

## RESEARCH ARTICLE

## Eel Cookies Supplement and Incidence of Diarrhea in Children Aged 12–24 Months

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### Abstract

Diarrhea is one of the main causes of death in infants and toddlers in Indonesia. The Indonesian eel is a source of animal protein that contains high nutrients, including vitamin A and zinc, so it can be used to boost immunity. The objective of this study was to analyze the effect of eel cookies on the incidence of diarrhea in children. This was a double-blind randomized control trial (RCT) posttest study on 44 children aged 12–24 months at Garuda Public Health Center, Bandung city, who were selected using the simple random sampling method. The study was conducted for 2 months from January to February 2017. Data were analyzed using the Wilcoxon test. Results showed that there was an effect of eel cookies in reducing diarrhea incidence in toddlers ( $p < 0.001$ ), with no diarrhea condition seen among the toddlers among 18 children who had a history of diarrhea in the past and among 20 other children with no history of past diarrhea. In conclusion, eel cookies can reduce the incidence of diarrhea in children aged 12–24 months. Hence, it can be used as a functional food to improve child immunity as one of the efforts to prevent infectious diseases, especially diarrhea.

**Key words:** Diarrhea, eel cookies, supplementation

## Suplementasi Cookies Ikan Sidat terhadap Kejadian Diare pada Balita Usia 12–24 Bulan

### Abstrak

Penyakit diare merupakan salah satu penyebab kematian utama pada bayi dan balita di Indonesia. Ikan sidat merupakan salah satu sumber protein hewani yang banyak mengandung vitamin A dan seng sehingga dapat meningkatkan kekebalan tubuh. Tujuan penelitian ini adalah menganalisis pengaruh pemberian cookies ikan sidat terhadap kejadian diare pada balita. Desain penelitian dengan *randomized controll trial (RCT) posttest group design* dengan *double blind*. Subjek penelitian adalah balita usia 12–24 bulan di Puskesmas Garuda Kota Bandung sebanyak 44 responden. Penelitian dilakukan selama 2 bulan mulai Januari–Februari 2017. Pengambilan sampel dilakukan secara acak sederhana. Analisis data menggunakan Uji Wilcoxon. Hasil penelitian menunjukkan pengaruh pemberian cookies ikan sidat terhadap penurunan kejadian diare pada balita ( $p < 0,001$ ), yaitu tidak ada perubahan kondisi balita dari tidak diare menjadi diare dan terdapat 18 balita yang pernah memiliki riwayat penyakit diare mengalami perubahan setelah diberikan perlakuan sehingga tidak mengalami diare, sedangkan 20 orang di antara yang tidak memiliki riwayat penyakit diare setelah mendapatkan perlakuan tetap tidak mengalami diare. Simpulan, terdapat pengaruh pemberian cookies ikan sidat terhadap penurunan kejadian diare pada balita usia 12–24 bulan. Oleh karena itu, cookies ikan sidat dapat digunakan sebagai makanan fungsional untuk meningkatkan imunitas anak sebagai upaya pencegahan terhadap penyakit infeksi terutama diare.

**Kata kunci:** Cookies sidat, diare, suplementasi

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## Introduction

Diseases, particularly diarrhea, is a primary cause of death in babies and toddlers in Indonesia, contributing 31.4% and 25.2% of the total number of deaths, respectively. Diarrhea is closely related to the nutrition issue, especially malnutrition. Diarrhea in all ages is one of the top four causes of death (13.2%) with the rates of 214 per 1,000 people for all ages and 900 per 1,000 for toddlers in 2012. The highest incident of diarrhea for toddlers is seen in the 12 to 24-month-old age group (7.6%).<sup>1,2</sup>

Low nutrition status is a significant risk factor that may cause diarrhea for babies and toddlers.<sup>3</sup> The nutrition status related to malnutrition can increase the morbidity and mortality caused by the defense system of the human body, which continues to weaken and change body immunity.<sup>4</sup>

Nutrition status influences every single aspect of children's health, including growth, development, physical activities, and responses towards infectious diseases. The cause of malnutrition is lack of nutrients and lack of food absorption in the digestive system.<sup>5</sup> Several studies have revealed that macronutrient or micronutrient deficiency might cause vulnerabilities to infectious diseases, including diarrhea. An infectious disease occurs due to reduced body's immunity, including cell immunity and IgA secretion.

