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Research Article

Giving Sprouted Corn Flour and Red Bean Cookies to Anaemic Toddlers

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Abstract

Background and Objective: Cookies made from sprouted corn flour and red beans were developed as a food for toddlers and were formulated to have the required nutritional value to be safely consumed and provide adequate supplementation. This research was conducted to determine the benefit of giving formula cookies made with sprouted corn flour and red beans to anaemic toddlers daily for 60 days. **Materials and Methods:** Research was conducted in the village of Coral Later, Deli Serdang district and in the Food Technology Laboratory of the Nutrition Department of Lubuk Pakam Poltekkes Kemenkes Medan. This type of research includes a quasi-experimental design with pre-tests and post-tests. Cookies made with sprouted corn flour and red beans were given to toddlers daily for 30 days, providing as much as 100 g of cookies. Before and after the intervention, nutrient consumption data (energy, protein, vitamin C, iron and zinc) was recorded on two consecutive days not during the intervention. The research study sample included as many as 30 toddlers who were anaemic. Cookies were administered to those toddlers with increased levels of blood haemoglobin level and data were analysed mainly using t-tests. **Results:** The results showed that, of the nutrient intake categories (energy, protein, vitamin C, iron and zinc), most toddlers take in less than 100% of their recommended daily allowance. The average haemoglobin level before the intervention was 10.5 g dL⁻¹ and the average haemoglobin level after the intervention was 11.8 g dL⁻¹. **Conclusion:** The average increases in haemoglobin levels by as much as 1.3 g dL⁻¹ are statistically significant (p = 0.000).

Key words: Anaemic toddler, formula cookies, haemoglobin, red bean, sprout corn flour

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

It is important to pay considerable attention to the growth and development of toddlers, as during this time, they experience a very rapid and critical growth spurt, usually known as the golden age or the golden period. Toddlers experience growth and development, particularly in the language and cognitive functions and emotional growth. Children aged 1-5 years often experience anorexia. Because of their increasing physical development and abilities, toddlers like to run and play, so they become reluctant to eat, which is a factor causing children to have poor nutritional status and to be susceptible to infectious diseases¹.

The toddler age group is most prone to anaemia, especially iron-deficiency anaemia, mainly because iron needs are greater relative to the growth of the body. The cause of anaemia is low consumption of protein, iron and vitamin C. The assortment of these nutrients can affect the onset of anaemia because iron plays a role in the formation of haemoglobin. Proteins serve as the ingredient that forms haemoglobin. The main causes of nutritional anaemia in infants are an insufficient intake of iron, low iron absorption and a diet that is comprised mostly of rice and is not diverse. In addition, hookworm infestation increases the rate of anaemia in toddlers¹. The high prevalence of nutritional anaemia in toddlers carries a negative effect of low immunity, causing high rates of morbidity. Thus, the functional consequences of nutritional anaemia cause a decrease in the quality of interactions². Anaemia causes the affected children to have lower intellectual intelligence (10-15 points) and a decreased learning capability compared with non-anaemic children³.

Corn has been used as a food ingredient in such products as instant cereal, corn meal and corn starch but the nutritional value of sprouted corn flour is much better. The value of the nutrients contained in the seeds of sprouted corn flour can change in the germination process⁴. Sprouted corn conforms with the four requirements for food to be processed into local hawker food: it is nutritious (the protein content meets approximately 30% of the protein needs of the breast milk standard and its levels of zinc are as high as $29.41 \mu\text{g g}^{-1}$), it appeals to the needs of toddlers to receive food in a variety of flavours and shapes, it is easy to eat for children who are developing the ability to chew and swallow and it is a local food. Another advantage of sprouted corn flour is a low water absorption value of 0.7 g g^{-1} . The lower the water absorption of food, the less saliva is needed to soften the food so that it is easier to eat⁵. This research aimed to assess the administration

of cookies, knowing that the formula of sprouted corn flour and red beans increases the levels of haemoglobin and blood protein status in toddlers who are suffering from anaemia.

