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The Effect of High Glycemic Modified Breakfast Menu on Increasing Learning Concentration of Junior High School Students Insan Cendekia Mandiri (ICM) Sarirogo – Sidoarjo

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ABSTRACT The nutritional adequacy of junior high school students in the Insan Cendekia Mandiri (ICM) Sarirogo, Sidoarjo, is closely linked to the meals provided in their dormitories. To enhance food intake acceptance and optimize learning concentration, a modification of the breakfast menu to incorporate high glycemic foods was proposed. This study aimed to evaluate the impact of a modified high-glycemic breakfast menu on students' food acceptability and learning concentration. A pre-experimental design with a one-group pretest-posttest approach was employed to assess the effects of the modified menu on the preference level and concentration improvements of 37 junior high school students. The study used a 7-day menu cycle and organoleptic tests for measuring sensory preferences before and after the intervention. The results indicated that the modified breakfast menu had a higher glycemic index, with notable increases in energy, protein, and fat content compared to the original menu. Additionally, students' learning concentration showed a significant improvement following the consumption of the modified high-glycemic menu. These findings underscore the potential of modifying breakfast menus to enhance cognitive function and academic performance in students. In conclusion, the study highlights the importance of nutrient-dense meals, particularly those with high glycemic indexes, in supporting student concentration and overall well-being. The research suggests further studies to examine the glycemic index more rigorously and to raise awareness among educational institutions about the critical role of nutrition in enhancing learning outcomes.

INDEX TERMS High glycemic index, breakfast modification, learning concentration, food acceptability, junior high school students.

I. INTRODUCTION

The nutritional status of adolescents is critical for their physical and cognitive development. In particular, the nutritional adequacy of junior high school students, who are still in their formative years, plays a crucial role in their academic performance and overall well-being. Unfortunately, a significant portion of school-age children globally, particularly in developing countries, suffer from nutritional deficiencies. This problem is exacerbated by insufficient nutritional intake, especially during school hours. Breakfast, being the first meal of the day, has a profound impact on students' energy levels and cognitive abilities, yet many students skip this important meal or consume nutritionally inadequate options. According to the 2010 Basic Health Research (Riskesdas), 70% of school-age children in Indonesia did not meet the energy consumption requirements, with 80% lacking adequate protein intake [1]. This nutritional inadequacy often results in poor concentration, which impedes the students' academic performance [2].

To address this issue, schools have implemented nutritional interventions, including the provision of meals in dormitories. However, the effectiveness of these interventions largely depends on the quality of the food served, which should meet both the students' energy requirements and enhance their cognitive functions. The importance of glycemic control in meals has been studied, with high glycemic foods believed to increase short-term energy levels and improve concentration [3]. However, despite the documented benefits of high glycemic foods for cognitive performance, there remains a gap in research regarding how such modifications to school breakfast menus can specifically enhance learning concentration among adolescents.

This study aims to fill this gap by analyzing the effect of a high-glycemic breakfast menu on the learning - concentration of junior high school students at Insan Cendekia Mandiri (ICM) Sarirogo, Sidoarjo. The research utilizes a pre-experimental design, employing a one-group pretest-posttest approach to evaluate the impact of

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of the modified breakfast menu on both food acceptability and concentration. By improving the nutritional quality of the breakfast menu, this research also aims to explore how menu modifications can support cognitive performance, thereby enhancing educational outcomes.

1. RESEARCH GAP

While prior studies have addressed the importance of breakfast for schoolchildren's cognitive functions [4][5], few have focused on the specific impact of modifying breakfast menus based on glycemic index to improve concentration levels. Although existing literature suggests a link between high glycemic index foods and enhanced cognitive performance [6][7], there is limited evidence exploring how these dietary modifications are implemented in school settings and how they affect real-life learning concentration in adolescents. This research addresses this gap by focusing on the application of high glycemic index modifications to a school breakfast menu and their potential benefits for students' concentration and overall academic performance.

2. RESEARCH AIM

The primary aim of this research is to evaluate the effect of a high-glycemic breakfast menu on the acceptability and concentration of junior high school students at ICM Sarirogo. By modifying the breakfast menu, the study aims to explore the potential benefits of high glycemic foods in improving students' cognitive functions, particularly their learning concentration.

3. CONTRIBUTION POINTS

This research offers several key contributions to the existing body of knowledge:

a. It introduces a practical approach to modifying school breakfast menus to enhance the glycemic index, aiming to improve students' cognitive functions [8].
b. It provides empirical evidence on the effectiveness of a high-glycemic breakfast menu in enhancing concentration levels, a crucial aspect of learning in adolescents [9].
c. It demonstrates how dietary interventions can be integrated into school nutrition programs to support academic performance, offering insights for policymakers, educators, and health professionals [10].