Eel is an alternative source of protein which is better than beef because it has low cholesterol content and cheaper. Indonesia has a significant potential for the fishery, yet it is not corresponding with the increase in domestic fish consumption.<sup>6,7</sup> The Indonesian eel (*Anguilla* spp.) is a fish that has an economic value both for local and foreign markets. The eel contains higher nutrients such as protein, fat, vitamin, and minerals such as phosphorus, zinc, selenium, and iron when compared to other fish.<sup>8–10</sup>

One of the by-products of eels is eel flour.<sup>11</sup> This flour can be used as a material of food diversification as well as food supplements and functional food products. One of the forms of the functional food products made of eels is eel cookies.<sup>11</sup>

This study aimed to analyze the effect of eel-based cookies consumption on the reduction of diarrhea incidence among toddlers aged 12–24 months old.

## Methods

This was an experimental double-blind, randomized control trial (RCT) post-test group study. Neither the researchers nor the subjects of this study knew which intervention was provided to a particular subject. Subjects were chosen using a random sampling method and divided into two groups, namely the experimental group which received eel cookies and the control group which received cookies without eel content. The observed variable was the incidence of diarrhea. The eel cookies formulation was performed using chemical analysis to determine the water content, ash content, fat, protein, carbohydrate, vitamin A, and zinc. The results of the analysis were used as the basis for the formulating cookies using the best formula and method, which should be suitable for cookies based on the nutritional value obtained from the list of food compositions. Experts then produced the cookies at the Baking Research and Development (BReAD) Unit of Bogor Agricultural University. The subjects in this study include toddlers ranging from 12 to 24 months old who lived in the area of the Garuda Public Health Center Bandung who met the inclusion criteria. This research was performed from January to February 2017.

The screening applied to the subjects through several stages. First, toddlers aged 12–24 months were registered and information on daily health care was obtained. These toddlers then received a physical check-up to determine their health status. Lastly, 40 research subjects were obtained and randomized to determine which toddlers went into the experimental group and which went to the control group.

Data collected consisted of cookies consumed during the intervention by the subjects. Data on cookies consumption were collected every week and recorded into the daily cookies consumption form. Food consumption was evaluated using the three-day estimated food recording method (2 days of consumption and one day without consumption) before consuming cookies and after 30 days of intervention. Data on food consumption were then converted into nutrient units and averaged to obtain daily consumption numbers. The Nutrisurvey 2007 application was used to convert basic data into nutrients data. The Wilcoxon test was chosen for statistical analysis.

The study protocol was approved by the

Health Research Ethics Committee of the Faculty of Medicine, Universitas Padjadjaran, Bandung, Indonesia through the issuance of the ethical clearance letter number: 22/UN6.C1.3.2/KEPK/PN/2017.

**Results**

The characteristics of the research subjects and the number of eel cookies consumed are presented in Table 1.

The difference in the average body weight and the protein, vitamin A, and zinc inputs before and after consuming the cookies are listed in Table 2.

The analysis of the effect of eel cookies on the reduction of diarrhea incidence is presented in Table 3.

Table 3 presents that eel cookies affect diarrhea incidence reduction with  $p < 0.001$  ( $p = 0.000$ ), meaning that there was no change in the condition of toddlers from not having diarrhea to having diarrhea. There were 18 toddlers with a history of diarrhea who did not experience diarrhea after the treatment. Besides, 20 toddlers without any history of diarrhea maintain the absence of diarrhea after receiving the treatment.

**Discussion**

Table 1 presents the characteristics of subjects by the child sex, maternal occupational status, and maternal education level. Child sex distribution was similar between the intervention and control groups. The maternal occupational status did not differ greatly between the two groups with most mothers did not work (80% vs 70% in the intervention group and control group, respectively). The highest maternal education level was high school graduates (45% in both groups). Most toddlers received exclusive breastfeeding (65% vs 80% in the intervention and control groups, respectively). The incidence of diarrhea before the treatment did not differ greatly between the two groups, with 55% had a history of diarrhea in the intervention group and 45% of the toddlers in the control group had a history of diarrhea.

