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The Substitution of Fresh Moringa Leaves and Moringa Leaves Powder on Organoleptic and Proximate Characteristics of Pudding

Pengaruh Substitusi Daun Kelor Segar dan Tepung Daun Kelor terhadap Hasil Uji Organoleptik dan Karakteristik Proksimat Pudding

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ABSTRACT

Background: Moringa Oleifera leaves "Marungga" contain fiber, vitamins, minerals, and polyphenol compounds that potential to fulfill nutritional requirements among children and adults. The product development often utilized Moringa leaves powder rather than the fresh ones. The powdering process might reduce the nutritional content while using fresh Moringa leaves is more applicable for the local community. However, the strong taste and aroma of Moringa leaves could influence the individual acceptance of a food product. Pudding is a simple and easy-to-make food product at the household level.
Purpose: This study aimed to compare the effectiveness of fresh Moringa leaves substitution compared with Moringa leaves powder on pudding product acceptance and proximate characteristics.
Methods: This was an experimental study with a complementary randomized design. The substitution of fresh Moringa leaves was 0%,20%,30%, while Moringa leaf powder was 0%, 5%, 10%. We conducted an organoleptic test, hedonic test, and proximate analysis of chosen formulations. Statistical analysis included Analysis of Variance (ANOVA), Duncan's multiple range test, and t-test.
Results: The chosen formula based on the hedonic test was the 20% of fresh Moringa leaf substitution (FML2) with a score of 3.64, and 5% of Moringa leaf flour (FMP1) with a score of 4.10. A significant difference between the two formulations was their texture; FMP1 had a hard texture than FML2. The protein, fat, carbohydrate, and total calorie content of those formulations were significantly different, but not for the ash content.
Conclusion: Substitution used fresh leaves utilized more Moringa leaves and improved pudding nutrients contents than powder type.

ABSTRAK

Latar Belakang: *Daun kelor (Moringa Oleifera) "Marungga" memiliki kandungan serat, vitamin, mineral serta senyawa polyphenol yang dapat memenuhi kebutuhan gizi anak dan dewasa. Daun kelor sering dimanfaatkan tepungnya dibandingkan dengan dalam bentuk segar untuk membuat produk pangan. Padahal proses penepungan dapat mengurangi kandungan gizi, dan pengolahan daun kelor segar lebih mudah diaplikasikan oleh masyarakat. Akan tetapi, rasa dan aroma daun kelor yang cukup kuat dapat merubah tingkat kesukaan seseorang terhadap produk pangan. Puding, produk pangan yang mudah dibuat di tingkat rumah tangga.*
Tujuan: *Penelitian ini bertujuan untuk membandingkan penerimaan produk dan kadar proksimat zat gizi dari produk pudding yang disubstitusi daun kelor segar dan tepung daun kelor komersial.*
Metode*: Penelitian ini merupakan eksperimental study dengan desain Rancangan Acak Lengkap dengan formulasi grup daun kelor segar (0,20%,30%) dan grup tepung daun kelor (0,5%,10%). Uji yang dilakukan antara lain (1) uji kesukaan melalui organoleptic; (2) uji hedonic dan (3) uji proksimat formulasi terpilih. Analisis statistik antara lain Analysis of Variance (ANOVA), Duncan's multiple range test dan t-test.*
Hasil: *Formula terpilih dari hasil uji hedonik substitusi daun kelor segar 20% (FML2) yang memiliki skor penerimaan 3,64 sedangkan tepung daun kelor 5% (FMP1) memiliki skor penerimaan 4,10. Perbedaan dari kedua formulasi terpilih diliat dari tekstur dengan FMP1 yang lebih keras. Kandungan protein, lemak, air, karbohidrat dan total kalori dari kedua formulasi terpilih secara signifikan berbeda nyata, namun tidak signifikan untuk kadar abu.*

Kesimpulan: *penggunaan daun segar memanfaatkan lebih banyak daun kelor dan meningkatkan zat gizi pudding dibandingkan dengan menggunakan tepung daun kelor.*

