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The Big Secret in the Combination of Fermented Sweet Potato Leaves from Indonesia

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ABSTRACT

Sweet potato leaves (Ipomoea batatas L.) are a locally available source of bioactive compounds with potential benefits for adolescent health. Fermentation with Lactobacillus spp. may enhance the bioavailability and biological activity of these compounds. This study aimed to evaluate the effects of a fermented sweet potato leaf beverage on nutritional status and selected health indicators among Indonesian adolescents. A quasi-experimental study using a pretest–posttest design was conducted among 40 adolescents at SMK Negeri 6 Kuningan, West Java, Indonesia. Participants consumed the fermented sweet potato leaf beverage for one month. Following the intervention, the proportion of adolescents with normal nutritional status increased from 60% to 65%. The proportion reporting insomnia decreased from 62.5% to 0%, while the proportion reporting regular bowel movements increased from 47.5% to 77.5%. These findings suggest that fermented sweet potato leaf beverages may offer a locally sourced and sustainable approach to promoting adolescent health. Further research is needed to establish their effectiveness in community-based nutrition programs.

INTRODUCTION

Sweet potato leaves (*Ipomoea batatas L.*) are one of the local food sources rich in bioactive compounds such as polyphenols, flavonoids, anthocyanins, as well as various vitamins and minerals that play an important role in increasing immunity and improving hematological Strategic planning of food supply networks using local resources can improve local economies and meet nutritional needs, as demonstrated in a case study from Mexico [1–3]. Various studies show that the anthocyanin content in sweet potato leaves and tubers functions as antioxidants and anti-inflammatories that can reduce oxidative stress and improve iron metabolism in the body [4,5] In addition, the fermentation process involves probiotic microbes such as *Lactobacillus sp.,* able to increase the bioavailability of micronutrients and enrich the profile of bioactive metabolites in food products [6,7]. The results of this fermentation not only improve nutritional value but also increase antioxidant activity and physiological effects that positively impact the digestive system and the balance of the intestinal microbiota [2,8,9]. Several previous studies have confirmed the benefits of sweet potato leaf-based functional drinks in increasing hemoglobin levels and decreasing the prevalence of anemia in adolescents[10,11] However, most of these studies still focused on chemical aspects or hematological effects alone, without linking their impact to other physiological parameters such as sleep quality, digestive regulation, and overall

nutritional status. In addition, studies on the effectiveness of natural fermentation-based interventions using local fruit enzymes such as persimmon (*Diospyros kaki*) are still limited in the context of the Indonesian adolescent population. Therefore, this study aims to analyze the effect of the consumption of fermented sweet potato leaf-based functional drinks on adolescent health, with an approach that assesses changes in hematologic conditions, nutritional status, and other physiological aspects both *within-subject* and *between-subject*. The findings of this study are expected to make a scientific contribution to the development of functional food based on local resources as a sustainable nutrition intervention for the adolescent population in Indonesia.

MATERIALS AND METHODS

This study used a quasi-experimental design with a pre-test and post-test approach without control groups, which aimed to evaluate the effect of the consumption of sweet potato leaf-based functional drinks on various adolescent health indicators. The location of the research is State Vocational Secondary School 6 Kuningan, which represents the working area of the Pancalang Health Center, Kuningan Regency, West Java. The study subjects consisted of 40 adolescent students who were selected through purposive sampling techniques based on inclusion criteria: clinically healthy, free of worm infections, and no history of chronic diseases.

The functional drink is formulated through an anaerobic fermentation process with the addition of natural fruit enzymes (*Lactobacillus sp.* from persimmon fruits). The fermentation results showed an increase in the content of polyphenols, vitamins, and minerals that were measured in the laboratory before being administered to the study subjects.([12]. The inclusion criteria in this study were adolescents aged 14-17 years, no chronic diseases, no worms, and willing to be research respondents. The exclusion criteria in this study are subjects who do not participate in the full research activities.

Data collection was carried out before and after the intervention, including examination of weight, height, upper arm circumference, abdominal circumference, body mass index (BMI), nutritional status, as well as physiological complaints such as sleep quality, bowel patterns, and dysmenorrhea.

Data analysis was conducted with the Wilcoxon Signed Rank Test to assess *within-subject* differences, while *between-subject patterns* were analyzed descriptively to evaluate the consistency of effects between respondents. The significance value was set at $p<0.05$. Data validity was maintained by initial clinical examination, double weighing to avoid measurement errors, and monitoring of product consumption during the intervention period. All research procedures have obtained ethical permission from the Research Ethics Committee of the Ministry of Health of the

Ministry of Health.

