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Impact of *Channa striata* and *Zea mays* Cookies Supplementation on Anthropometric Measures in School-Aged Children

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ABSTRACT

Nutritional deficiencies, particularly in protein and energy, are major contributors to stunting and underweight in school-age children, adversely affecting physical, cognitive, and overall health. This study examined the impact of cookies formulated with cork fish (*Channa striata*) and corn (*Zea mays*) flour as a local food innovation to enhance children's nutritional status. This study employed a quasi-experimental design with a nonequivalent control group, involving 74 children aged 7-12 from SDN 72 and SDN 75 Palembang. The control and experimental groups were not randomly selected. The control group received standard biscuits (50 g/day for 14 days), while the intervention group received biscuits formulated with cork fish and corn flour (50 g/day for 14 days). This study was conducted from April to June 2024. The results showed that the intervention positively impacted children's nutritional status. Significant differences were observed in WAZ (p=0.000) and HAZ (p=0.024) between the control and intervention groups. However, no significant differences were found in weight (p=0.030), height (p=0.480), or WHZ (p=0.064). However, the direct effects on weight and height gain were limited due to the short intervention period. Further research with a longer duration is recommended to assess the intervention's long-term impact on children's physical growth.

1. INTRODUCTION

School-aged children are a vulnerable group that needs specific attention regarding their nutritional requirements. This developmental stage is crucial for supporting both cognitive and physical development. Underweight and stunting are still major public health issues in Indonesia due to dietary deficiencies [1-3]. Indonesia classifies the incidence of underweight as moderate and the prevalence of stunting as high [3].

Stunting and underweight are caused by inadequate intake of nutrients, both in terms of quality and quantity, such as energy, protein, and other essential micronutrients. Challenges such as food safety concerns, limited dietary diversity, inadequate consumption of animal protein, and high levels of antinutrients in food impede adequate nutrition intake among school-aged children [4-7]. This poses risks to children's physical health, cognitive abilities, and future productivity and increases the likelihood of chronic diseases in adulthood [8, 9]. Furthermore, these problems can hamper economic growth and exacerbate poverty in a country [10]. Therefore, addressing nutrition problems in school-age children requires effective and sustainable interventions.

Various strategies have been implemented to address these issues, including the School Children's Supplementary Feeding Program (PMT-AS). This program aims to enhance children's nutritional intake by utilizing locally available, affordable, and nutrient-rich food sources [11, 12]. Consistent supplementary feeding has effectively enhanced children's nutritional status, cognitive function, school attendance, learning capacity, and academic performance. Furthermore, this intervention has been associated with a reduction in school dropout rates [13-16]. Among potential supplementary foods, cookies are promising due to their appealing, crunchy, and dense texture, which children highly favor. Additionally, cookies are moderately satiating, making them an ideal snack to complement main meals without disrupting their consumption [17].

This study developed cookies based on cork fishmeal and cornmeal as an innovative supplementary food for school-aged children. The formulation is enriched with protein, carbohydrates, and essential micronutrients necessary to support children’s growth. Cork fish (*Channa striata*) serves as a high-quality source of animal protein, providing albumin, complete essential amino acids, and high digestibility, which are crucial for muscle growth and brain development, improving memory and concentration. Meanwhile, corn (*Zea mays*) offers a source of complex carbohydrates and plant-based protein, containing essential amino acids such as methionine and lysine as well as fiber that helps maintain digestive health and the stability of children's blood sugar levels [18, 19]. With a combination of savory and sweet flavors, these cookies offer a healthy snack alternative that is attractive, nutritious, and convenient for school consumption. These products are also easy to consume without requiring a long time, making them a better choice compared to processed snacks that generally contain excess sugar and preservatives. Thus, these cookies can provide essential nutrients for children's daily activities and growth.

Previous research has demonstrated that supplementation with animal protein, such as cork fish, can significantly enhance the body weight and height of school-aged children [20, 21]. With its abundant fishery resources, Palembang City provides an ideal setting for developing this supplementary food. However, the utilization of cork fish as a dietary component, particularly for children, remains relatively low. Furthermore, there hasn't been extensive research on the effectiveness of combining cork fish and corn in cookies to enhance the nutritional status of school-aged children.