Kata Kunci: *Moringa, Pudding, Serat, Vitamin, Mineral*

INTRODUCTION

A widely known commodity, Moringa Oleifera is abundantly available in several developing countries such as Indonesia, India, and Africa[1,2]. East Nusa Tenggara, the eastern part of Indonesia, has acknowledged the potential development of Moringa or "Marugga" as a functional food to combat malnutrition among children [2]. A previous study revealed that Moringa leaves provide many benefits to human life related to health, such as an antibiotic to inhibit the growth of microorganisms, increasing breast milk as a galactagogue, anti-diabetes, preventing coronary heart disease, and preventing cancer cell growth[2]. Besides its benefit to human health, Moringa Oleifera also contains high macronutrient contents such as protein, fat, and carbohydrates. Moringa also has high fiber, necessary vitamins (B1, B2, B3, B4, C, and E), and minerals to meet the individual nutrient requirement[3]. Therefore, Moringa leaves are the potential ingredient to increase the nutrient content of a food product to alleviate malnutrition and also promote health status.

A long time ago, Indonesian people thought of Moringa as a plant that was considered taboo. However, Moringa plants have begun to be recognized not only for their leaves but also for their seed and drumstick [4]. Their nutrient content is considered useful as food product ingredients in a variety of delicious food at a cheaper price such as in pudding, candy, and ice cream[5,6]. The application of Moringa leaves powder for food fortification, baking cake or biscuit, yogurt, and cheese were also common[1]. However, most studies used the Moringa leaves powder as food ingredients, but were less likely to use the fresh leaves because it was easy to mix with other ingredients. Moreover, the original taste and color of Moringa leaves might influence the product texture, aroma, and delicacy to be less favorable when the recipes are not well-composed [4].

Converting the Moringa leaves into flour is supposed to increase the shelf life of Moringa leaves and facilitate the distribution process. In addition, Moringa leaves powder could be substituted and processed into various forms of products. Unfortunately, the heating process during the conversion of moringa leaves into a powder harms the final product due to the reduction of bioactive compounds. However, Moringa leaf flour has a higher value than those fresh leaves, thus, it requires a higher cost. Indeed, Indonesian local people can easily find or grow Moringa plants themselves in their yards. Pudding is a kind of food product that uses simple ingredients and techniques that are applicable at the household level. Therefore, this study analyses and compared the best formulation of pudding product using fresh moringa leaves and moringa leaves powder that was acceptable in the sensory analysis as well as determines the most optimal nutritional content of a product.

METHODS

This was an experimental study with a complementary randomized design (CRD). Several steps in this study were 1) Formulation of pudding; 2) Organoleptic test; 3) Proximate analysis for preferable pudding formulation chosen by the organoleptic test. The conceptual framework of this study has been presented in Figure 1.