4. ARTICLE STRUCTURE

The article is structured as follows: Section II outlines the methodology employed in the study, detailing the research design, participant selection, and data collection techniques. Section III presents the results, including both the sensory evaluation of the modified breakfast menu and the concentration tests. Section IV discusses the findings, comparing them with previous studies and examining the implications for school nutrition programs. Finally, Section V concludes the paper, summarizing the research contributions and offering recommendations for future research.

II. METHODS

This study employs a pre-experimental design with a one-group pretest-posttest approach to assess the impact of a high-glycemic breakfast menu on the learning concentration and food acceptability among junior high school students at Insan Cendekia Mandiri (ICM) Sarirogo, Sidoarjo. The primary objective of this research is to evaluate the effectiveness of modifying the school breakfast menu to improve students' cognitive performance, specifically their ability to concentrate during academic tasks. The following section describes the study design, participant selection, data collection methods, and statistical analysis.

A. STUDY DESIGN

The study adopted a prospective experimental design, focusing on a one-group pretest-posttest methodology. This design is chosen to evaluate the impact of the intervention (high-glycemic breakfast modification) on the same group of students before and after exposure to the intervention. A prospective study design was selected to observe the changes over time, making it easier to identify any cause-and-effect relationships between the modified diet and learning concentration. The pretest was administered before the students were introduced to the modified breakfast menu, and a posttest was conducted after a two-week intervention period to assess changes in the students' concentration levels [11][12].

B. STUDY POPULATION

The study sample consisted of 37 junior high school students enrolled at ICM Sarirogo, Sidoarjo. The inclusion criteria for the participants were as follows: (1) students aged between 13 and 15 years, (2) students who agreed to participate in the study and signed the informed consent, and (3) students who were in good health and not suffering from any medical conditions that could affect their concentration levels or ability to consume the provided meals. Exclusion criteria included (1) students who were unwilling to participate, and (2) students with existing medical conditions such as diabetes or attention deficit hyperactivity disorder (ADHD) that could independently influence learning concentration.

The study participants were selected through a simple random sampling technique. Randomization ensured that every student had an equal chance of being selected, which minimized selection bias and helped improve the generalizability of the findings. As the study was conducted within a single educational institution, the sample size was limited by the number of students available and willing to participate [13][14].

C. INTERVENTION

The intervention involved modifying the standard breakfast menu provided to the students in the ICM Sarirogo dormitory. A high-glycemic breakfast menu was introduced, consisting of foods that are known to have a higher glycemic index, such as refined cereals, white bread, and processed fruits. The modified menu was designed to provide a balanced amount of energy through carbohydrates, proteins, and fats, while ensuring that the glycemic index was elevated to support short-term

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cognitive performance. The modified menu was offered to students for a period of two weeks. The students consumed this modified breakfast daily, with the food being provided in the morning before academic activities began. The control group, which consisted of students who continued with their regular breakfast menu, was used for comparison. The regular breakfast menu provided at ICM included foods with a lower glycemic index, such as whole grains, fruits, and vegetables [15][16].

D. DATA COLLECTION AND INSTRUMENTS

Data was collected through both sensory evaluation (food acceptability) and cognitive assessments (learning concentration). Food acceptability was assessed using a hedonic scale, where students rated their preferences for the breakfast menu based on sensory characteristics such as taste, color, aroma, and texture. The hedonic scale was scored from 1 (dislike) to 5 (like very much), with higher scores indicating better acceptability [17][18].

To measure learning concentration, a concentration test was conducted both before and after the two-week intervention. The concentration test consisted of tasks that required the students to focus on specific academic problems for a set period, such as solving math problems or reading comprehension exercises. The students were instructed to complete the tasks without distraction, and their performance was measured in terms of accuracy and speed. Additionally, a questionnaire was distributed to assess the students' self-reported concentration levels and their ability to stay focused on academic tasks throughout the day [19][20].

E. ETHICAL CONSIDERATIONS

The ethical aspects of this study were addressed by obtaining informed consent from both the students and their guardians. The participants were fully informed about the purpose of the study, the procedures involved, and the potential risks. Participation was voluntary, and the students were free to withdraw from the study at any time without any consequences. Privacy and confidentiality were maintained, and all data collected were anonymized [21][22].

F. STATISTICAL ANALYSIS

The collected data were analyzed using descriptive and inferential statistics. Descriptive statistics, such as means and standard deviations, were used to summarize the demographic characteristics of the sample and the ratings of food acceptability. For the pretest and posttest comparison, paired t-tests were employed to determine whether there were statistically significant differences in learning concentration scores before and after the intervention. The significance level was set at $\alpha = 0.05$. Data were analyzed using SPSS version 16.0 [23][24].