MATERIALS AND METHODS

Experimental site: The research was conducted in the Village of Karang Anyar Subdistrict Sekip and in the Food Technology Laboratory of the Nutrition Department of Lubuk Pakam Poltekkes Kemenkes Medan. The data collection was conducted from June-December 2017.

Experimental design: This study used a quasi-experimental design with pre-tests and post-tests. The measurement of haemoglobin, blood protein levels and nutrient consumption (energy, protein, vitamin C and iron) was performed before and after the intervention.

Research materials for making sprouted corn flour and red bean cookies are presented in Table 1. Research tools for the measurement of haemoglobin, blood protein levels and nutrient intake are presented in Table 2.

Research procedure:

- **First stage:** Ample determination. The study population in this research was the entire toddler population suffering from anaemia in the Village of Karang Anyer Subdistrict Sekip. The participants in this research were toddlers 6–60 months old who suffered from anaemia in the village of Coral Later. Samples were obtained from as many as 31 people
- **Second stage:** Collection of data on the presence of childhood anaemia
- **Third stage:** Examination of the levels of haemoglobin
- **Fourth stage:** Preparation of sprouted corn flour and red bean flour
- **Fifth stage:** Preparation of sprouted corn flour and red bean cookies
- **Sixth stage:** Administration of cookies (10 pieces, 100 g cookies) to toddlers with childhood anaemia for 30 days
- **Seventh stage:** Examination of the levels of haemoglobin and child consumption data collection (phase two)

Data collected: (a) Haemoglobin levels, (b) the average consumption of nutrients before and after intervention and (c) compliance with the consumption of sprouted corn flour and red bean cookies.

Parameters measured: Data on the average daily consumption of foodstuffs containing energy, protein, vitamin C, iron (Fe) and zinc (Zn) were obtained by the method of food recall once in a 24 h period, done twice on non-consecutive

days, before and after the cookie intervention and categorized as (a) enough (more than 100% of the RDA) and (b) less (less than 100% of the RDA). Measurements of blood haemoglobin levels, or the number of red blood cells found in the blood of toddlers, expressed in grams per decilitre, were conducted before and after the cookie intervention. The method of haemoglobin measurement used was cyanmet haemoglobin with a spectrophotometer measurement tool. The haemoglobin measurements were used to categorize the subjects (after the intervention) as (a) anaemic (<11 g dL⁻¹ haemoglobin) or (b) not anaemic (≥11 g dL⁻¹ haemoglobin).

Statistical analysis: Analyses of univariate data were conducted to describe the characteristics of the independent and dependent variables. A t-test was used to analyse the bivariate data to determine the difference between the independent and dependent variables after the sprouted corn flour and red bean cookies were administered to increase levels of haemoglobin.

RESULTS AND DISCUSSION

Data on the characteristics of the subjects of this research study, including sex, age, a history of consuming breast milk exclusively and nutrient intake (energy, protein, vitamin C, Fe and zinc), were obtained. The characteristics of the subjects are presented in detail in Table 3.

The subjects of the research included 31 children; most were male (58.1%) and the rest were female (41.9%). The percentage of subjects who were exclusively given breast milk was only 25.6%. Based on Table 3, as many as 58.1% of the subjects were 12-47 months old and 22.6% were 6-11 months old. Regarding the distribution of the subjects' nutrient consumption levels, most of the intake was at a level below the RDA for each of the nutrients.

Most toddler intake of the nutrients of energy, protein, vitamin C, Fe and Zn was less than 100%. These five nutrients have a very important role in the formation of haemoglobin. Almsier⁶ stated that iron and protein are the main elements in the formation of haemoglobin, whereas a number of other nutrients, such as vitamin A, vitamin C, vitamin B6 and zinc, play a role as catalysts or enzymes at different levels of haemoglobin formation. The intake of vitamin C helps in the absorption of non-haem iron by changing the iron from the ferric to the ferrous state⁶. The level of vitamin C intake of toddlers is most often less than the RDA.