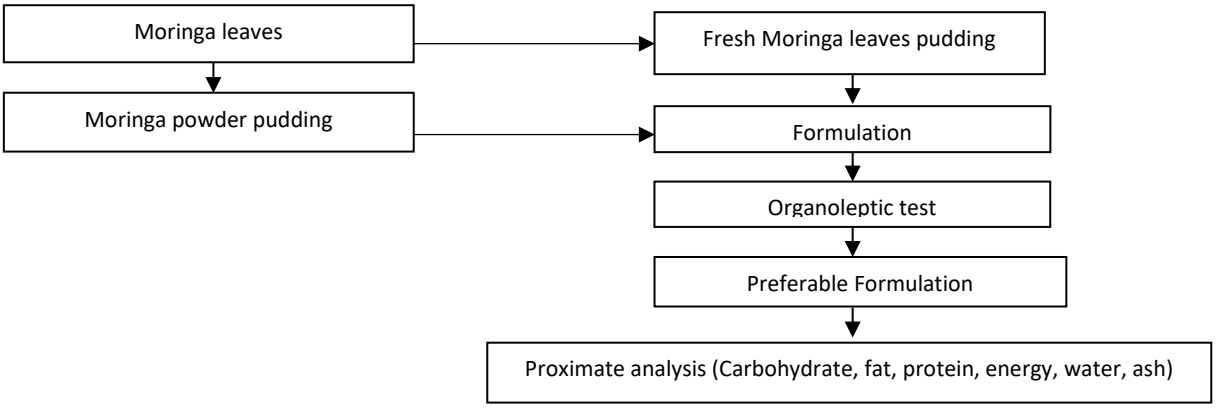

Figure 1. Research framework of the study

Pudding Formulation

The formulations were substituting full cream milk and or fresh milk with fresh Moringa leaves and Moringa leaves powder. The preparation of fresh Moringa leaves was just simply washed, boiled, chopped the leaves in a blender, weighted with the following formula that was presented in Table 1, and mixed with pudding ingredients. Meanwhile, the Moringa leaves powder used in this study was from the commercial Moringa leaves powder. The formulation with substitution of fresh Moringa leaves powder was divided into 0% (FML0), 20% (FML1), and 30% (FML2). Meanwhile, formulation with Moringa leaves powder was divided into 0% (FMP0), 5% (FMP1), and 10% (FMP2).

Table 1. Substitution formula of Fresh Moringa Leaves (FML) pudding

Material	FML0 (0%)	FML1 (20%)	FML2 (30%)
Milk	100%	80%	70%
Fresh Moringa Leaves	0 g	10 g	15 g
Full Cream Milk	50 ml	40 ml	35 ml
Sugar	10 g	10 g	10 g
Pudding Powder	3 g	3 g	3 g
Water	100 ml	100 ml	100 ml
Total	163 g	163 g	163 g

The formulation of Moringa leaves pudding has been previously determined through a trial-and-error experiment by the authors. For the fresh Moringa leaves powder, there was no crucial concern raised when increasing the proportion of substitution up to 20 and 30%. The initial formulation of Moringa powder pudding was supposed to substitute the full cream milk powder up to 25-50%. However, during the simple organoleptic test, the bold green color of the pudding due to the high proportion of Moringa leaves powder, made many respondents refuse to eat the product. Therefore, a smaller proportion of Moringa leaves powder was used as the substitution. The detailed ingredients of Moringa powder pudding formulation were presented in Table 2.

Table 2. Substitution Formula of Moringa Powder (FMP) pudding

Material	FMP0 (0%)	FMP1 (5%)	FMP2 (10%)
Milk	100%	95%	90%
Moringa Leaves Powder	0 g	3 g	6 g
Fresh milk	60 ml	57 ml	54 ml
Sugar	15 g	15 g	15 g
Pudding Powder	3 g	3 g	3 g
Water	150 ml	150 ml	150 ml
Total	228 g	228 g	228 g

Organoleptic analysis

After product formulation, the sensory analysis through the organoleptic test (hedonic test) was conducted to 30 semi-trained panelists from the Department of Nutrition, Binawan University, Jakarta. They were asked to determine and evaluate several aspects of the product such as taste, texture, color, odor, and overall acceptance. The hedonic tests were 1) the acceptance to the product with criteria from "dislike extremely" (score =1) until "like extremely" (score 5); and 2) hedonic quality of the product with evaluating their a) taste: 1 = very bitter until 5 = very sweet; b) texture: 1= soft texture until 5= hard texture; c) colour: 1= white until 5= dark green; d) odour: 1= unpleasant until 5= smell good. The mechanism of sensory analysis follows guidelines on sensory evaluation of food [7]. The product samples also have been set to be blindly labeled with different coding to prevent the panelist perception bias.

Proximate analysis

The nutritional composition of the best formulation with high overall acceptability from the organoleptic test, for each fresh Moringa leaves and Moringa powder pudding, were analyzed using a proximate analysis. The proximate analysis covered water, ash, fat, protein, carbohydrate, and total calorie. The analysis followed the latest AOAC Procedures, water was analyzed using the oven dry method; ash was analyzed using the dry ashing method; fat was analyzed by semicontinuous solvent extraction method (Soxhlet method); protein was analyzed using Kjehdal methods; carbohydrate was analyzed using by difference method[8]. The conversion of those macronutrients were 4 calories for carbohydrate and protein, while 9 calories for lipid. All the proximate analysis procedures were performed at *Laboratorium Kimia Terpadu*, IPB University, Bogor.