This study assesses the impact of cookies formulated with cork fish and cornmeal on improving body weight and height in school-aged children. The research seeks to develop practical, innovative, and sustainable nutritional interventions to address the issues of stunting and underweight, particularly in regions with a high prevalence of stunting, such as Indonesia.

2. MATERIAL AND METHODS

2.1 Study design

This study employed a quasi-experimental design [22] *with a pre-post intervention approach* [23]. The research location was selected based on the high prevalence of stunting, focusing on Seberang Ulu 1 District, Palembang City. This area is characterized by slums and underdeveloped environments, where the majority of residents rely on the Musi River for daily needs, including bathing, washing, and drinking water consumption [24]. Two elementary schools that met the study criteria, SDN 072 and SDN 075, were chosen as intervention sites. Field data collection was conducted from April to June 2024, and the intervention consisted of providing cookies for 14 days.

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, Sriwijaya University, under Approval Number 059/UN9.FKM/TU.KKE/2024, dated February 7, 2024. All human participant procedures were conducted according to the ethical guidelines established by the institutional ethics committee and the principles outlined in the Declaration of Helsinki. The confidentiality of data collected from each participant was strictly maintained. Children identified as stunted or underweight were reported to their respective schools to facilitate appropriate interventions and follow-up measures.

2.2 Population, sample size, and recruitment

The study population comprised boys and girls aged 7-12 years enrolled in grades one through six in the Seberang Ulu 1 sub-district, Palembang City. Inclusion criteria encompassed children who were stunted (height-for-age z-score between ≥-3 and <-2) and underweight or severely underweight (weight-for-age z-score ≥-3 and <-2). Exclusion criteria included children with evident physical disabilities (e.g., kyphosis or scoliosis), deformities preventing upright standing, severe illnesses, or medical conditions that could impair appetite.

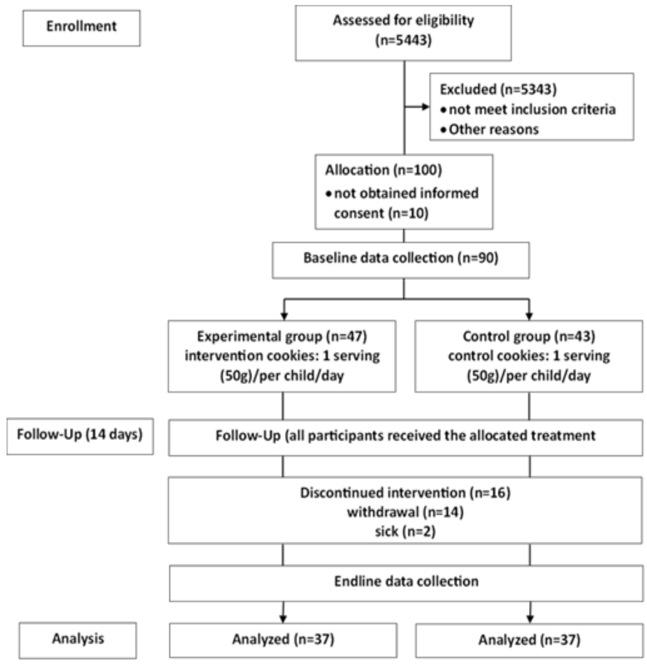

Figure 1. Consort flow diagram

The sample size was determined using the hypothesis test formula for two population means (two-sided test) with the results of a minimum sample of 36. To anticipate the occurrence of fallen samples, the sample size was enlarged with an estimated failure rate of 30% to increase higher statistical power so that the sample size was increased to 50 samples for each group.

Children whose parents or guardians provided informed consent were enrolled in the study. The researcher selected the sample using a purposive sampling technique based on the nutritional status of school-aged children classified as stunted and/or underweight. Blinding was maintained, as neither the enumerators, the schools/teachers, nor the children were aware of the group assignments (intervention or control). Trained enumerators conducted the screening process, which included anthropometric measurements of body weight and height. A physical examination was also performed to assess the health status of participants. This process continued until the required sample size was achieved.