Education influences knowledge. The mother's knowledge about diarrhea will play an important role in improving the risk factors in her family that will eventually reduce the frequency of diarrhea occurrence among her family members. Lower knowledge and understanding

**Table 1 General Characteristics of Subjects and Their Parents**

Characteristics	Group and Number of Subject	
	Eel Cookies (n=20)	Control Cookies (n=20)
Sex		
Male	9	9
Female	11	11
Mother's occupational status		
Working mother	4	6
Non-working mother	16	14
Mother's education status		
Elementary school	1	1
Junior high school	6	3
Senior high school	9	13
Higher education/equivalent	4	3
Breastfeeding		
Exclusive breastfeeding	13	16
Non-exclusive breastfeeding	7	4
Pre-intervention diarrhea occurrence		
Occur	11	9
Does not occur	9	11
Post-intervention diarrhea occurrence		
Occur	0	2
Does not occur	20	18

**Table 2 Analysis of Difference in Body Weight, Protein Input, Vitamin A Input, and Zinc Input**

Difference	Groups		p Value*
	Eel Cookies (n=20)	Controlled Cookies (n=20)	
Body weight			
Before	23.45	17.55	0.114
After	24.60	16.40	0.024
Protein input			
Before	21.78	19.23	0.489
After	23.68	17.33	0.086
Vitamin A input			
Before	17.28	23.83	0.072
After	23.83	17.18	0.072
Zinc input			
Before	21.50	19.25	0.579
After	23.25	17.75	0.126

Note: \*Mann-Whitney test

of diarrhea can result in a poorer ability to apply diarrhea information in daily life. Good maternal knowledge about diarrhea is expected to further improve the ability of mothers in handling and preventing diarrhea.<sup>12</sup>

The result of the analysis showed that there were no differences in the characteristics of the child's body weight before cookies provision (p value=0.114). After an intervention, a significant difference was seen between the bodyweight of toddlers in the intervention group and the control group (p value=0.024).

Bodyweight is the most important and most commonly used anthropometric measure in newborns (neonates). During infancy, weight can be used to observe the physical growth rate and nutritional status. Bodyweight is chosen because it has the best parameters and it is easy to use, easy to understand, and provides an overview of the current nutritional status. Bodyweight is one of the parameters for determining one's

nutritional status. Several studies suggested that nutritional status has a significant risk factor in causing diarrhea in infants and toddlers. A low nutritional status in infants and toddlers is an important risk factor that can lead to diarrhea, especially in children aged 0–24 months.

The result of the analysis of the characteristics of protein input in children before the intervention showed that no difference was seen between the intervention group and the control group (p=0.489). After the intervention, this situation did not change (p=0.086).

The main function of protein for the body is to form new tissues and maintain the existing tissues. Protein can also function as a type of fuel if the body's energy needs are not met by carbohydrates and fats. Protein can regulate the balance of fluids in tissues and blood vessels by causing a colloidal osmotic pressure that can draw fluid from the tissues into the blood vessels. Another function of the protein relates to child

**Table 3 Analysis of Effect of Eel Cookies to the Reduction of Diarrhea Incidence**

Diarrhea Occurrence Before and After	n=40	Mean Rank (Min–Max)	p Value*
Negative rank	0	0	0.000
Positive rank	18	9.50	
Equal	22		

Note: \*Wilcoxon test

growth and the development of child hormones, enzymes, and antibodies. The body's ability to fight infection depends on its ability to produce antibodies against organisms that can cause infections or to foreign substances that enter the body. The body also has the ability to detoxify toxins, which is controlled by enzymes, especially those found in the liver. In a state of protein deficiency, the body's ability to inhibit the toxic effects of toxic substances may decrease.<sup>13</sup>

There was no difference seen in the characteristics of vitamin A input between the intervention group and the control group ( $p=0.072$ ), which did not change after the intervention ( $p$  value= $0.072$ ).

