Tempeh and Carrots in A Brownies: Their Effects on Nutritional Status of Undernourished Students

Tempe dan Wortel dalam Brownies: Efek Terhadap Status Gizi pada Siswa Gizi Kurang

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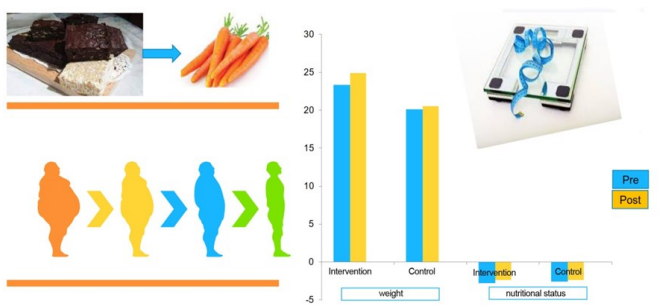
ABSTRACT

The role of nutrition is certainly needed to fulfill the growth process in school-age children because they are still in the growth phase. Whilst optimal growth and development depend on the provision of nutrients, both in terms of quality and quantity, that are considerably right. This study aimed to determine the effects of giving carrots and tempeh as the ingredients of brownies on the nutritional status of undernourished students at elementary school, Gowa Regency. This research was conducted through a quasi-experimental study with a non-randomized control group pretest-posttest design. The number of samples was as many as 24 people, with a sampling technique using purposive sampling. The method of analysis was a paired t-test. The results of this study indicated that there was an effect on nutritional status in the case group (p=0.001) and the control group (0.030,) and there was an effect on body weight in the case group (p=0.001) and the control group (p=0.028). However, providing tempeh brownies as a substitute for carrots and tempeh, brownies had not been able to change the nutritional status of undernourished students for 30 days which was indicated by the average z-score, which was still at <-2 SD. Further research is needed to be developed to determine the duration and efficient frequency of providing intervention in order to get optimal results. This study is expected to provide a new effort in presenting a combination of nutritious foods in an effort to overcome nutritional disorders among children.

ABSTRAK

Peranan gizi sangat dibutuhkan untuk memenuhi proses tumbuh kembang pada anak usia sekolah karena masih berada pada fase pertumbuhan. Sedangkan pertumbuhan dan perkembangan yang optimal tergantung pada pemberian zat gizi. Penelitian ini bertujuan untuk mengetahui pengaruh pemberian brownies tempe substitusi wortel terhadap status gizi siswa gizi kurang pada SD di Kabupaten Gowa. Penelitian ini merupakan penelitian studi eksperimen semu dengan rancangan *non-randomized control group pretest posttest design*. Jumlah sampel sebanyak 24 orang dengan teknik pengambilan sampel menggunakan purposive sampling. Metode analisis menggunakan paired t-test. Hasil penelitian ini menunjukkan bahwa ada pengaruh status gizi pada kelompok kasus (p=0.001) dan kelompok kontrol (0.030) dan ada pengaruh berat badan pada kelompok kasus (p=0.001) dan kelompok kontrol (p=0.028). Namun, pemberian brownies tempe substitusi wortel dan brownies tempe belum mampu mengubah status gizi siswa gizi kurang selama 30 hari yang ditandai dengan rata-rata nilai z-score yang masih berada pada angka <-2 SD. Penelitian perlu dikembangkan untuk mengetahui durasi dan frekuensi yang efisien untuk pemberian intervensi guna mendapatkan hasil yang optimal, sehingga studi ini dapat memberikan upaya baru dalam menghadirkan jenis kombinasi makanan yang bergizi dalam upaya mengatasi gangguan nutrisi pada anak.

GRAPHICAL ABSTRACT



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INTRODUCTION

The nutritions undeniably play an important role in fulfilling the growth and development stage of school-aged children as they are still in the growth phase of life (Savarino et al., 2021). The growth and development of youngsters while they are still in school determine their future quality of life. Proper nutrition, both in terms of quality and quantity, is necessary for healthy growth and development. Malnutrition in terms of carbohydrates (energy substances) and protein (building substances) is a sign of malnutrition in school-aged children who have a lean body condition or are underweight for their age (Singh et al., 2017).

