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Formulation of instant porridge based on moringa leaves as a functional food for nursing mother

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Abstract. Female workers reach 43.3 million people nowadays, which 25 million are in the reproductive age. Based on Basic Health Research, the number of nursing mothers only 42% far below the target of 80%. This study is to make instant porridge formulations for nursing mothers. The materials are Moringa leaves, soy flour, banana flour, oats, palm sugar and skim milk. This research was arranged using Linear Programming Solver 1.9.4 to determine the best formulation based on nutritional adequacy rate for nursing mothers and hedonic test to determine the level of consumer preference for the product. The optimal porridge formulation is 5 grams Moringa leaves powder, 5 grams of soy flour, 20 grams of banana flour, 25 grams of oat, 22.5 grams of palm sugar and 22.5 grams of skim milk. The hedonic test is carried out on nursing women and productive age in the area of Temas, Batu, Malang Regency with the results of taste, colour, appearance and average texture worth four which means they like the product.

1. Introduction

The survey of Central Statistics Agency shows that the number of women labour continues to increase every year. Currently, female workers reach 43.3 million people, which 25 million are in the reproductive age [1]. Based on Basic Health Research, the number of breastfeeding mothers is only 42% far below the target of 80%. Some factors can make the baby not getting breast milk properly. According to Budiarto [2], these factors are the characteristics of the mother itself, the baby, environment and family support. Nursing mothers are encouraged to drink at least 3 litres of water every day and consume an additional 500 calories per day [3]. A disease that is often found in pregnant/nursing women workers is anaemia. The highest anaemia prevalence was 47.4% in pre-school children, 41.8% in pregnant women, 30.2% in non-pregnant women, 25.4% in school children, 23.9% in elderly and the lowest in adult men 12.7% [4].

Products for nursing mothers that are widely circulated in the market are supplementary foods such as supplement, milk, biscuits, etc. There is no substitute food which the nutrition or calories are sufficient for nursing mothers. This product is needed especially for female workers with hectic activities. This is an opportunity to create a ready to eat product for nursing women with high activity. As what government instructed on Instruction of Bantul Regent Number 4 of 2012 concerning the use of local food raw materials in government activities. Moringa leaves is one of the main ingredient of this product. Moringa plant (*Moringa oleifera*) is a local food ingredient that has a potential to be developed in the culinary of nursing mothers. Moringa leaves contains phytosterol compounds that the



function is to increase and smoothen the production of breast milk (lactagogum effect). One of the compounds that have lactagogum effects effect is sterols. Sterol is a steroid group compound [5]. The alkaloid and sterol content of Moringa leaves can increase milk production because of the increasing of glucose metabolism for lactose synthesis [6]. This study is to formulate instant food products for breastfeeding mothers.

2. Materials and Methods

Firstly, the ingredients are analysed the content of carbohydrate, protein, fat and fiber for each material such as Moringa leaves powder, soybean flour, banana flour, oats, palm sugar and skim milk. The method for protein, fat and fiber analysis is based on AOAC [7] and the carbohydrate analysis is based on Apriyantono *et al* [8]. The formulation was made from the result of the analysis. The mathematical models using linear programming techniques to determine the right formula. Then the formula is used to minimize the price. Mathematically, the formula can be written as follows:

Price minimizes function:

$$H = C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4 + C_5X_5 + C_6X_6 \quad (1)$$

Obstacles:

$$\alpha_{11}X_1 + \alpha_{12}X_2 + \alpha_{13}X_3 + \alpha_{14}X_4 + \alpha_{15}X_5 + \alpha_{16}X_6 \geq K \quad (2)$$

$$\alpha_{21}X_1 + \alpha_{22}X_2 + \alpha_{23}X_3 + \alpha_{24}X_4 + \alpha_{25}X_5 + \alpha_{26}X_6 \geq P \quad (3)$$

$$\alpha_{31}X_1 + \alpha_{32}X_2 + \alpha_{43}X_3 + \alpha_{34}X_4 + \alpha_{35}X_5 + \alpha_{36}X_6 \geq L \quad (4)$$

$$\alpha_{41}X_1 + \alpha_{42}X_2 + \alpha_{43}X_3 + \alpha_{44}X_4 + \alpha_{45}X_5 + \alpha_{46}X_6 \geq S \quad (5)$$

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \geq 0 \quad (6)$$

Notes:

C_1 = price of Moringa leaves powder (g)

C_2 = the price of soy flour (g)

C_3 = price of banana flour (g)

C_4 = price of oat (g)

C_5 = price of palm sugar (g)

C_6 = price of skim milk (g)

K = carbohydrates

P = protein

L = fat

S = fibre

α_{11} = carbohydrate content in Moringa flour

α_{12} = carbohydrate content in soy flour

α_{13} = carbohydrate content in banana flour

α_{14} = carbohydrate content in oats

α_{15} = carbohydrate content in palm sugar

α_{16} = carbohydrate content in skim milk

α_{21} = protein content in Moringa leaves powder

α_{22} = protein content in soy flour

α_{23} = protein content in banana flour

α_{24} = protein content in oats

α_{25} = protein content in palm sugar

α_{26} = protein content in skim milk

α_{31} = fat content in Moringa leaves powder

α_{32} = fat content in soy flour

α_{33} = fat content in banana flour

α_{34} = fat content in oats

α_{35} = fat content in palm sugar

α_{36} = fat content in skim milk

α_{41} = fat content in wheat

α_{42} = fiber content in soy flour

α_{43} = fiber content in banana flour

α_{44} = fiber content in oats

α_{45} = fiber content in palm sugar

α_{46} = fiber content in skim milk

2.1 Making instant food products for nursing mothers

Moringa leaves powder, soybean flour, banana flour, oats, palm sugar and skim milk were weighed according to the formulation obtained from linear programming. All the ingredient except palm sugar and cocoa powder are combined in dry conditions, then stirred with a dry blender until the ingredients are well mixed. The instant porridge was made according to the method used by Condro [9].