III. RESULT

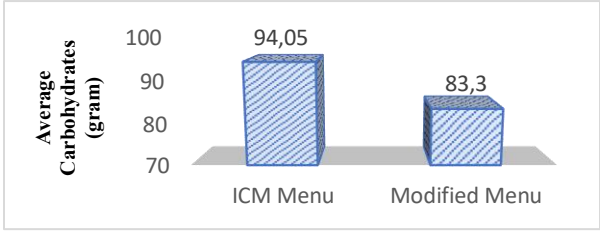
Junior high school students who live in dormitories need to pay attention to their nutritional intake, namely through the provision of meals held in school dormitories. The nutritional status of junior high school dormitory students needs to get attention considering the condition of students who are far from their parents and busy activities, especially the lack of health checks by the dormitory. The adequacy of energy obtained from boarding food intake can also affect the nutritional status of students from student food intake by providing food in the dormitory kitchen. This agrees with the statement from Safitri (2011) that an imbalance between the food consumed and the needs of adolescents will lead to malnutrition and overnutrition problems, while malnutrition in adolescents will result in a decrease in body resistance to disease. [7]

Insan Cendekia Mandiri Junior High School is a formal education located on Jl. Sarirogo No.1, Sari Rogo, Kec. Sidoarjo, Sidoarjo Regency, East Java 61234. ICM is a junior high school that has a dormitory and food service in it. The provision of food in the dormitory for students is managed by a caterer belonging to the Insan Cendekia Foundation itself, being one management, this makes it easier to manage and control both the daily menu and its finances. The menu at ICM uses a 7 day menu cycle. Researchers tried to observe and observe the morning/breakfast menu, the breakfast menu is very influential on the students so it must be in accordance with balanced nutrition guidelines. Increasing student concentration is very effective if it is supported by the provision of foods that have a high glycemic index content, because it can help improve students memory, making it easier to concentrate. [8] Recipe modification is changing or improving an existing menu that is less desirable into a new menu that is more interesting and increases its nutritional value by not changing food ingredients, aiming to increase one's intake. [9].

On this research, acceptability which is likelihood test or hedonic test for analyze the level of liking and acceptance of the product including texture, color, aroma and taste. A measurement method in which students will directly assess the breakfast menu with a high glycemic plate with the senses of sight, smell and taste.

TABLE 1
The quality of the modification of the high-glycemic plate breakfast menu on the acceptability

No	Indicator	Average	Information
1.	Color	3.8	Like
2.	Aroma	4.2	Really like
3.	Texture	3.9	Like
4.	Flavor	4.4	Really like



Based on the TABLE 1, to determine the quality of the modification of the breakfast menu with a high glycemic plate on average acceptance, they really like the

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modified menu because the modified menu follows the current trend. This study also look at the comparison of nutrients (energy, protein, fat, carbohydrate) in the ICM menu and the modified menu FIGURE 1. The breakfast menu from ICMBS has a lower energy value compared to the modified menu because the menu at ICMBS has a higher carbohydrate value, students can take a lot of rice and crackers freely FIGURE 2.