Statistical Analysis and Ethical Clearance

Analysis of Variance (ANOVA) was performed on the sensory test such as hedonic and hedonic quality tests. Further, the difference between formulations was analyzed using Duncan's multiple range test. To compare the proximate characteristics of chosen formulation, the independent sample t-test was also conducted. All statistical analysis was done using SPSS for Windows. This study has been approved by the Ethical Clearance

Committee of Binawan University No. B/2358/1/2020/KEPK.

RESULTS AND DISCUSSION

Organoleptic Analysis

Moringa Oleifera has much nutritive importance and health-related application in daily life. Some implementations were to control body weight, increase breastmilk production with galactagogue effects, and promote macronutrient consumption[3]. However, a previous study reported low acceptance of products containing Moringa Oleifera due to the bitter aftertaste[4]. An organoleptic analysis is a test to determine the quality of the product from four basic attributes such as color, odor, taste, and texture. It is based on consumer preferences that are greatly affected by these attributes [9]. Assessing the taste of food products was determined with the food product aftertaste [10]. Therefore, a proper product formulation thus prevents rejection from panelists while also considering the nutrition content was the main objective. Pudding is a simple food product, that people can easily cook at home that was preferable to all age categories from children up to the elderly. The sensory evaluation test was given to all formulas for fresh Moringa leaves pudding (0%, 20%, 30%) and Moringa powder pudding (0%, 5%, 10%). The average sensory characteristic test results of all the formulas for the fresh Moringa leaves and the Moringa powder pudding products were acceptable by the panelists (Table 3).

Table 3. Sensory characteristics of fresh Moringa leaves pudding and moringa powder pudding

Formula	Characteristics				
	Taste	Texture	Colour	Odor	Overall acceptability
Fresh Moringa Leaves Pudding					
FML0 (0%)	3.70^{ab}	3.96^{a}	3.33^{a}	3.73^{ab}	3.68^{a}
FML1 (20%)	3.46^{a}	3.63^{b}	3.30^{a}	3.46^{a}	3.46^{b}
FML2 (30%)	3.93^{b}	3.30^{c}	3.90^{b}	3.86^{b}	3.75^{a}
Moringa Powder Pudding					
FMP0 (0%)	4.15^{a}	3.82^{ab}	3.65^{ab}	4.00^{a}	3.91^{a}
FMP1 (5%)	4.12^{a}	3.97^{a}	3.92^{a}	3.92^{a}	3.98^{a}
FMP2 (10%)	3.50^{b}	3.62^{b}	3.45^{b}	3.55^{b}	3.53^{b}

*Score 1 (dislike extremely) – 5 (like extremely). Different superscript letters on the same column indicate a significant difference (p-value < 0.05)

Taste

Taste is an aspect that determines whether a food product is accepted or not by consumers [11]. The substitution of milk powder with Fresh Moringa Leaves (FML) and Moringa Leaves Powder (MLP) was assumed to change the average rating flavor by the panelist. The reasonable cause is because milk powder protein and fat contents are high [12], thus will contribute to the flavor of the product[13], especially in a control pudding (Table 1). Based on the sensory evaluation test, in terms of taste, the preferable formulation was FML2 and FMP0. In detail, the average rating flavor for FML2 pudding was not significantly different from the FML0 pudding, but it has a significant difference from the FML1 pudding. In contrast, after substitution of MLP, the pudding sample without Moringa powder (FMP0) has the highest score of average rating flavor. Increased substitution of Moringa powder showed a comparably lower pudding's average rating flavor; the score for FMP2 pudding contained 10% MLP has the lowest acceptance rating and is significantly different from FMP0 pudding (Table 3).

Most studies utilized dry moringa leaves powder as the substitution materials [5,14] and revealed a consistent result to our study. Meanwhile, a limited study utilized fresh Moringa leaves as a composition which indeed showed a contrasting finding. The MLP has to pass through a drying process until it could be mixed and used as an additional composition. The drying process is not only to make the food product have a longer shelf-life [13] but also to increase the concentrated extract of raw materials [15]. Therefore, the unacceptable taste could occur when using a powder than a fresh one due to the higher concentration of Moringa Leaves in powder type.

