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THE OPTIMAL COMPOSITIONS OF DAILY MENU FOOD FOR BREASTFEEDING MOTHERS USING THE SIMPLEX METHOD

Adin Lazuardy Firdiansyah*

Department of PGMI, Faculty of Tarbiyah, State Islamic Institute of Madura
Panglegur St., Km. 4, Pamekasan, 69371, Indonesia

*Corresponding author's e-mail: *adin.lazuardy@iainmadura.ac.id*

Abstract. *In this research, we want to find the optimal compositions of the daily food menu for breastfeeding mothers at the minimum cost. These problems are formed into linear programs by including some available data, like the price of food in the traditional market, the nutritional content of each food, and the recommended nutritional adequacy rate. After that, we count the linear programs by using the Simplex method with the help of the LINDO solver. The output of this research is the weight of food consumed by mothers to meet their daily nutritional needs. Based on the data collected, we obtain the 36 food combinations that include the staple type of food (rice), the type of side dishes (pindang fish, tilapia fish, mackerel tuna, chicken eggs), the type of vegetables (cassava leaves, katuk leaves, moringa leaves), the type of fruits (melon, watermelon, orange), and the type of nut (peanuts). Next, we analyze the model according to the groups of breastfeeding mothers in the first and second 6 months. From this research, we obtain that the optimal compositions of the daily food menu for breastfeeding mothers in the first 6 months are cassava leaves. Meanwhile, the optimal compositions of the daily food menu in the second 6 months are rice and cassava leaves.*

Keywords: *breastfeeding mothers, nutrition, optimal, Simplex method.*

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1. INTRODUCTION

Lack of nutrients needed by the body can affect performance and the immune system so we are susceptible to disease, where it can be fatal, especially at the age of toddlers. In Indonesia, there are still many toddlers who have problems such as deficiency or excess nutrition. According to [1], toddlers who are malnourished reach 3,4%, 14,4% indicates that toddlers are undernourished, 1,5% indicates that toddlers are overweight, and 80,7% indicates that toddlers have good nutrition. In [2], toddlers who have good nutrition have decreased to 80,4%, while toddlers who are malnourished have increased to 3,8%, 14% indicates that toddlers are undernourished, and toddlers who are overweight reach 1,8%. Moreover, many mothers find it difficult to continue exclusive breastfeeding even though it has been advised by experts [3].

Exclusive breastfeeding since the toddler was born until the age of six months has an important role because the breast milk given in the first six months can directly affect the growth of toddlers [4]. It is known that breast milk can provide protection and nutrition according to the needs of toddlers in the first six months, where the highest metabolic and growth rates occur at this time [5]. Therefore, the quality and frequency of breastfeeding should be maintained to anticipate toddlers with malnutrition [6]. In addition, we have to weigh and check the height regularly to find out the growth of toddlers and also to notice the nutritional intake of food that enters the toddlers [7].

Breastfeeding mothers need more nutrients than non-breastfeeding mothers because apart from mothers, nutrients are also needed by toddlers [8]. During lactation, the mothers must increase the amount and type of food consumed so they can meet the needs of their body and the need to produce breast milk [9]. If the mother's daily food does not contain enough nutrients needed, then the need for these nutrients in producing the breast milk to meet the need of toddlers will be taken from the stock in the mother's body [10]. Moreover, the increase in the food price has an impact on the people's purchasing power, especially for groups of people living on the poverty line [11]. Mothers with toddlers need more money to fulfill their nutritional needs optimally. Fulfillment of nutrition for toddlers is considered very important.