According to the World Health Organization (2015), the number of children suffering from thinness is approximately 95.2 million, with a frequency of 14.3%. According to the results of the 2013 Riskesdas, the prevalence of undernourished or underweight children aged 5 to 12 years is 11.2 percent countrywide (according to BMI/U), with 4.0 percent for very thin and 7.2 percent for thin children (Kementerian Kesehatan RI, 2013). The nutritional status of children aged 5–12 years in South Sulawesi based on the BMI/U Index decreased in comparison to the results of the PSG in 2016, with a thin prevalence of 9.4 percent to 7.1 percent and a very thin prevalence of 2% to 1.7 percent, according to the results of the Nutritional Status Monitoring (PSG) 2017. (Kementerian Kesehatan RI, 2018).

Malnourished children are more susceptible to infectious diseases due to such weakened immune systems. They physically appear thin and short as a result of a lack of appropriate growth and development (Farhadi & Ovchinnikov, 2018). Furthermore, their brain development is not ideal, which might lead to a reduction in children's IQ (Li et al., 2016). This effect will last until teenagers and adults achieve lower levels of achievement and productivity, leaving older people hungry and diseased. This situation will have an impact on the low quality of human resources (Norman et al., 2021).

Food diversification efforts are very significant in exploring the potential of local food in each area. Tempeh and carrots are two common Indonesian foods. Tempeh has the potential to combat free radicals, which can slow the aging process and prevent diseases including atherosclerosis, coronary heart disease, diabetes, cancer, and others. Furthermore, the antimicrobial compounds in tempeh aid in the prevention of diarrhea, the reduction of blood cholesterol, and the prevention of heart disease, hypertension, and other ailments (Miranti et al., 2021; Permatasari et al., 2021; Stodolak et al., 2020). Carrots are low-cost, high-nutrient plants with numerous health benefits. Regarding pro-vitamin A, specifically, beta-carotene has a high content. It can be used to reduce and prevent micronutrient deficiencies, such as Vitamin A deficiency (Bystrická et al., 2015; Ibeanu et al., 2020). To get the most out of the vitamin A in carrots, they can be turned into food additives for brownie cakes.

Several studies have been previously conducted on the significant impact of tempeh on nutritional status (Fatmah, 2013; Faidah et al., 2019; Suriani et al., 2021).

Similarly, carrots can be used to enhance the nutritional value of cuisine (Cotwright et al., 2017; Elhadidy et al., 2020; Saputri et al., 2021). However, research on nutritional status interventions in children with nutritional difficulties by delivering tempeh brownies swapped with carrots has not been done extensively, according to the researcher's consensus. This experimental study aimed to see how giving undernourished kids Brownie Tempeh with carrot replacement affected their nutritional status. Tempeh and carrots, as fundamental brownie ingredients, could give the required nutrients and be readily available and accessible to all people.

METHODS

This study applied a quantitative field study using a quasi-experimental design. The experiment was carried out on schoolchildren with poor nutritional status using a non-randomized control group pretest and posttest design. This study took place between July 17 and August 15, 2019, at State elementary school (hereafter SDN) Samata and elementary school (hereafter SD) Inpres Bakung, Samata Village, Gowa Regency.

All elementary school pupils in grades 4-6, aged 10-12 years, at both SD Inpres Bakung 105 students and SDN Samata 239 were included in this study. School students aged 10-12 years had to meet inclusion criteria such as being malnourished with a BMI of -3 SD to -2 SD, not having major infectious disorders such as Typhoid, DHF, diarrhea, or ARI, being willing to be respondents, and not having moved. There were 24 pupils who met the inclusion and exclusion criteria in this study, with 12 students split into SD Inpres Bakung and SDN Samata. The samples of 24 students were divided into two groups: 12 students in the case group and 12 others in the control group, with the case group receiving carrot-substituted tempeh brownies and the control group receiving tempeh brownies.

The parents or guardians of the students, who were respondents, were given a consent sheet and an explanation of the intervention program (informed consent) prior to the intervention. Deworming was not administered in this study because all students at SDN Samata and SD Inpres Bakung, particularly those who were research participants, received deworming medications every six months from local health organizations. The information gathered included sample identity, anthropometric measures before and after the intervention, and the results of a two-day meal recall questionnaire to get a picture of food intake before and after the intervention. In this study, all aspects of validity, such as measuring instruments, measurement procedures, and measurements, were valid or in accordance with operational requirements, allowing all elements to perform as intended. The researchers could maintain the concentration level of a measuring instrument by repeating weighing and measuring three times. So that the information gathered is more accurate and trustworthy. The researchers used WHO Antroplus software, Nutrysurvey 2007, Microsoft Excel, and SPSS version 25 to handle and analyze da-