A total of 5,443 children were screened for eligibility to participate in a cookie intervention targeting children aged 7–12 years who met the criteria for stunting or underweight (Figure 1). From this population, 100 children were selected based on the inclusion criteria, and 90 of them provided informed consent signed by their parents or guardians. These participants were subsequently divided into two groups: a control group consisting of 43 children and an intervention group comprising 47 children.

The measurement process was conducted systematically. Anthropometric assessments, including weight and height measurements, were performed at baseline (before the intervention) and at endline (following the intervention) to assess changes in nutritional status. Participants in both the intervention and control groups received cookies in a controlled manner daily for 14 days. Supplementary feeding based on local food for 14 days is believed to be effective in increasing the weight of children in vulnerable groups. Daily interventions may yield better results than weekly interventions, with higher rates of weight gain [25-27]. After the intervention period, the drop-out rate was documented, resulting in 37 children in each group who met the criteria for inclusion in the final analysis.

2.3 Intervention

This study aimed to evaluate the impact of providing supplementary food in the form of cookies made from cork fishmeal and cornmeal to school-aged children (7-12 years) with short and very short nutritional status. The participants were divided into two groups: the intervention group received cookies enriched with cork fishmeal and cornmeal (50 grams per child per day), while the control group received standard cookies without the added cork fishmeal and cornmeal (50 grams per child per day). The intervention was implemented over 14 consecutive days. Cookies were distributed daily to the children by research assistants (n=4) and consumed during recess under the supervision of class teachers. Cookie consumption was recorded daily by trained enumerators to ensure consumption compliance. On Sundays, cookies were distributed the previous day to be consumed at home under parental supervision.

The intervention cookies were prepared with the addition of cork fishmeal and cornmeal, while the standard cookies were made without these ingredients. Both types of cookies were developed based on previous experiments, which included acceptance tests [28]. The intervention and standard cookies were made with uniform shape, weight, and packaging, but they differed in color. The intervention cookies were brownish, whereas the standard cookies were golden yellow. Each 50 g serving of intervention cookies contains 244.4 kcal, 7.7 g of protein, 12.6 g of fat, and 25.3 g of carbohydrates. In comparison, the standard cookies contain 246.9 kcal, 3.6 g of protein, 12.4 g of fat, and 30.8 g of carbohydrates.

2.4 Data collection methods and measurement

Research data were collected through interviews with children and their mothers or caregivers using questionnaires, as well as anthropometric measurements conducted by trained enumerators (n=10), comprising alumni and students from the Nutrition Study Program at the Faculty of Public Health, Sriwijaya University. The measurement process also involved two laboratory analysts and was supervised by the principal investigator. Before data collection, the principal investigator and enumerators underwent initial training to align their understanding and ensure consistency in the procedures for measuring children's weight and height. Interviews and measurements were carried out at the schools during the data collection period. The parents of the children were provided with a detailed explanation of the study, and written consent was obtained through the informed consent process before data collection commenced.

Anthropometric measurements

Enumerators measured height and weight at two points in time: before and after the intervention. A 2-meter stature meter or microtome (Seca 213), fixed on a level area of the classroom wall, was used to measure the height (in centimeters) with an accuracy of 0.1 cm. Children were told to stand erect, barefoot, and to touch the wall with their head, shoulders, buttocks, calves, and heels. To guarantee good posture, the head position was changed such that the sight was in line with the Frankfurt line. The precision of the height measurements was 0.1 cm [29]. Body weight (in kg) was measured using a Seca digital scale (Model 770) with an accuracy of 0.1 kg, placed on a flat floor. Children stood upright, barefoot, without shoes, sandals, or socks, and were asked to remove heavy clothing or accessories such as jackets. Weight measurements were recorded to the nearest 0.1 kg [28]. The weight and height data obtained were analyzed using WHO AnthroPlus 2007 software to calculate z-scores (HAZ and WAZ).