It is not easy to calculate the nutritional needs and determine the compositions of the daily food menu for breastfeeding mothers because it takes a lot of time to do it manually. Therefore, we need a smart way to meet the nutritional intake of food for breastfeeding mothers with the minimum cost. One way is to determine the right combination of ingredients at the lowest possible cost so that they are available to all levels. In the initial step, we build a mathematical model to find the optimal combination of food models that matches the recommended nutritional adequacy rate. In this research, we aim to give one of the efforts to determine the right food menu so that the nutritional needs of mothers and toddlers are met with the minimum cost. Therefore, this research reviews and analyzes the problems of minimizing costs in fulfilling the balanced nutrition for breastfeeding mothers by considering the nutritional content in several foods. This study analyzes a mathematical model in the form of linear programs using the Simplex method with the help of the LINDO solver. The Simplex method is a method in the linear programs used to solve the optimized problems. This method is often used by researchers in the last few decades. As in [12], Kimutai et al. present a linear program for optimizing energy use in textile manufacturing using the Simplex method with the help of LiPS software. Kimutai's research aims to obtain the minimum cost. In [13], the Simplex method with the help of LINDO solvers is used to get a product picture of optimizing benefits on the Bintang Bakery home industry. The results of this study show that the production of the Bintang Bakery home industry has been optimal. Meanwhile, [14] presents the balanced menu optimization problem for pregnant women using the linear program which is solved by using the Simplex method with the help of the WinQSB. Therefore, the output in current research is the weight of food consumed by the user to get balanced nutrition for breastfeeding mothers with the minimum costs.

2. RESEARCH METHODS

To achieve the research objectives, several stages are given as follows.

a. Literature study

We conduct library research by collecting information from various sources such as books, articles, and the internet.

b. Identification of problems

The problem in this research is to optimize the compositions of the daily food menu for breastfeeding mothers by considering the food prices in the traditional market so that we can obtain the minimum prices. Here, we choose Ki Lemah Duwur's traditional market in Bangkalan as research place.

c. Data collection

Data is collected through literature research, observations, and interviews with traders in the traditional market. The data needed in this research are the food prices, the recommended nutritional adequacy rate, and the composition of nutritional content from selected food ingredients.

d. Formulation model

The data collected is created into linear programs by constructing decision variables, objective functions, and constraint functions.

e. Data analysis

The linear programs are analyzed by using the Simplex method with the help of the LINDO solver.

f. The results

The optimal solutions in this research are obtained from the generated values of the LINDO solver.

3. RESULTS AND DISCUSSION

3.1. Data Collection

Based on the previous discussion, we need several data to construct linear programs. The following two tables show the nutritional adequacy figures for breastfeeding mothers.

Table 1. The Nutritional Content of Each Food Item (per 100 g BDD)

No	Food	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	Vit. C (mg)	Water (g)
1	Rice	350	2.7	1.1	82.3	28	2.9	0.2	11.3
2	Pindang fish	157	28	4.2	1.8	50	1	0	59
3	Tilapia fish	89	18.7	1	0	96	1.5	0	79.7
4	Mackarel tuna	100	13.7	1.5	8	92	1.7	0	74.7
5	Chicken eggs	154	12.4	10.8	0.7	86	3	0	74.3
6	Cassava leaves	50	6.2	1.1	7.1	166	1.3	103	84.4
7	Katuk leaves	59	6.4	1	9.9	233	3.5	164	81
8	Moringa leaves	92	5.1	1.6	14.3	1077	6	22	75.5
9	Melon	37	0.6	0.4	7.8	12	0.4	0.2	90.8
10	Watermelon	28	0.5	0.2	6.9	7	0.2	6	92.1
11	Orange	45	0.9	0.2	11.2	33	0.4	49	87.2
12	Peanuts	525	27.9	42.7	17.4	316	5.7	0	9.6

Data source:[15]

Table 2. The Nutritional Adequacy Rate (NAR) per person per day

No	Nutrition	NAR for Breastfeeding Mothers	
		The first 6 months	The second 6 months
1	Energy (kcal)	+330	+400
2	Protein (g)	+20	+15
3	Fat (g)	+2.2	+2.2
4	Carbohydrate (g)	+45	+55
5	Calcium (mg)	+200	+200
6	Iron (mg)	+0	+0
7	Vit. C (mg)	+45	+45
8	Water (g)	+800	+650

Data source:[16]

Table 3. The Price List of Each Food Item on September 2021

No	Name	Price (Rp/Kg)	Price (Rp/g)
1	Rice	8500	8.5
2	Pindang fish	35000	35
3	Tilapia fish	30000	30
4	Mackerel tuna	30000	30
5	Chicken eggs	20000	20
6	Cassava leaves	8000	8
7	Katuk leaves	8000	8
8	Moringa leaves	8000	8
9	Melon	9000	9
10	Watermalon	10000	10
11	Orange	20000	20
12	Peanuts	25000	25