The result was linear with a hedonic test presented in Table 4. The most preferred pudding from the scale of 1 (very bitter) – 5 (very sweet) was FML2 (4.10) and FMP0 (3.93), respectively. The taste of the FML2 pudding was significantly tastier than the other formulas in the fresh Moringa leaves the group (FML0 and FML1). Contrary, the FMP0 pudding was significantly sweeter than others in the Moringa powder group. The original taste of Moringa leaves was almost similar to the green tea that was not new for Indonesian people. However, the powder type might have a more bitter taste than the fresh ones.

Texture

The texture is one of the characteristics of food assessed from sensing through hands touch or using another sense like a mouth when the food was bitten and chewed. Raw food characteristics and nutrient content could change during processing with different temperatures and methods; this can affect food texture [11,16,17]. In this study, the FMP1 (5% addition of Moringa powder) and FML0 pudding (0% addition of fresh Moringa leaves) had the most preferred texture with a score is 3,97 and 3,96, respectively. Results also showed a significant difference in pudding texture preferences and or characteristics in all formulas for the substitution using fresh Moringa leaves (FML0, FML1, FML2). An increased amount of fresh Moringa leaves in pudding formulas significantly lowered the FML1 and FML2 panelists' preference (Table 3) and hardened the pudding

texture (Table 4). This result was consistent with previous studies; since the substitution of more Moringa to a bakery and cookies product might result in the denser or harder food product texture[14,18].

Further, the FML2 has significantly had a hardened texture than FMP1 (Table 5). A past study mentioned that dry Moringa leaves powder contained more fiber (12.5 g) than fresh leaves (0.9 g)[3]. Fiber can bind more excessive water that causes the hardened texture of food products. Hardened pudding texture led to lower panelists' preference. Nevertheless, all of the pudding formulas in the fresh Moringa leaves group had a texture similar to the control pudding products, which was acceptable to the panelists (sensory characteristic and hedonic test score higher than 3).

In contrast, among the fresh Moringa leaves group, the substitution of 10% Moringa powder to the pudding (FMP2) did not significantly affect the panelist's preference and the texture characteristics compared to the control pudding (FMP0). A significant difference in panelist preferences and texture characteristics only occurred in the pudding with the 5% addition of Moringa powder (FMP1). Pudding with 5% Moringa powder has the softest texture compared to other formula puddings (FMP0, FMP1) and has become a preferred product. Therefore, the proper formulation of Moringa Powder could increase the preferable texture from the panelists.

Color

Color is one of the factors that influence a person's appetite, the attractive color of food would increase a personal appetite. Colour in food products is affected by the original color or pigments of raw materials, chemical reactions due to processing (such as caramelization, Maillard, and oxidation), and food color additives [19]. Table 3 shows that the panelists' preference towards FML2 pudding (30% fresh Moringa leaves) and FMP2 (10% Moringa powder) is higher than other pudding formulas in each group.

Observing the color characteristics in the hedonic test, pudding without fresh Moringa leaves (FML0) had a white color. It was significantly different from FML1 and FML2 puddings that had light green to green colors. The pudding color in the Moringa powder group was almost similar. FMP0 formula (without Moringa powder) was white-colored pudding while the FMP1 (5% Moringa powder) was green-colored pudding and FMP2 (10% Moringa powder) was light green-colored pudding. The green color in the FMP1 pudding was significantly different from the FMP0 (white) and FMP2 (light green) pudding color. The light green and green color in the pudding with fresh Moringa leaves (FML1, FML2) and Moringa powder (FMP1, FMP2) was due to the pigment of the Moringa leaves. Moringa leaves contain a green pigment called chlorophyll. Chlorophyll is the pigment commonly found in green leaves[18].

Odor

Odor is one parameter to determine the delicacy of the food taste, either delicious or not. Adding other ingredients that contain unique smells during food processing; food processing itself is two factors affecting the odor of food products[11,17]. The results of the sensory test showed that pudding with substitution of 30% fresh Moringa leaves (FML2) and 0% Moringa powder (FMP0) have the most preferred product considering its odor by the panelists (Table 3). The panelists' preference for the odor of FML2 pudding was significantly higher than the FML1 pudding (20% fresh Moringa leaves), but not with FML0 pudding (0% fresh Moringa leaves). Meanwhile, the odor of FMP2 pudding was significantly different from FMP0 and FMP1 in the Moringa powder group to have a lower preference.