Cookies consumption compliance

Children's compliance with consuming the cookies was recorded by the enumerators with the assistance of the homeroom teacher through the completion of a checklist. The level of compliance was calculated by dividing the number of cookies consumed by the children over the 14 days by the total number of cookies that should have been consumed during the same period. Compliance was categorized as "non-compliant" if the compliance percentage was <70% and "compliant" if the percentage was ≥70% [30].

2.5 Data analysis

Statistical software was used to process the data. For age and pocket money variables, descriptive statistics were shown as means (±SD), and for other characteristic factors, as proportions. The Kolmogorov-Smirnov test was used to evaluate the normality of the data. Depending on the data distribution, the Independent T-test or Mann-Whitney Test was used to examine significant differences between the means of the two groups. A Wilcoxon Signed Rank Test or Paired Samples T-test was used to assess mean differences in a variable before and after the intervention. The significance level for all analyses was set at $p < 0.05$.

3. RESULT

3.1 Baseline characteristics

Table 1 presents the baseline characteristics of the study subjects. The results indicate the general characteristics of the children in both groups. A significant difference was observed in the age of the children between the control and intervention groups ($p = 0.000$). However, no significant differences were found in other variables.

The results revealed a significant difference in age distribution between the intervention and control groups, with all children in the intervention group being aged 6-9 years, while the control group included some children aged 10-12 years ($p = 0.000$). The development of school-age children is divided into middle (6-9 years) and late childhood (10-12 years) [31]. Interventions may be more effective in younger age groups (6-9 years old) who are in grades 1-3 of primary school with shorter class hours than children over 9 years old so nutrition improvement interventions such as supplementary school feeding (PMT-AS) are different and also have different nutritional needs [32]. Younger ages are also easier to adopt new habits, so interventions can have more positive results [33].

However, no significant differences were observed between the two groups in terms of gender, pocket money, breakfast habits, snacking habits, or adherence to cookie consumption, as indicated by p-values greater than 0.05. Despite the age difference between the groups, other factors, such as eating habits and adherence to cookie consumption, did not significantly influence the observed differences between the intervention and control groups.

Table 1. Baseline characteristics of the two study groups

Characteristics	Intervention (n=37)	Control (n=37)	Total	*p-value* [x]
Age (years old), n (%)				
6 – 9	37 (100)	31 (83,8)	68 (91,9)	0,000*
10 - 12	0	6 (16,2)	6 (8,1)	
Gender, n (%)				
Male	19 (51,4)	20 (54,1)	39 (52,7)	0,858
Female	18 (48,6)	17 (45,9)	35 (47,3)	
Pocket Money, n (%)				
< Rp 10.000	30 (81,1)	27 (73,0)	57 (77,0)	0,308
Rp 10.000 – Rp 20.000	7 (18,9)	10 (27)	17 (23,0)	
Breakfast Habits, n (%)				
Everyday	23 (62,2)	24 (64,9)	47 (63,5)	1,000
Sometime	13 (35,1)	10 (27)	23 (31,1)	
Never	1 (2,7)	3 (8,1)	4 (5,4)	
Snack Habits, n (%)				
Everyday	19 (51,4)	23 (62,2)	42 (56,7)	0,898
Sometime	18 (48,6)	14 (37,8)	32 (43,3)	
Cookies Consumption Compliance, n (%)				
Non-compliant	1 (2,7)	3 (8,1)	4 (5,4)	1,000
Compliant	36 (97,3)	34 (91,9)	70 (94,6)	

[x] *Chi-Square Test or Fisher's Exact Test*
* *Significance level p ≤ 0.05*

Table 2. The difference in mean nutritional status between intervention and control groups before and after intervention