Iron is used for the synthesis of haemoglobin, which is the part of the red blood cells that carries oxygen from the lungs to all body tissues and carries back carbon dioxide from all the

Table 1: Research materials for making sprouted corn flour and red bean cookies

Materials	Amount
Corn	60 kg
Red beans	40 kg
Wheat flour	12 kg
Eggs	100
NaHCO ₃	1 box
KCN	1 box
K ₃ Fe(CN) ₆	1 box
Sterile cotton	1 pack
Alcohol	1 bottle

Table 2: Research tools for the measurement of haemoglobin, blood protein levels and nutrient intake

Tools	Amount
Spectrophotometer	1
Pen lancet	5
Lancet	1 box
Test tube	30
Whatman paper	60 sheets
Mixer	1
Oven	1

Table 3: Subject characteristics

Variables	No.	Percentage
Sex		
Male	18	58.1
Female	13	41.9
Age		
6-11 months	6	19.4
12-47 months	18	58.1
48-60 months	7	22.6
History of exclusively consuming breast milk		
Yes	8	25.8
No	23	74.2
Energy intake		
Enough	13	41.9
Less	18	58.1
Protein intake		
Enough	12	38.7
Less	19	61.3
Vitamin C intake		
Enough	2	6.5
Less	29	93.5
Fe intake		
Enough	3	9.7
Less	28	90.3
Zinc intake		
Enough	7	22.6
Less	24	77.4

cells to the lungs to be removed from the body. Iron deficiency affects productivity and in toddlers, based on immunological research, there is a decrease in immunity and the body's ability to kill bacteria⁷. The level of iron intake in most toddlers is below the RDA. The absorption of iron between haem iron and non-haem iron is different because the bioavailability of non-haem iron is lower than that of haem iron. The absorption of non-haem iron is improved with the transition of iron from the Fe³⁺ to the Fe²⁺ state. The low

absorption of non-haem iron can be increased by consuming vitamin C and meat products such as meat, fish and chicken. In addition to the fact that the absorption of iron is influenced by the presence of supporting factors such as vitamin C, there are also factors that inhibit iron absorption, such as tannins in tea, oxalate in spinach and phosvitin in egg yolk⁶. The absorption status of iron is also influenced by the people who consume it. Haem and non-haem iron can be absorbed by people with iron deficiency better than by those with normal iron status³.

Before the intervention of giving cookies to the anaemic toddlers, an examination was first conducted of the haemoglobin level. The haemoglobin levels obtained for these toddlers were at least 10.0 g dL⁻¹ and the highest was 10.90 g dL⁻¹, with an average of 10.5 g dL⁻¹. These results showed that the toddlers were at a level of mild to moderate anaemia. Clark² revealed that malnutrition in the form of iron-deficiency anaemia has an extensive impact, including lower work capacity, lower heat regulation, immune dysfunction, gastrointestinal disorders and lower cognitive ability. Olney⁸ revealed that children who are malnourished experience obstacles in the development of motor skills as well as iron-deficiency anaemia.

The organoleptic nature of the cookies includes their colour, aroma, texture and flavour. The brown colour of the cookies is from the addition of red beans, although the cookies appear yellowish because of the basic ingredients of sprouted corn flour. In addition, the wet warming process increases the yellow colour component and decreases the white component⁹. The aroma is associated with the sense of smell. The distinctive aroma of corn flour is caused by the presence of tocopherol oil (volatile) in corn. The process of stirring or heating sprouted corn flour increases the Maillard reaction, which is important as a source of flavour.

A 100 g sprouted corn flour and red bean cookie contains 513.98 kcal energy, 15.32 g protein, 2.6 mg vitamin C, 4.5 mg iron and 1.8 mg zinc. Cookies are distributed daily to toddlers, packed in plastic bags with as many as five pieces and must be consumed by the subjects within a day. Local organizations helped the study administrator deliver the cookies. The number of cookies consumed was recorded on the compliance control form, which was provided. Table 4 shows the nutritional value of cookies compared with the RDA values.

The laboratory chemical test results of the cookies by the USU Food Chemistry Analysis compared with cookies, corn, mung and bean flour formulas obtained the levels of grey (89%), moisture content (6.8%) and protein (27.61%). The chemical test results already meet the Indonesian National Standard cookie guidelines¹⁰.