Table 1
Frequency Distribution of Undernourished Students

Characteristics of Respondents	Case Group		Control Group	
	n	%	n	%
Sex				
Male	8	80.00	7	58.30
Female	2	20.00	5	41.70
Class Level				
Class 4	0	0.00	7	58.30
Class 5	2	20.00	4	33.30
Class 6	8	80.00	1	8.30
Age				
10 years	4	40.00	10	83.30
11 years	6	60.00	2	16.70
Father Job				
Labor	1	10.00	8	66.70
Civil Servant	1	10.00	0	0.00
Self-employed	8	0.00	1	8.30
Farmer	0	0.00	3	25.00
Mother Job				
Housewife	7	70.00	11	91.70
Trader	3	30.00	1	8.30
Total Product Consumption				
Comsumed	4069.5	62.60	3415.4	52.50
Overmeasure	2.430.5	37.40	3.084.6	47.50
Average Product Consumption				
Comsumed	206.7	82.70	134.7	53.90
Overmeasure	43.3	17.30	115.3	46.10

ta. The nutritional status of the sample was determined by inputting sample data in the form of date, month, and year of birth, weight, and height into the WHO Antroplus software. By entering the recall findings into Nutrysurvey 2007, the food consumption was analyzed. All sample data were entered into Microsoft Excel (master table). While SPSS was used to examine statistics using paired T-Tests and Independent T-Tests, it was also used to create graphs.

RESULTS

Table 1 reveals that there were eight male respondents (80.0 percent) and two female respondents in the case group, with a total of 10 respondents. There were seven male respondents (58.3%) and five female respondents in the control group, which had a total of 12 respondents (41.7 percent). In the case group, there were ten respondents in each class; the most respondents were in class 6, with eight people (80.0 percent), and there were no respondents in class 4 (0.00 percent). While there were as many as 12 persons in the control group, the most respondents were in class 4, with seven people (58.3%), and the least responders were in class 6, with one person (8.3 percent).

From the ten respondents in the case group, four persons aged ten years (40.0 percent) and six people aged 11 years (40.0 percent) fell within the age category of respondents (60.0 percent). Meanwhile, 10 of the 12 responders in the control group were ten years old (83.3 percent), and two were 11 years old (16.7 percent). In the case group, the respondent's father operated as an

Table 2
Respondents' Weight and Nutritional Status Before and After The Intervention

Average Intake	Case Group	Control Group	Independent T-test
Before Intervention			
Weight (kg)	23.29	20.11	0.000
Nutritional status (SD)	-2.27	-2.57	0.279
After Intervention			
Weight (kg)	24.09	20.53	0.000
Nutritional status (SD)	-2.38	-2.33	0.78

entrepreneur with a total of 8 persons (80.0 percent), one worker (10.0 percent), and one civil servant (10.0 percent). While most of the mothers of the respondents worked as housewives (70.0 percent) and three persons (30.0 percent) worked as dealers, The fathers of the respondents in the control group generally worked as laborers, with a total of 8 people (66.7 percent), three farmers (25.0 percent), and one entrepreneur (8.3%). The mothers of the respondents were predominantly housewives, with 11 (91.7%) of them being homemakers and 1 (8.3%) being a trader. The number of respondents who consumed products in the case group during the 30 intervention days was 4069.5 (62.6%), while the number who did not consume products was 2,430.5 (37.4 percent). Meanwhile, the overall consumption of items in the control group was 3415.4 (52.5%), with 3,084.6 remaining unconsumed (47.5 percent). During the 30 intervention days, the average product consumption in the case group was 206.7 (82.7%), with 43.3 (17.3%) not consumed. The control group consumed 134.7 (53.9%) and 115.3 percent of the product, respectively (46.1 percent).

The conclusion was that statistically, there was no change in the mean nutritional status between the case group and the control group before the intervention," based on table 2, which shows the nutritional status variable with a p-value > 0.05. Meanwhile, the conclusion for the weight variable (P-value 0.05) was that statistically, there was a difference in the mean weight between the case and control groups before the intervention. Statistically, there was no difference in the average nutritional status between the case group and the control group after the intervention, the conclusion stated in the nutritional status variable (p-value > 0.05). Meanwhile, the conclusion for the weight variable (P-value 0.05) was that statistically, there was a difference in average body weight between the case and control groups following the intervention.