Based on the results of the hedonic test in Table 4, the pudding odor with the substitution of fresh Moringa leaves has a pleasant smell. All products have no significant difference in terms of product odor (FML0, FML1, FML2). This result is inconsistent with other studies[18,20] in which food products with the addition of Moringa leaves have an unpleasant aroma. It could be because the amount of the fresh Moringa leaves added was not too much different to influence the smells among formulas. Further, no significant difference may be due to the composition of milk powder, which is the main ingredient in the pudding formulas. Improving the pudding smells with food additives (such as fruit flavor) or strong-flavored ingredients in Moringa leaves products can increase consumer acceptability [5].

Similar to the fresh Moringa leaves group, the hedonic test result for the three formulas in the Moringa powder group showed the pudding formulas (FMP0, FMP1, FMP2) has a pleasant odor pudding with the substitution of 10% Moringa powder (FMP2) was the pudding with the lowest sensory characteristic and hedonic test scores. It is significantly different from the other pudding formulas in the Moringa powder group. The unpleasant odor of food products can reduce consumer preference for food products [11]. Therefore, the lower preferable score of a sensory characteristic of FMP2 pudding odor is caused by the lower pleasant odor level of the pudding.

Overall Acceptability

Overall acceptability is the average score of all the food attributes in the organoleptic analysis (taste, texture, color, and odor) [16]. In this study, the most preferred pudding with the highest hedonic score from the overall acceptability aspect was FML2 pudding (30% fresh Moringa leaves substitution) for the fresh Moringa leaves group and FMP1 pudding (5% Moringa powder substitution) for the Moringa powder group (Table 3 and Table 4).

The overall acceptability sensory characteristic of fresh Moringa leaves pudding was significantly different between the FML2 pudding and FMP1 pudding, but the difference was not significant compared to FML0 pudding. However, based on the hedonic test, the overall acceptability of the FMP2 has significantly different characteristics from FMP0 pudding. This result revealed that pudding FML2 with 30% additional fresh Moringa leaves is the most potent formulation of a pudding product that utilizes Moringa leaves. This study highlighted that, using fresh Moringa leaves than the powder ones could increase the utilization of Moringa.

The acceptance level of panelists on the overall acceptability attribute for FML2 pudding was significantly

different from the acceptance level for FMP2 pudding, but it was not different from the FML0 pudding. Based on the hedonic test for the Moringa powder group (FMP0, FMP1, FMP2), the score was significantly different among overall acceptability attributes. Pudding with 5% Moringa powder substitution (FMP1) has the highest score of overall acceptability then followed by FMP2 pudding with 10% addition of Moringa powder. Meanwhile, FMP0 pudding without Moringa powder substitution significantly has the lowest overall acceptability in hedonic tests. This result explained that the Moringa powder substitutions could enhance the preference and acceptance of the pudding to some extent. The substitution of Moringa powder for pudding product was 5% to maintain a high overall acceptance.

Table 4. Hedonic test on fresh Moringa leaves pudding and moringa powder pudding

Formula	Characteristics				
	Taste	Texture	Colour	Odour	Overall acceptability
Fresh Moringa Leaves Pudding					
FML0 (0%)	3.70[a]	3.96[a]	1.00[a]	3.73[a]	3.10[a]
FML1 (20%)	3.46[a]	3.63[b]	3.60[b]	3.46[a]	3.54[b]
FML2 (30%)	4.10[b]	3.16[c]	3.56[b]	3.73[a]	3.64[b]
Moringa Powder Pudding					
FMP0 (0%)	3.93[a]	3.67[a]	1.00[a]	3.83[a]	3.12[a]
FMP1 (5%)	3.89[a]	3.95[b]	4.68[b]	3.87[a]	4.10[b]
FMP2 (10%)	3.32[b]	3.75[a]	3.13[c]	3.57[b]	3.44[c]