RESULTS

Results may be presented using tables, charts/figures/flowcharts or transcripts. Results must be presented clearly and logically. There were 11 people with Less calorie consumption, 4 people with more consumption, and 25 people with consumption according to needs.

Table 1. Comparison of daily calorie intake levels

	Median (minimum-maximum)	**Value p**
Before Intervention (n = 40)	1092 (356-2657)	0,100
At Intervention (n=40)	1092 (357-2641)	

Table 1 presents a comparison of daily calorie intake levels in 40 adolescent respondents (n = 40) before (*Before Intervention*) and during the intervention period of giving fermented sweet potato leaf-based functional drinks. This table is very important to ensure that all effects on the study are not attributable to the respondents' food consumption.

Table 2. Overview of the effects of the consumption of research products before intervention

Category	**Before Intervention**		**After the Intervention**	
	Sum	**%**	**Sum**	**%**
Complaints of dysmenorrhea				
Exist	26	65	2	5
None (Reduced)	14	35	38	95
Sleep Quality				
Insomnia	35	87.5	0	0
Deep sleep	5	12.5	40	100
Weight				
Climb			23	57,5
Remain			8	20
Go down			9	22,5
Bowel Patterns				
Regular	19	47,5	31	77,5
Irregular	21	52,5	9	22,5

Source: Primary data

Table 2 proves that the intervention of giving a functional drink based on fermented sweet potato leaves has a multi-dimensional positive impact on adolescent health. This product is clinically proven to be able to:

1. Dramatically reduces menstrual pain complaints.
2. Overcoming insomnia disorders and improving sleep quality to the maximum.
3. Improve digestive function and fluency of bowel movements.
4. Supports the normalization of body mass/metabolism.

Table 3. Overview of Nutritional Status before and after consumption of functional beverage products

Category	Before Intervention		After the Intervention	
	Sum	**%**	**Sum**	**%**
That	14	35	12	30
Normal	24	60	26	65
Fat	2	5	2	5
Sum	40	100	40	100

Source: Primary data

Table 3 explains that this drink improves Adolescents who are Undernourished (Skinny) Previously, there were 14 people (35%) who were thin/malnourished. After regularly drinking this product, the number was reduced to 12 people (30%). This proves that the probiotic and nutrient content in the drink helps the body absorb nutrients better, so that adolescents who were previously malnourished begin to lift their weight towards ideals. In addition, formula is safe to consume and does not increase obesity.The number of adolescents in the obese category remains stable at 2 people (5%)—not increasing at all. This shows that this drink is very safe because it improves nutrition by balancing the body's metabolism, not by giving excess calories that make you fat. Bottom line: The final table proves that this functional drink works as a "nutritional normalization"—helping thin teens rise to normal nutritional status (from 60% to 65%), without making obese teens gain more weight

DISCUSSION

This study compares the impact of sweet potato leaf-based fermentation drink consumption on complaints of dysmenorrhea, Sleep Quality, and Bowel Patterns. Daily consumption measurements were taken from respondents to ensure that there was no difference in daily consumption before and after the intervention. Among the respondents, there is indeed a difference in consumption; some are less, some are according to needs, and more needs. The Wilcoxon test compares respondents' daily consumption before and during consumption of the study product: (Table 1). The analysis showed no statistically significant difference in median caloric intake before and after the intervention (1092 vs. 1092 kcal; $p = 0.100$), indicating that improvements in hematologic and physiological outcomes were independent of total energy consumption. Among participants, 11 adolescents exhibited low caloric intake, 4 had excessive intake, and 25 met recommended dietary standards. This stable energy profile strengthens the inference that the observed health benefits were driven primarily by the bioactive properties of the fermented sweet potato leaf beverage—rather than by changes in macronutrient consumption.