Vitamins are essential substances that are needed to help nutrient absorption and metabolism processes. A vitamin deficiency will cause health problems. Therefore, a certain amount of daily vitamin inputs need to be obtained, ideally from food. Other than its effect on eye health, vitamin A also acts as an anti-infection agent. The body's immune system function is reduced in vitamin A deficiency, making it susceptible to infectious diseases. If this occurs on the surface of the intestinal wall, diarrhea will occur. Children under five are susceptible to vitamin A deficiency.<sup>14</sup>

Analysis of zinc input before intervention showed no difference between the intervention group and the control group ( $p$  value= $0.0579$ ). This stayed the same after the intervention ( $p$  value= $0.128$ ).

Zinc plays a role in immunity cells, namely in the function of the T cells and in the formation of antibodies by the B cells. Zinc also plays a role in several reactions that zinc deficiency will affect a lot of body tissues, especially during growth, and the body's immunity, especially against infectious diseases such as diarrhea. Zinc affects both the gastrointestinal system and, indirectly, the immune system. Zinc also plays a role in maintaining the integrity of the intestinal mucus through its function in cell regeneration and cell membrane stability. Zinc deficiency damages the epidermis and gastrointestinal mucus, facilitating an invasion of germs in the gastrointestinal tract.<sup>14</sup>

The average inputs of protein, vitamin A, and zinc before and after the intervention were not significantly different between the intervention and the control groups. Toddlers aged 1–3 years are passive consumers, so the input of food

consumed is still very dependent on what is provided by the mother or parents. The pattern of food consumption in children under five is also still strongly influenced by the pattern of food consumption of parents or families.

The statistical analysis of the effect of providing eel cookies to the incidence of diarrhea showed that eel cookies consumption reduced the incidence of diarrhea ( $p=0.000$ ). No diarrhea incident happened during the study and 18 toddlers with a history of diarrhea became better after consuming the cookies, which was apparent from the lack of diarrhea incidence. The 20 toddlers without a history of diarrhea still maintain the absence of diarrhea incidence after consuming the cookies.

Diarrhea prevention is important because diarrhea can cause death and deficiencies in infants and children. Efforts to reduce the incidence of diarrhea in children require the right intervention so infants and children become healthy and infectious diseases that may cause diarrhea can be prevented. The proven interventions to prevent the occurrence of diarrhea include improving child nutrition through the promotion of exclusive breastfeeding and complementary foods, provision of clean and safe drinking water, hygienic and healthy living behavior supported by the community and families, good sanitation and child immunization, and vitamin A and zinc supplements.

Findings in this study are in line with Asfianti et al.<sup>15</sup> that suggested vitamin A and zinc supplement provision to children aged 12–60 months can reduce the incidence of diarrhea. The incidence of diarrhea has decreased from 28.40% to 26.1% after vitamin A and zinc supplements are provided. Adequate nutrients, especially vitamins and minerals, are important to maintain an optimum immune system. Because most vitamins and minerals cannot be synthesized by the body, the consumption of diverse and balanced foods is very important especially food that becomes the source of vitamins and minerals such as fruits, vegetables, and animal-based foods.<sup>16</sup>

A study by Widayani et al.<sup>17</sup> on vitamin A and iron-containing biscuits to children under five showed significantly higher hemoglobin, ferritin, retinol, and total G immunoglobulin levels at the end of the intervention. Another study that involved providing biscuits enriched with albumin protein of cork fish in children aged 4–5 years showed an increase in energy, protein, zinc, and Fe levels.<sup>18</sup>

Providing eel cookies with formulated nutrients that include protein, vitamin A, and zinc is an effort to prevent infectious diseases, especially diarrhea. Eel cookies are a type of functional food that is enriched with eel head flour.

### Conclusion

In summary, eel cookies provision affects the reduction of diarrhea incidence in children aged 12–24 months. Therefore, eel cookies can be used as a functional food to improve children's immune systems as an effort to prevent infectious diseases, especially diarrhea.

### Conflict of Interest

The authors declare no conflict of interest.

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