*Taste: 1 (very bitter) – 5 (very sweet); texture: 1 (soft) – 5 (hard); color: 1 (white) – 5 (dark green); odor: 1 (unpleasant) – 5 (smell good). Different superscript letters on the same column indicate significant difference (p-value < 0.05)

The pudding formulation determined by the highest score of the hedonic test on the overall acceptability attribute were FML2 with 30% fresh Moringa leaves substitution and FMP1 with 5% substitution of Moringa leaves powder (Table 4). The statistical analysis results using an independent paired t-test (Table 5) show that the panelist preference towards the taste, odor, and color attributes of the preferred pudding products of fresh Moringa leaves and Moringa powder were not significantly different (p > 0,05). The FML2 (fresh Moringa leaves) and FMP1 (Moringa powder) puddings have a sweet taste from the sugar added to the pudding formulas on both groups. The FML2 and FMP1 puddings odor was also not significantly different were both had a pleasant odor with a slightly Moringa leaves a distinctive odor. The same thing happened to the pudding color, FML2 and FMP1 puddings both had a green color due to the chlorophyll pigment from Moringa leaves.

In contrast to the three attributes, table 5 shows that FMP1 pudding has a softer texture than FML2 pudding, which is statistically significant. This result could be due to the differences in the characteristics of the substitution materials (fresh Moringa leaves and Moringa powder). The previous study has shown that the fiber content of Moringa powder (19.2 g) is known to be significantly higher than fresh Moringa leaves (0.9 g) [3]. A food product with high fiber content will result in dense texture[5,18]. Further, the crude fiber content in Moringa powder is significantly higher than fresh Moringa leaves[21], but Moringa powder pudding has a softer texture than fresh Moringa leaves pudding. Therefore, it concludes that as long as the proportion of Moringa powder added to the pudding was not more than 5% could maintain the pudding texture.

Some studies using an ingredient with high fiber content showed that increasing the ratio of black carrot extract and the peach puree to the pudding formula results in more hardness and chewiness texture of the pudding[22,23]. Based on these results, the addition of Moringa powder to the pudding formula could improve the chewiness of pudding, with the addition of 5% Moringa powder (FMP1). The addition of 30% fresh Moringa leaves to the preferable pudding product (FML2) may be too much, so it decreases the chewiness level of pudding.

Table 5. The difference of hedonic test result on preferable formula of fresh Moringa leaves pudding (FML2) and Moringa powder pudding (FMP1) (n=30)

Variable	Fresh Moringa Leaves Pudding (Mean ± SD)	Moringa Powder Pudding (Mean ± SD)	*Independent paired t-test*
Taste	3.93 ± 0.58	3.97 ± 0.67	0.838
Texture	3.30 ± 0.47	3.97 ± 0.56	<0.001*
Odour	3.87 ± 0.78	3.80 ± 0.55	0.703
Colour	3.90 ± 0.71	3.83 ± 0.53	0.683

*) statistically significant based on an independent paired t-test with α percent.

Proximate Characteristics

The results of the proximate analysis from the preferable pudding products FML2 and FMP1 showed that the protein, calorie from fat, total fat, water, total calorie, and carbohydrate compositions were significantly different (p-value < 0.05) between fresh Moringa leaves pudding and Moringa powder pudding

(Table 6). The protein, calories from fat, total fat, total calorie, and carbohydrate content were significantly higher in fresh Moringa leaves pudding. In contrast, the water content was significantly higher in Moringa powder pudding. The ash content of both pudding products was similar (p-value > 0.05). The ash composition of a food can illustrate the food mineral content[19]. It presented a similar estimated mineral content in fresh Moringa leaves pudding and Moringa powder pudding.

The result of the proximate analysis of fresh Moringa pudding and Moringa powder pudding in this study was lower than the nutrient content of Moringa pudding in the other studies[24]. In that study, Moringa pudding products contained 68% energy, 10.73% protein, 2.83% fat, 11.59% carbohydrates, and 2.30% fiber. It could be due to the proportion of Moringa used in the study[24] being higher (about 68%) than the proportion of fresh Moringa leaves and Moringa powder used in this study.