Table 4: Cookie nutritional value compared with the recommended dietary allowances (RDA)

Nutrients	RDA	Cookie nutritional value
Energy (kcal)	1. 6-11 months: 725	513.98
	2. 12-47 months: 1125	
	3. 48-60 months: 1160	
Protein (g)	1. 6-11 months: 18	15.31
	2. 12-47 months: 26	
	3. 48-60 months: 35	
Vitamin C (mg)	1. 6-11 months: 50	2.60
	2. 12-47 months: 40	
	3. 48-60 months: 45	
Iron (mg)	1. 6-11 months: 7	4.50
	2. 12-47 months: 8	
	3. 48-60 months: 9	
Zinc (mg)	1. 6-11 months: 3	1.80
	2. 12-47 months: 4	
	3. 48-60 months: 5	

The cookie intervention for 60 days resulted in an average haemoglobin level of 11.7 g dL⁻¹, with a minimum of 10.1 g dL⁻¹ and a maximum of 14.1 g dL⁻¹. A review of the study results showed that, after being given sprouted corn flour cookies for 60 days, only 8 people (25.8%) had haemoglobin levels of <11 g dL⁻¹ (anaemia). Table 5 demonstrates that the average haemoglobin levels increased by 1.3 g dL⁻¹ after being given the intervention for 60 days. The increased levels of haemoglobin are statistically meaningful (p = 0000). Administering the cookies can improve the levels of haemoglobin. Of the 31 subjects who suffered from anaemia, as many as 71% of the intervention subjects experienced an increase in haemoglobin levels.

Atamna¹¹ has shown that a deficiency of haem iron causes mitochondrial oxidation that may harm the immature function of cells in the brains of toddlers. The slow process of myelination and the decrease in the activity of some enzymes decrease the affinity of dopamine D2 receptors and affect system neurotransmitters that are all related to the lack of iron and are potentially responsible for motor, cognitive and behavioural performance. Morphological and biochemical changes in the brains of rats also occurred when iron depletion levels were severe, including a decrease in protein concentration or energy metabolism activity (cytochrome C oxidase and cytochrome c), slow dendrite growth and a loss of metabolism in the nerves of the hypothalamus¹¹.

The intervention of providing cookies every day for 30 days increased the levels of haemoglobin significantly and decreased the prevalence of anaemia. The results obtained are in line with the results of the meta-analysis by Sun *et al.*¹² with the provision of fortification and modification of food interventions, which had a significant effect [odds ratio (OR)= 5.03, 95% confidence interval (CI) 3.09-0.18] on anaemic children.

Table 5: The results of the measurement of haemoglobin levels before and after intervention

Measurement	Mean ± 1 SD	Minimum	Maximum	p-value
Haemoglobin level before (g dL ⁻¹)	10.5 ± 0.3	10.0	10.9	0.000
Haemoglobin level after (g dL ⁻¹)	11.8 ± 1.0	10.1	14.1	
Increase (g dL ⁻¹)	1.3 ± 1.1			

The analysis shows that cookies containing high levels of zinc provide 1.8 mg of zinc. Zinc functions in the regulation of enzyme cofactors such as superoxide dismutase and plays a role in protein synthesis and the regulation of immune system cells. Zinc can help prevent disease and is beneficial in the growth and development of infants and toddlers. Cookies with a fairly high zinc content, per 100 g cookie, meet nearly 40% of the RDA for zinc for babies ages 7-11 months and 35.87% of the RDA for zinc for toddlers ages 1-3 years.