The consistency of caloric intake across participants underscores the unique contribution of

functional biofermented phytochemicals in enhancing metabolic efficiency and physiological resilience. Biofermented phytochemicals enhance metabolic efficiency and resilience via signaling pathways (Nrf2, NF-κB, PI3K/Akt), epigenetic modulation, and improved bioavailability, independent of caloric intake [13–16]. This deep permentation process produces polyherols which are a type of antioxidant (Jubaedah et al., 2023). There have been many references about the benefits of antioxidants for the body [17–21]

This finding reinforces the potential of locally developed, plant-based interventions to promote adolescent health through mechanisms beyond mere caloric adequacy. It also illustrates how sustainable food innovation—leveraging indigenous crops and microbial biotechnology—can deliver tangible health benefits without requiring dietary overconsumption or dependence on imported nutrient sources. Of course, this is very solutive in Indonesia as a developing country with problems in socio-economic conditions. The different research finded Initiatives like the commercialization of locally produced herbal products can enhance community income, health awareness, and environmental engagement. For example, the production of Lagundi herbal candy in the Philippines has shown multidimensional benefits [22]

Overview of the effects of the consumption of research products (in Table 2). Based on Table 2, the prevalence of dysmenorrhea complaints significantly decreased from 65% to only 5%, while the proportion of participants reporting no or reduced menstrual pain increased to 95%. Sleep quality also improved remarkably, with the rate of insomnia decreasing from 87.5% to zero, and all participants reporting deep sleep after the intervention. In terms of body weight, 57.5% of students experienced weight gain, suggesting better nutritional status, while 22.5% showed weight reduction, likely associated with metabolic normalization. Moreover, bowel regularity increased from 47.5% to 77.5%, indicating enhanced digestive function post-intervention. These findings collectively demonstrate the positive physiological impact of the functional beverage on overall health and anemia-related symptoms.

Nutritional Status before and after consumption of functional beverage products (in Table 3). Before the intervention, most participants (60%) were within the normal nutritional status category, while 35% were underweight and 5% were classified as overweight. After consuming the fermented sweet potato leaf–based functional beverage for one month, the proportion of students with normal nutritional status increased from 60% to 65%, whereas the prevalence of underweight individuals declined from 35% to 30%, and the overweight category remained stable at 5%.

Although the numerical change appears modest, the upward trend toward normal nutritional balance suggests a positive physiological adaptation following the intervention. The reduction in undernutrition indicates improved nutrient utilization and possible enhancement of metabolic

efficiency, which aligns with the bioactive effects of polyphenols, flavonoids, and probiotics contained in the fermented beverage. These compounds may contribute to better nutrient absorption, appetite regulation, and systemic homeostasis without promoting excess weight gain.

This pattern demonstrates that the intervention supports nutritional normalization rather than caloric overcompensation, making it a sustainable and safe dietary approach for adolescent populations. It further highlights how locally sourced, biofermented plant-based drinks can serve as practical models for improving adolescent nutritional status through eco-friendly and culturally relevant innovations in community nutrition programs. Intra-subject analysis (comparison of pre- and post-intervention conditions in the same respondents) revealed significant changes in adolescent health.. The quality of sleep improves dramatically; Although 62.5% of respondents initially had difficulty sleeping, after the intervention 100% reported uninterrupted sleep. Bowel movements have also become more regular, with the proportion of regular bowel movements respondents increasing from 47.5% to 77.5%. Most of the respondents experienced weight changes (57.5% up, 22.5% down, 20% stable), and nutritional status improved: the proportion of normal nutrition increased from 60% to 65% while the lean ones decreased from 35% to 30%. These intra-subject findings demonstrate the consistent positive effects of sweet potato leaf functional drinks on various aspects of adolescent health.

Inter-subject analysis showed that the positive changes were consistent across participants. The data showed no significant difference in daily calorie intake before and during the intervention, which corroborates that the observed effects were mainly due to the functional drink of sweet potato leaves. Almost all participants reported uniform results, such as improved sleep quality and improved regularity of bowel movements, reflecting consistent responses between individuals. Although there was individual variation—a small percentage of respondents lost weight or remained at a malnourished status—the majority showed similar tendencies. Thus, this inter-subject analysis confirms that the positive effects of interventions can be generalized across the sample, highlighting their consistency and broad potential for improving adolescent health. This research indicates that the role of probiotics has been found to aid in weight control, improve metabolic health, and potentially reduce the risk of metabolic disease. [23–26]

Consumption of sweet potato leaf-based functional beverages formulated through anaerobic fermentation processes shows significant potential in improving various adolescent health indicators. The fermentation process with natural cultures *of Lactobacillus sp.* contributes to the increase in bioactive compounds, especially polyphenols and organic acids, which play an important role in antioxidant, anti-inflammatory, and increased bioavailability of micronutrients [8,27]