According to table 3, there was an effect of giving tempeh brownies with carrot substitution in the case group and tempeh brownies in the control group on the body weight of undernourished students, with a p-value of 0.001 (smaller than the alpha value (0.05) in the group, according to the results of the paired t-test statistic. Group A and group B The p-value achieved was 0.028, which was less than the alpha value (0.05). With the results of the paired t-test statistic, p-value = 0.001, which was smaller than the alpha value (0.05) in the case group and control group.

Table 3
Proporsi Jawaban terhadap Pertanyaan Tentang Pengetahuan Diabetes

Intake	Intake Mean		Mean (Different)	Paired t-test
	Before	After		
Weight				
Case Group	23.29	24.09	0.8	0.001
Control Group	20.1	20.53	0.42	0.028
Nutritional Status				
Case Group	-2.78	-2.38	-0.4	0.001
Control Group	-2.57	-2.33	-0.24	0.03

There was an effect of giving tempeh brownies with carrot substitution in the case group and tempeh brownies in the control group on the nutritional status of undernourished students. The p-value achieved was 0.030, which was less than the alpha value (0.05).

DISCUSSION

Males dominated the respondents in this survey, with 15 men and seven women, divided into multiple classes, including classes IV, V, and VI, with an age range of 10 years, with 14 people and 11 years old, with eight people.

There were 18 mothers who did not work or work as housewives among the respondents, and four mothers working as traders among the others. While the respondents' fathers were largely business people and workers, each time employed nine people, the other three were farmers, and one was a civil servant. The intervention research with Supplementary Feeding (PMT) of brownies with tempeh substituted with carrots utilized a 1:1 formula, namely 50 grams of tempeh and 50 grams of carrots, which provided additional energy of 264.59 kcal and protein of 7.88 grams in undernourished school children.

Carbohydrates, proteins, and lipids can all be found in foods that provide energy. The body obtains energy through burning carbs, proteins, and lipids. Therefore sufficient food substances are required to supply the body's energy requirements. Metabolism, growth, temperature regulation, and physical activity are only a few of the roles of energy as an energy substance. The nutritional status will result from an energy imbalance. Weight, height, age, and gender are all aspects that influence a person's energy requirements. There is a variation in intake by sex among school-aged children aged 10-12 years, with boys consuming 2100 kcal/day and girls consuming 2000 kcal/day.

Energy use increased in both intervention groups. Even though energy intake increased in both the case and control groups, it was still less than the energy demand as determined by the Nutritional Adequacy Ratio. This is owing to children's excessive snack eating, which has resulted in a lower daily staple and product intake.

This is in keeping with opinion of Hess & Slavin (2014), which indicates that due to the lack of nutrition in street food, it cannot be used to replace breakfast or lunch. Because of the dense calories that enter their bodies, children who eat many snack items will feel full on their tummies.

Protein, vitamins, and minerals, for example, are still in short supply (Branscum & Sharma, 2014).

Protein is a source of amino acids that fat and carbs do not own. Protein can provide up to 4 kcal or gram of energy, although it is used to replace damaged bodily tissues and cells, not as an energy source. Protein serves as a source of energy, building blocks, and regulators in the body.

Nutritional status is influenced by adequate protein intake. A shortage of protein in the body causes disruptions in the absorption and movement of nutrients. Protein insufficiency causes inadequate growth, weakens the immune system, reduces mental capacity, and makes people less productive (Herring et al., 2018; Rytter et al., 2014).

The protein adequacy rate (AKP) for boys and girls in elementary school is 56 grams per day for boys and 60 grams per day for girls. Protein intake has increased as the quality and quantity of protein have improved. In terms of quality, the intervention boosted the consumption of vegetable protein as a snack daily for 30 days.

Body weight is one of the most popular ways to monitor nutritional status. Body weight is a weight measurement taken in a minimally clad state without the use of any equipment. Body weight is measured on a scale and stated in kilos. Body weight grows with age in normal circumstances, where a person's health and the balance between consumption and the body's nutritional demands are guaranteed. Weight gain in atypical circumstances can be faster or slower than in normal circumstances. Body weight is one of the indicators used to determine nutritional health that is extremely vulnerable to rapid changes, such as those caused by viral diseases or decreased food intake. Body weight monitoring is essential as a preventive measure to evaluate the rate of weight loss or undesired weight increase so that treatments can be implemented as soon as possible (Thomas et al., 2014). This finding is corroborated by research of Paramashanti & Sulistyawati's (2019), which found that PMT interventions, despite their small size, can have a positive impact on children's weight gain in many types of studies.