Cookies with a high iron content contain 4.5 mg iron (Fe). This value is quite high for iron content in food. The functions of iron in humans include acting as a constituent of haemoglobin and binding oxygen with red blood cells, regulating body temperature, acting as a constituent in cytochrome myoglobin and serving roles in immunity, muscular activity development, brain function, catecholamine metabolism, balance and motor intelligence. Iron deficiency occurring between the ages of 6 and 24 months can lead to difficulty in speaking. The results of the research conducted by Ma *et al.*¹³ showed that cereals fortified with iron and zinc have an increased effect on the mean haemoglobin level (121.6 ± 11.7 g L⁻¹) and on the serum ferritin level (18.95 µg L⁻¹) compared with unfortified local cereals, with an effect on the mean haemoglobin level (119.5 ± 12.1 g L⁻¹) and on the mean serum ferritin level (15.20 µg L⁻¹).

The minimum number of cookies that the toddlers consumed was 240 pieces and the maximum was 300 pieces. The number of cookies that were consumed was categorized into two categories: obedient (300 pieces consumed) and dutiful (less than 300 pieces consumed). The research results included 22 people (71%) in the obedient group and 9 people (29%) in the non-obedient group. The results showed that of the subjects who consumed high-iron cookies during the research, most (95.5%) experienced no anaemia, whereas of the subjects in the non-obedient group, as many as 77.8% experienced anaemia. This result can be seen more clearly in Table 6.

Compliance in subjects receiving cookies during the research is an important factor for increasing haemoglobin. The research intervention achieved an average level of haemoglobin of 12.1 g dL⁻¹ in the subjects who dutifully ate the cookies, while subjects who were non-obedient had an average increase of 10.8 g dL⁻¹. Causes of noncompliance in consuming the cookies included smell, which is a factor that

Table 6: Distribution status of anaemia based on compliance to consume the sprouted corn and bean flour cookies

The level of compliance		No.	Percentage
Obedient	Anaemic	1	4.5
	Not anaemic	21	95.5
Not obedient	Anaemic	7	77.8
	Not anaemic	2	22.2

is less liked by the child; the mother's lack of awareness about the importance of consuming cookies and threat of anaemia for the children and no special counselling from health care personnel. A mother's influence is considerable because the mother is often a determinant and regulator of food consumption for toddlers. Toddlers may be vulnerable to a deficient nutritional state. Andiana and Sumarmi¹⁴ argued that the age of 12-23 months is the age of transition between prepared and adult food as well as the most critical period because of the danger of infectious diseases and nutritional insufficiency. According to Davidson and Nestel¹⁵, less successful iron supplementation interventions can be due to several factors, including the fortification not providing a sufficient dose of iron, the level of compliance, a short intervention time frame, the nutrient needs of the period being extremely high and a deficiency of other micronutrients and macronutrients, as well as a low nutritional status before the intervention.

Haemoglobin levels are used to indicate whether a person is suffering from anaemia or not. Anaemia can cause excessive bleeding, damage to red blood cells and inadequate production of red blood cells. The main causes of nutritional anaemia include inadequate consumption of dietary iron, low iron absorption and a diet that is composed mostly of rice and is not diverse. In addition, hookworm infestation exacerbates the condition of people who suffer from anaemia in certain areas, especially rural areas⁶. There are three stages of iron deficiency in the body: successive depletion of iron storage, iron deficiency of erythropoiesis and iron-deficiency anaemia. In this research, the assessment of iron status was based on the final stages in the occurrence of iron deficiency called anaemia. With haemoglobin indicators, the cause of anaemia that can be explained is caused by iron deficiency or infection, so a toddler who has an infection/inflammation can have a decrease in haemoglobin levels¹⁶. To maximize the effectiveness of the cookies in increasing haemoglobin levels, toddlers must consume the cookies in accordance with

the recommended dosages. In addition to providing supplementary feeding to children less than 5 years of age, health policymakers need to take into account the nutritional content of the food provided in accordance with the RDAs. Nutritional counselling needs to be provided for those who make these decisions. In future studies, an increased intervention time and the use of iron status indicators are recommended.

CONCLUSION

There was an increase in the average haemoglobin level in anaemic toddlers after consuming corn flour cookies for 60 days.

SIGNIFICANCE STATEMENT

This study found an increase in haemoglobin levels in anaemic toddlers after consuming corn flour and red bean cookies. These are a beneficial supplementary food item for anaemic toddlers.

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