Variable	Pre-Test		Post-Test	
	Mean ± SD	*p-value* [X]	Mean ± SD	*p-value* [X]
Weight (kg)				
Control (n=37)	20.85 ± 5.16	0.034*	21.09 ± 5.16	0.019*
Intervention (n=37)	18.65 ± 2.20		18.84 ± 2.23	
Height (kg)				
Control (n=37)	121.18 ± 7.13	0.000*	121.52 ± 7.13	0.000*
Intervention (n=37)	113.88 ± 5.08		114.08 ± 5.09	
Weight-for-age Z-score (SD)				
Control (n=37)	-2.56 ± 1.09	0.081	-2.50 ± 1.11	0.092
Intervention (n=37)	-2.18 ± 0.66		-2.14 ± 0.67	
Height-for-age Z-score (SD)				
Control (n=37)	-1.98 ± 0.67	0.057	-1.96 ± 0.65	0.042*
Intervention (n=37)	-2.23 ± 0.48		-2.23 ± 0.49	
Weight-for-height Z-score (SD)				
Control (n=37)	-1.65 ± 1.12	0.001*	-1.60 ± 1.14	0.007*
Intervention (n=37)	-1.02 ± 0.79		-0.96 ± 0.82	

[X] *Independent T-Test or Mann-Whitney Test*
* *Significance level p ≤ 0.05*

3.2 Implementation of the intervention

This study analyzed the differences in the average body weight and height of the control and intervention groups before and after the intervention, as presented in Figure 2.

The results in Table 2 demonstrated statistically significant increases in both body weight and height in the control and intervention groups. In the control group, body weight increased from 20.85 ± 5.16 kg to 21.09 ± 5.16 kg ($p = 0.004$), while in the intervention group, it increased from 18.65 ± 2.20 kg to 18.84 ± 2.23 kg ($p = 0.000$). Similarly, the height of the control group increased from 121.18 ± 7.13 cm to 121.52 ± 7.13 cm (p=0.000), whereas the height of the intervention group increased from 113.88 ± 5.08 cm to 114.08 ± 5.09 cm (p=0.000).

However, based on Figure 2, the intervention group demonstrated greater improvement in nutritional status. The weight-for-age z-score in the intervention group improved significantly from -2.18 ± 0.66 to -2.14 ± 0.67 ($p = 0.009$), as did the weight-for-height z-score, which increased from -1.02 ± 0.79 to -0.96 ± 0.82 ($p = 0.046$). In contrast, the control group did not exhibit significant changes in either indicator.

Table 2 compares changes in weight, height, and weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ), and weight-for-height z-scores (WHZ) between the control and intervention groups before and after the intervention.

The results indicated a significant increase in body weight and height in both groups. In the control group, body weight increased from 20.85 ± 5.16 kg to 21.09 ± 5.16 kg ($p = 0.019$), while height increased from 121.18 ± 7.13 cm to 121.52 ± 7.13 cm ($p < 0.001$). Similarly, the intervention group showed an increase in body weight from 18.65 ± 2.20 kg to 18.84 ± 2.23 kg and an increase in height from 113.88 ± 5.08 cm to 114.08 ± 5.09 cm.

Improvement in nutritional status was observed in the weight-for-height z-score, with an increase in the intervention group from -1.02 ± 0.79 to -0.96 ± 0.82 and in the control group from -1.65 ± 1.12 to -1.60 ± 1.14 (p = 0.007). Conversely, the height-for-age z-score showed a significant increase only in the control group (p = 0.042). These findings suggest that the intervention utilizing cork fishmeal and corn has the potential to contribute to the improvement of children's nutritional status.

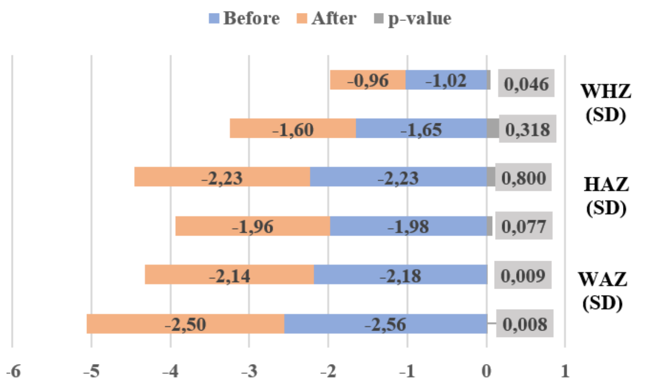

Figure 2. Difference in mean nutritional status in the control and intervention groups before and after intervention

Table 3 presents a comparison of changes in weight, height, and weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ), and weight-for-height z-scores (WHZ) between the control and intervention groups.