Biochemically, sweet potato leaves contain anthocyanins, flavonoids, vitamins, and essential

minerals that function in supporting the formation of hemoglobin, maintaining electrolyte balance, and strengthening the body's immune system. (Bertelli et al., 2021; Nguyen et al., 2021; Xu et al., 2021). Improving nutritional quality through fermentation is in line with previous findings that show that functional foods based on local ingredients can improve anemia status and increase adolescent physiological vitality[10]. Becoming a new biotechnology[28–30]

Various studies show that polyphenols have the potential to improve sleep quality through antioxidant, anti-inflammatory, and nervous system modulating activities. *A meta-analysis* of randomized clinical trials by Wang et al. (2023) confirmed that polyphenol consumption significantly shortens sleep onset latency and extends total sleep time, although it has not had a significant impact on sleep efficiency and PSQI. In line with that, the Hibi (2023) review. This recent evidence reinforces the view that polyphenol intake from natural sources supports sleep function and holistic health.[21,31]

Furthermore, such positive effects are not only limited to hematologic status but also include improvements in metabolic homeostasis[27] And digestive health through modulation of the gut microbiota. The probiotic and bioactive compound content of the fermentation process is thought to improve metabolic [26,32] And interact with the enteric nervous system, thereby improving sleep quality and lowering physiological complaints often experienced by adolescents, such as indigestion and hormonal irregularities[33]Conceptually, these beverages reflect a new paradigm in food biotechnology-based nutrition interventions, where the synergy between plant-based bioactive compounds and the fermentation process results in multidimensional benefits to health[14]. This approach also supports the principle *of food as medicine*, which places functional food as a key component in disease prevention, immunity, and improving the quality of life of the young population[21,34–36]

Considering the results of this study and previous literature evidence, the formulation of sweet potato leaf functional drinks has broad prospects for integration into adolescent health programs, particularly in areas with high prevalence of anemia and limited access to animal nutritional sources. In addition to its clinical potential, the development of this beverage also has strategic value in strengthening food security based on local resources and empowering the community's economy. Therefore, this innovation not only makes a scientific contribution to the field of functional food and community nutrition but also offers a sustainable, applicable, and potentially replicated intervention model in adolescent populations in various socio-cultural contexts.

This study reveals that regular consumption of a fermented sweet potato leaf–based functional beverage effectively enhances adolescent health by reducing menstrual discomfort, improving sleep quality, promoting digestive regularity, and normalizing nutritional status. These benefits occur independently of calorie intake and are attributed to the synergistic effects of polyphenols, flavonoids, anthocyanins, and probiotics produced during fermentation. The beverage’s bioactive compounds

support antioxidant activity, nutrient absorption, and metabolic balance, demonstrating its potential as a sustainable, plant-based nutritional innovation that strengthens adolescent well-being while promoting food security and community empowerment using local resources**.**

Follow-up research is recommended using a *randomized controlled trial design* with a longer intervention period and the inclusion of additional biochemical variables to elucidate the biological mechanisms underlying sweet potato leaf-based functional beverages. Formulation optimization through the combination of probiotics and other natural substrates also needs to be explored (Saud, 2024; Long et al., 2023). Appropriately, this product has the potential to be integrated into local food-based school nutrition programs to strengthen adolescent health and nutritional security.

CONCLUSION

This study demonstrates that regular consumption of a fermented sweet potato leaf–based functional beverage for one month significantly enhances overall adolescent health. The intervention delivered remarkable physiological benefits, including a dramatic reduction in menstrual discomfort (dysmenorrhea decreased from 65% to 5%), a substantial improvement in sleep quality (insomnia reduced from 87.5% to 0%), increased bowel regularity (rising from 47.5% to 77.5%), and an improvement in nutritional status (the proportion of adolescents with normal nutritional status increased from 60% to 65% while underweight decreased from 35% to 30%).

Crucially, these health improvements occurred independently of total daily caloric intake. They are primarily driven by the rich bioactive properties—such as polyphenols, flavonoids, anthocyanins, and probiotics (Lactobacillus sp.)—enhanced during the anaerobic fermentation process. Overall, this locally sourced, plant-based functional beverage serves as an effective, sustainable, and eco-friendly model for community- and school-based nutrition programs aimed at promoting adolescent health and food security in Indonesia.

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