The Pudding Formulation and Macronutrient content

Moringa leaves powder contains more protein (27.1 g) than fresh Moringa leaves (6.7 g); higher fat content (2.3 g) than fresh Moringa leaves (1.70 g) and has more carbohydrates (38.2 g) than fresh ones (12.5 g)[3]. However, the proximate analysis showed a contrast result that the protein, fat, and carbohydrate content in fresh Moringa leaves pudding was higher (Table 6). This could be due to-the proportion of Moringa Powder used in chosen pudding formulation (FMP1: 5%/ 3 g substitution) in this recent study was the smallest, while Fresh milk covered the other 95%. The chosen Moringa Leaves Pudding Formulation (FML2), in contrast, contains 30%/15 g substitution with another 70% covered by Full cream milk.

Full cream milk is known as a source of protein, fat, and carbohydrate. Full cream milk contains 25.2% of protein[25]. Meanwhile, the protein content of fresh liquid milk was revealed in another study for 3.34%[26]. Other studies have shown that the protein content of raw, pasteurized, and UHT (ultra-high temperature) liquid milk is 3.20%, 3.19%, and 3.20%, respectively[27]. The fat content in 100 g of Full cream milk powder was 26.2 g[28] 26.75 g[29], 26.3 g[26], and 26.5 g[25].

The full cream milk powder has a significantly higher fat content rather than fresh milk. The fat content of fresh milk was 3.58% for raw, 3.07% for pasteurized, and 3.15% for UHT milk[27]. Further, the lactose content of liquid milk is 4.51% (fresh milk), 4.28% (raw milk), 4.25% (pasteurized milk), and 4.27% (UHT milk)[26,27]. Whereas in full cream milk powder, the lactose content is 38.8%, 42.90%, 38.7%, and 38.7% in several studies[25–29]. Therefore, the formulation of fresh Moringa leaves with Full cream milk in FMP2 brought higher protein, fat, and carbohydrate content than the formulation of Moringa Leaves Powder with fresh milk in FMP1. Following these results, fat, protein, and carbohydrate content then was used to convert the total calories of a product. Since the fat, protein, and carbohydrate content in FML2 was high, the total calories linearly higher than the FMP1.

Water

In contrast with the proximate analysis for the water content of Moringa powder pudding (90.65 ± 0.191%) was significantly higher than the water content of fresh Moringa leaves pudding (88.1 ± 0.61%). The higher water content in Moringa powder pudding could be because Moringa powder contains more fiber that easily binds the water from the product. It also influenced the pudding texture. Further, the higher water content in Moringa powder pudding is due to the difference in the amount of water added to the pudding formulation. In the fresh Moringa leaves pudding group the amount of water added was 100 ml whereas in the Moringa powder group the amount of water added was 150 ml.

Table 6. The difference of proximate characteristics between Fresh Moringa Pudding and Moringa Powder pudding

Variable	Fresh Moringa Leaves Pudding (Mean ± SD)	Moringa Powder Pudding (Mean ± SD)	*Independent paired t-test*
Protein	1.31 ± 0.021	1.12 ± 0.035	0.03*
Ash	0.31 ± 0.31	0.34 ± 0.00	0.15
Calorie from Fat	8.82 ± 0.00	7.02 ± 0.127	0.017*
Total Fat	0.98 ± 0.00	0.78 ± 0.014	0.017*
Water	88.1 ± 0.361	90.65 ± 0.191	0.02*
Total Calorie	51.24 ± 1.38	39.92 ± 0.69	0.016*
Carbohydrate	9.3 ± 0.325	7.1 ± 0.24	0.019*

Mean ± SD. *) statistically significant based on independent paired t-test with α percent.

CONCLUSION

Fresh Moringa leaves substitution in the pudding would provide the best organoleptic characteristics at 20% substitution, while Moringa powder at 5%. The nutrient content in pudding substituted with fresh Moringa leaves was higher than pudding with Moringa powder. For utilizing more Moringa leaves that were available in Indonesia. This formulation presented a method that was easy but will give benefits to improve the health status of the community since it can also provide high nutritional contents. Furthermore, the chosen formulation was potential for mass production at the industrial level and or household level.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

We have no conflict of interest to declare.

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