Table 3. The difference in mean changes in nutritional status between intervention and control groups

Variable	Control (n=37)	Intervention (n=37)	*p-value* [x]
	Mean ± SD	Mean ± SD	
Weight (kg)	0.24 ± 0.43	0.19 ± 0.28	0.939
Height (cm)	0.34 ± 0.38	0.2 ± 0.22	0.480
WAZ (SD)	0.77 ± 0.48	0.13 ± 0.50	0.000*
HAZ (SD)	-1.14 ± 0.76	-0.67 ± 0.99	0.024*
WHZ (SD)	21.91 ± 18.74	16.92 ± 9.14	0.064

[X] *Independent T-Test or Mann-Whitney Test*
* *Significance level* $p \leq 0.05$

Table 3 shows that the changes in weight and height between the control and intervention groups were not significant (p = 0.939 and p = 0.480, respectively). However, the change in WAZ demonstrated a significant difference, with the control group showing a greater increase (0.77 ± 0.48) compared to the intervention group (0.13 ± 0.50) (p = 0.000). Additionally, the change in HAZ was also significant, with the intervention group experiencing a smaller decrease (-0.67 ± 0.99) than the control group (-1.14 ± 0.76) (p = 0.024). The change in WHZ did not show a significant difference (p = 0.064).

4. DISCUSSION

The study demonstrated that although both groups showed improved weight and height, no significant difference was found between the control and intervention groups in these parameters. However, the analysis revealed that the control group exhibited a more substantial weight-for-age (WAZ) improvement. In contrast, the intervention group improved weight-for-height (WHZ). This finding suggests that the supplementary feeding intervention based on cork fishmeal and maize has the potential to support nutritional status, particularly in terms of weight-for-height balance. However, its effect on overall physical growth requires further investigation. The decrease in height-for-age z-scores (HAZ) in the intervention group also implies that the intervention's impact on physical growth may not be immediately observable, particularly given the relatively short duration of the intervention.

The observed enhancement in nutritional status among the control group, as opposed to the intervention group in this study, implies that the children in the control group may have benefited from a more balanced or natural diet, even without targeted nutritional interventions. The increase in body weight of the control group may also be due to the nutritional contribution of the standard cookies provided during the intervention period. Although not specially formulated, supplementary foods such as standard cookies still provide sufficient nutritional intake to support weight gain, especially in children with nutritional deficiencies. The results of this study are in line with the results of a study in Pare-Pare City, which found that the weight of children in the control group also increased after being given control biscuits [34]. Prior studies have demonstrated that a well-rounded diet is essential for promoting healthy growth in children and that indirect interventions can also facilitate improvements in nutritional status [35, 36]. Furthermore, the intake of energy, protein, fats, and carbohydrates has been shown to have a significant correlation with the nutritional status of elementary school children, evidenced by a p-value of 0.000. This finding underscores the critical role that all macro-nutritional components play in influencing the nutritional status of children [37].

Other factors beyond the intervention, such as the child's age, diet, and physical activity, also influenced the results of this study. Children aged 6-12 years are in a phase of rapid growth, which can naturally impact weight and height gain. According to growth theory, this period is crucial for optimizing nutritional intake to support optimal physical development [38, 39]. Furthermore, children's diets, including their breakfast and snacking habits, play a significant role in determining nutritional status. In this study, although no significant differences were found in snacking (p = 0.898) and breakfast habits (p = 1.000) between the two groups, the daily snacking habits reported by most children may affect the quality and quantity of their nutritional intake. The surrounding environment, including the availability of unhealthy snacks, also poses a challenge in promoting a more nutritious diet [40-44].