2.2 Consumer preference test

Organoleptic testing was done by affective and hedonic quality tests. There were 50 panellists of women in productive age (15-64 years old) and nursing mother. A preference test was done using the rating from 1 to 5 with category one for very dislike, two for dislikes, three for average, four for likes and five for very like.

3. Results and Discussions

3.1 Nutritional content of ingredient

The analyze result for nutritional content of Instant porridge ingredients can be seen in table 1. The nutritional content instant porridge can be seen in table 2.

Table 1. The nutritional content of instant porridge ingredients

Nutritional content	Moringa Leaves Powder	Soybean Flour	Banana Flour	Oats	Palm sugar	Skim Milk
Carbohydrate	0.5257	0.3425	0.4085	0.6857	0.9652	0.5333
Protein	0.2257	0.361	0.025	0.1142	0.00043	0.3333
Fat	0.1093	0.2	0.006	0.1	0	0
Fiber	0.2058	0.487	0.10075	0.0857	0.00043	0

Table 2 shows that the total nutrition of instant porridge can supply the minimum nutrition needs for a nursing woman based on Nutritional Adequacy Rate for 100 grams. Proverawati [10] stated that a nursing woman with good nutrition could breastfeed a baby for at least six months. Nutritional Adequacy Rates based on balanced nutrition guidelines from the Indonesia Ministry of Health (2014) are presented in table 3.

Table 2. The nutritional content of instant porridge

Composition	Instant Porridge (gr)	Nutritional Content			
		Carbohydrate	Protein	Fat	Fiber
Moringa leaves powder	5	2.6285	1.1285	0.5465	1.029
Soybean Flour	5	1.7125	1.805	1	2.435
Banana Flour	20	8.17	0.5	0.12	2.015
Oats	25	17.1425	2.855	2.5	2.1425
Palm Sugar	22.5	21.717	0.0096	0	0.0096
Skim Milk	22.5	11.9992	7.4992	0	0
Total	100	63.3697	13.7974	4.1665	7.6311
Minimum Nutrition based on NAR/100 grams		3.54	0.76	0.86	0.37

*NAR = Nutritional Adequacy Rate

Table 3. Nutritional Adequacy Rates based on balanced nutrition guidelines

Age	Weight (kg)	Height (cm)	Energy (kcal)	Protein (g)	Total Fat (g)	Carbohydrate (g)	Protein (g)
Women							
19-29 years old	54	159	2250	56	75	309	32
30-49 years old	55	159	2150	57	75	323	30
Nursing							
Six months first			+330	+29	+11	+45	+5
Six month second			+400	+20	+1.3	+55	+6

3.2 Formulation of instant porridge

Mathematical models are processed using Microsoft Excel Solver and the optimal results for composition of instant porridge are 5 grams of Moringa flour, 5 grams of soy flour, 20 grams of banana flour, 25 grams of wheat, 22.5 grams of palm sugar and 22.5 grams of skim milk. The formulation of raw material using Microsoft Excel Solver can be seen in figure 1. The optimum formulation defined a price for a product is 6,688.75 rupiahs. The optimum formulation for a price can be seen in figure 2.

	x1	x2	x3	x4	x5	x6		RHS
Objective	150	110	110	38	13	86.5	>	MIN
Constraint1	0.5257	0.1425	0.817	0.685714286	0.956521739	0.533333333	=	1.74
Constraint2	0.2257	0.361	0.045	0.114285714	0.000434783	0.333333333	>	0.76
Constraint3	0.1093	0.2	0.012	0.1	0	0	>	0.86
Constraint4	0.2058	0.487	0.2015	0.085714286	0.000434783	0	=	0.37
Constraint5	1	1	1	1	1	1	=	100
Constraint6	0	1	0	0	0	0	<=	5
Constraint7	0	0	1	0	0	0	=	20
Constraint8	0	0	0	0	1	0	<=	25
Constraint9	0	0	0	0	0	1	<=	22.5
Constraint10	0	0	0	0	0	1	<=	22.5
Integer	NO	NO	NO	NO	NO	NO		

Figure 1. The formulation of raw material using Microsoft Excel Solver

```
>> Optimal solution FOUND
>> Minimum = 6688.75
```

*** RESULTS ***

variable	value	obj. cost	reduced cost
x1	5	150	0
x2	5	110	0
x3	20	110	0
x4	25	38	0
x5	22.5	13	0
x6	22.5	86.5	0

Figure 2. The optimum formulation for a price

3.3 Hedonic test

Affective test results showed that respondents liked the whole test component, both regarding aroma, colour, texture, taste and appearance. However, 20% of respondents did not like the product due to the less attractive colours and appearance (dark green). Suggestions for further product development are increasing flavour variations and improving product colour

4. Conclusion

Instant porridge formulation using linear programming with Microsoft Excel Solver resulted an optimal composition for instant porridge was 5 grams of Moringa leaves powder, 5 grams of soy flour, 20 grams of banana flour, 25 grams of oat, 22.5 grams of sugar and 22.5 grams of skim milk. The results of the affective test by 50 respondents of nursing mothers and women in productive age (15-64 years old) with the characteristic of the taste, texture and aroma are liked by respondents. But the respondents don't really like the colour and appearance of the instant porridge.

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