°C for 120 min, to obtain the highest antioxidant activity of Moringa leaves, as described by Ferreira.²⁸

Conclusions

The resulting product's nutritional value of baby porridge is in accordance with SNI 01-7111.1-2005, and it is prepared for consumption by simply brewing with hot water. Meanwhile, organoleptic evaluations showed colour, texture, and taste, had no significant influence on panellist acceptance, but flavour had a significant effect, with a p-value >0.05 . Furthermore, the results showed formula with the best Moringa leaf flour content, was F3 (5 grams of leaf flour), with an energy of 196 kcal/serving.

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