Breakfast habits have a significant positive influence on supporting children's growth and development. Most respondents in this study reported having a daily breakfast habit, which is known to contribute to an increased intake of essential nutrients such as fiber, calcium, iron, and vitamins [45, 46]. Breakfast is also associated with improved cognitive abilities, physical activity, and academic achievement [47, 48]. Sebaliknya, kebiasaan melewatkan sarapan dapat menyebabkan defisit energi, gangguan metabolisme, serta penurunan fungsi kognitif [49]. Conversely, skipping breakfast can result in energy deficits, metabolic disorders, and decreased cognitive function [41]. In the context of this study, the combination of supplementary nutrition interventions and good breakfast habits may offer greater opportunities to support children's overall growth and nutritional status. Therefore, a holistic approach that focuses on supplementary feeding and encourages healthy eating patterns and the management of children's food environment is essential to achieving more optimal results.

The enhancement in nutritional quality obtained from the cookies provided to the intervention group has the potential to assist in maintaining the nutritional status of children, even though it may not result in a direct increase in height over a short period [50]. Additionally, food supplements are critical in improving children's nutritional status and mitigating micronutrient deficiencies that can hinder growth [50]. Additionally, food supplements are critical in improving children's nutritional status and mitigating micronutrient deficiencies that can hinder growth [51]. While the intervention group did not exhibit significant improvements across various parameters, the overall enhancement in nutritional status can still play a vital role in promoting the long-term health of children. Nutritional interventions aimed at improving dietary quality can help lower the risk of malnutrition and foster better growth outcomes in the future [52].

Previous studies have demonstrated that incorporating cork fishmeal into traditional snacks can significantly enhance their nutritional value by providing essential proteins, vitamins, and minerals often absent in local foods that primarily focus on energy sources [53]. In this study, cookies formulated with cork fish and corn contain 244.4 kcal, 7.7 g of protein, 12.6 g of fat, and 25.3 g of carbohydrates per 50 grams. This nutritional profile indicates their potential to meet children's dietary requirements. Additionally, other research has reported that cork fish cookies, with their high protein content, are well accepted by children and can contribute to improving the nutritional status of those experiencing stunting [34, 53].

The results of this study make a significant practical contribution by developing healthy foods based on local resources such as cork fish and corn to improve the nutrition of malnourished children. The cookies produced offer a nutritious, affordable, and easy-to-consume food alternative that can support the growth and development of school children. The potential to develop sustainable nutrition interventions by utilizing local ingredients allows the creation of environmentally and economically friendly solutions that can strengthen the local economy. The use of easily accessible local ingredients, such as cork fish and corn, supports production efficiency, reduces costs, and reduces dependence on imported ingredients. These healthy cookies are easy to consume, store and distribute, so they can be a supplementary meal, snack or school lunch. In addition, these cookies can be produced in large quantities at an affordable cost, supporting the sustainability of nutrition interventions that are accessible to families in poor and remote areas in an environmentally and economically friendly way, and have the potential to be expanded to other regions, providing a sustainable positive impact on public health and food security.

Strength and limitation

One of the strengths of this study is its structured design, utilizing both intervention and control groups, which facilitated a comparison of the effects of supplementary feeding on children's nutritional status. This design provides a solid foundation for evaluating the effectiveness of the intervention. In this study, cork fish and corn cookies were made using local ingredients with high nutritional value, highlighting the practical relevance and potential applicability of such interventions within the community. The cookies were tested for acceptability, ensuring that they would be well-received by children. Additionally, the active involvement of parents, teachers, and schools in supporting children to consume the cookies both at school and at home ensured proper consumption and accurate recording.

This study has several limitations, including the use of a quasi-experimental design with non-randomly selected samples in both the control and intervention groups. This approach may increase the risk of bias and the presence of confounding factors that could potentially affect the validity of the study results [54]. Additionally, this design does not allow for the control of external variables [55], such as daily food intake patterns and the participants' health conditions, including any illnesses that may have occurred during the study period.

5. CONCLUSIONS

Overall, while the supplementary feeding intervention using cork fishmeal and cornmeal positively impacted children's nutritional status, its immediate effects on weight and height increases were limited, particularly over a short duration. Significant improvements were observed in z-scores, notably in weight-for-age and height-for-age indicators. Thus, while this intervention shows promise in enhancing nutritional status, further research with a longer intervention period is necessary to evaluate its long-term effects on children's physical growth.

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