Men outnumbered women in this survey, with 15 men and seven women responding. Respondents were split throughout multiple classes, including classes IV, V, and VI, with an age range of 10 years old, with 14 individuals responding, and 11 years old, with eight people responding.

There were 18 mothers who did not work or work as housewives among the respondents, and four mothers working as traders among the others. While the respondents' fathers were largely business people and workers, each of whom employed nine people, the other three were farmers, and one was a civil servant. The intervention research with supplementary feeding (PMT) of brownies with tempeh substituted with carrots utilized a 1:1 formula, namely 50 grams of tempeh and 50 grams of carrots, which provided additional energy of 264.59 kcal and protein of 7.88 grams in undernourished school children.

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gy. The body obtains energy through burning carbs, proteins, and lipids. Therefore, sufficient food substances are required to supply the body's energy requirements. Metabolism, growth, temperature regulation, and physical activity are only a few of the roles of energy as an energy substance. The nutritional status will result from an energy imbalance.

Weight, height, age, and gender are all aspects that considerably influence a person's energy requirements. There was such a variation in intake by sex among school-aged children aged 10–12 years, with boys consuming 2100 kcal/day and girls consuming 2000 kcal/day.

Energy use increased in both intervention groups. Even though energy intake increased in both the case and control groups, it was still less than the energy demand as determined by the Nutritional Adequacy Ratio. This is because kids eat too many snacks, which has made them eat less of their daily staples and products.

This is in line with a study by Hess & Slavin (2014), which indicates that due to the lack of nutrition in street food, it cannot be used to replace breakfast or lunch. Because of the dense calories that enter their bodies, children who eat many snack items will feel full in their tummies. Protein, vitamins, and minerals, for example, are still in short supply (Branscum & Sharma, 2014).

Protein contains amino acids that fat and carbohydrates do not, protein has up to 4 kcal/gram of energy, but it is used to replace damaged bodily tissues and cells rather than as an energy source. Protein serves as a source of energy, building blocks, and regulators in the body. Nutritional status is influenced by adequate protein intake. A shortage of protein in the body causes disruptions in the absorption and movement of nutrients. Protein insufficiency causes inadequate growth, weakens the immune system, reduces mental capacity, and makes people less productive (Rytter et al., 2014; Herring et al., 2018).

The protein adequacy rate (AKP) for boys and girls in elementary school is 56 grams per day for boys and 60 grams per day for girls. Protein intake has increased as the quality and quantity of protein have improved. In terms of quality, the intervention made people more likely to eat a snack with vegetable protein every day for 30 days.

Body weight is one of the most popular ways to monitor nutritional status. Body weight is a weight measurement taken in a minimally clad state without the use of any equipment. Body weight is measured on a scale and stated in kilos. Body weight grows with age in normal circumstances where a person's health and the balance between consumption and the body's nutritional demands are guaranteed. Weight gain in atypical circumstances can be faster or slower than in normal circumstances. Body weight is one of the indicators used to determine nutritional health that is extremely vulnerable to rapid changes, such as those caused by viral diseases or decreased food intake. Body weight monitoring is essential as a preventive measure to evaluate the rate of weight loss or undesired weight gain so that treatments can be implemented as soon as possible (Thomas et al., 2014). This finding is corroborated by research of Para-

mashanti & Sulistyawati (2019), which found that PMT interventions, despite their small size, can have a positive impact on children's weight gain in many types of studies.

CONCLUSIONS

This study revealed that there was an effect of giving carrot-substituted tempeh brownies on changes in body weight and nutritional status (BMI/U) among undernourished students before and after giving carrot-substituted tempeh brownies. Before and after carrot-substitute tempeh brownies were given to malnourished students, this study represented a fresh approach to presenting the type of nutritious food combination that can help children overcome nutritional disorders. The researchers' inability to control other factors affected children's nutritional status, as well as the fact that they did not evaluate physical activity during the trial, which could affect the nutritional content of the respondent's body.

As the provision of carrot-substituted tempeh brownies has been shown to improve the nutritional status of elementary school children, it is necessary to inform parents about these processed products made from tempeh and carrots to reduce cases of malnutrition at the family level. In addition, there is certainly the need for more research on the duration of the substituted tempeh brownies intervention carrots for optimal results. It is intended that the school will activate the School Health Unit (UKS) operations under the supervision of local health institutions so that nutritional status assessments and nutrition counseling can be done on a regular basis to prevent malnutrition in kids. More research on the duration of the brownie intervention is thus needed. Likewise, tempeh can be used for carrots to achieve better outcomes.

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2

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