Data source: Based on the survey

3.2. Formulation Model

In this paper, the decision variables are divided into 5 types according to the selected food ingredients, namely X_1 is the staple type of food (rice), X_2 is the type of side dishes (pindang fish, tilapia fish, mackerel tuna, chicken eggs), X_3 is the type of vegetables (cassava leaves, katuk leaves, moringa leaves), X_4 is the type of fruits (melon, watermelon, orange), and X_5 is the type of nut (peanuts). Based on the foodstuffs that have been divided, we obtain 36 food combinations according to the general multiplication rules. These combinations will be analyzed.

The data collected will be analyzed using the Simplex method according to the constraints faced and the objectives achieved. Here, we assume that the model follows the nutritional content of each ingredient, and the recommended nutritional adequacy rate for breastfeeding mothers becomes nutritional requirement limits. In this research, we want to minimize the cost of purchasing food but it still follows the recommended nutritional adequacy rate for breastfeeding mothers. Therefore, the objective function for this case is given as follows.

$$\min Z = a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5, \quad 1)$$

where $a_i, i = 1,2,\dots,5$ are the price of each food j and Z is the total price of food. Based on the assumptions used, we obtain the constraint functions as follows.

$$\begin{gathered} b_{11}X_1 + b_{12}X_2 + \cdots + b_{15}X_5 \geq c_1, \\ b_{21}X_1 + b_{22}X_2 + \cdots + b_{25}X_5 \geq c_2, \\ \vdots \\ b_{81}X_1 + b_{82}X_2 + \cdots + b_{85}X_5 \geq c_8, \\ X_1, X_2, \dots, X_5 \geq 0, \end{gathered} \quad (2)$$

where $b_{ji}, j = 1,2,\dots,8, i = 1,2,\dots,5$ are the value of nutritional content for food i, and $c_j, j = 1,2,\dots,8$ are the recommended nutritional adequacy rate for breastfeeding mothers. Next, we can count the model with the help of the LINDO solver.

3.3. The Results

After we count the 36 food combinations using the LINDO solver, we obtain that the cassava leaves are the optimal compositions of daily menu food for breastfeeding mothers in the first 6 months. This can be seen from the calculation results of the LINDO solver, where $X_1 = 0$ for the rice, $X_2 = 0$ for all kinds of side dishes, namely pindang fish or tilapia fish or mackerel tuna or chicken eggs, $X_3 = 947{,}87$ for cassava leaves, $X_4 = 0$ for all kinds of fruits, namely melon or watermelon or orange, and $X_5 = 0$ for peanuts. Based on the results, we get the total price $Z = 7582{,}938$ or can be rounded to Rp. 7600,00 per day.

In the second 6 months, we can conclude that rice and cassava leaves become the optimal compositions of the daily food menu for breastfeeding mothers. This is proven by the calculation of the LINDO solver, where $X_1 = 4{,}349$ for the rice, $X_2 = 0$ for all kinds of side dishes, $X_3 = 769{,}56$ for cassava

leaves, $X_4 = 0$ for all kinds of fruits, and $X_5 = 0$ for peanuts. Therefore, the total price is $Z = 6193{,}443$ or can be rounded to Rp. 6200,00 per day.

4. CONCLUSION

In this article, we aim to find the optimal compositions of the daily food menu for breastfeeding mothers with the minimum prices. Moreover, the nutritional needs of toddlers can be met. Here, we also consider the nutritional composition of each food ingredient such as energy, protein, fat, carbohydrate, calcium, iron, vitamin C, and water for breastfeeding mothers in the first and second 6 months. Based on the data collected, we find the 36 food combinations according to 5 types of food groups. After that, we analyze these combinations using the Simplex method with the help of the LINDO solver. So, we conclude that the optimal compositions of the daily food menu for breastfeeding mothers in the first 6 months are cassava leaves. Meanwhile, rice and cassava leaves are the optimal compositions of the daily food menu for breastfeeding mothers in the second 6 months.

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