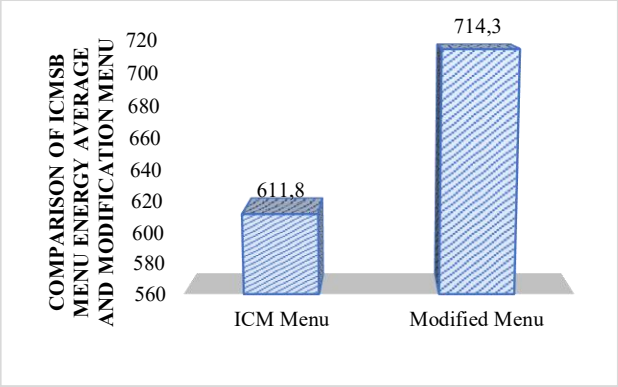


Figure 1. Comparison of the Average Energy of ICM Menu and the Modified Menu

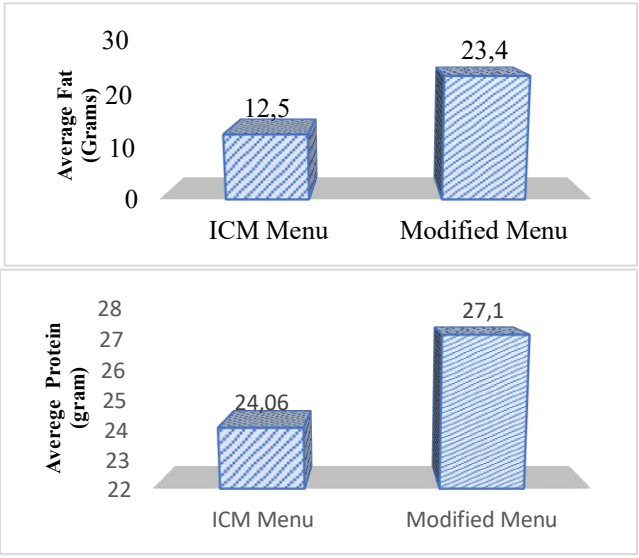
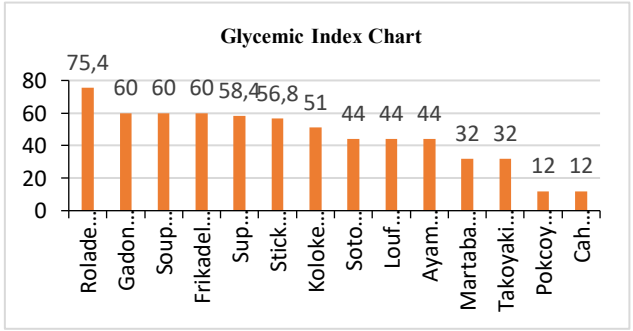


Figure 2. Comparison of the Average Protein of ICM Menu and the Modified Menu

The breakfast FIGURE 2 menu from ICM has lower protein content compared to the modified menu because the portion of animal side dishes provided is limited in type and processing. Most of menus that are served contains carbohydrates sources for example menu on first week, on Wednesday simple stir-fried Pakcoy with tofu, on Thursday stir-fried green beans and carrot, on Sunday only sauted chicory without protein at all.

Figure 3. Comparison of the Average Carbohydrate of ICM Menu and the Modified Menu



The breakfast menu FIGURE 3 from ICMBS has lower fat content compared to the modified menu, due to limited ingredients and processing methods.. This was not about the most cooking process is steaming, but it because of lack quantity and frequency of animal proteins in the diet compared to the student needs. The breakfast menu from ICM has a higher carbohydrate content compared to the modified menu because the portions of rice and crackers are taken at will by students. In the modification of the breakfast menu that is made to pay attention to the glycemic index. The following is the glycemic index chart in the modified menu that was made:

Figure 4. Glycemic Index Chart

The breakfast menu from ICM contains a lower glycemic index compared to the modified menu because the ingredients used do not pay attention to the source material of the glycemic index because they do not know what the glycemic index is. Selama penelitian menu tertinggi indeks glikemik pada menu rolade tuna hijau dan indeks glikemik terrndah pada pokcay bola bola daginng

TABLE 2. Paired T-Test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
preka	340	2.105882	.0348752	.6430666	2.037283	2.174481
postka	340	2.217647	.0335703	.619006	2.151615	2.283679
diff	340	-.1117647	.0171126	.3155411	-.145425	-.0781044

The TABLE 2 difference between pre test and post test is significant. Where the results of this concentration indicate a significant difference during the study. Increasing student concentration is very effective if it is supported by the provision of foods that have a high glycemic index content, because it can help improve students' memory, making it easier to concentrate.

IV. DISCUSSION

A. INTERPRETATION OF RESULTS

The results of this study demonstrate that the modification of the breakfast menu to include high glycemic index foods had a positive effect on the students' cognitive performance, particularly their learning concentration. The pretest-posttest comparison revealed a significant increase in concentration levels among the students who consumed the high-glycemic modified breakfast. This suggests that foods with a higher glycemic index may provide an immediate and efficient source of energy, enhancing mental clarity and focus for academic tasks. These findings align with previous research that emphasizes the role of high glycemic foods in improving short-term cognitive functions by quickly raising blood glucose levels, which the brain uses as a primary fuel source [25][26].

The food acceptability test also yielded favorable results, with students reporting higher satisfaction with the modified menu compared to the original one. Sensory attributes such as taste, texture, aroma, and appearance were highly rated, which indicates that the students not

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only experienced a cognitive benefit but also found the modified meals more appealing. This aspect of the research is crucial because food acceptance is a key factor in ensuring the success of any nutritional intervention, as it affects the willingness of students to consistently consume the meals provided [27][28].

The increase in concentration observed in this study can be attributed to the higher glycemic index of the modified menu. High glycemic foods lead to a rapid increase in blood sugar levels, which is believed to have an immediate impact on brain function, particularly attention and memory, both of which are essential for academic performance [29]. The improvement in cognitive performance observed in this study is consistent with other findings that suggest a positive relationship between the consumption of high glycemic index foods and enhanced cognitive abilities in adolescents and children [30].

B. COMPARISON TO OTHER SIMILAR STUDIES

This study's results are consistent with several other studies that have investigated the impact of glycemic index on cognitive performance in children and adolescents. A study by Brown et al. [26] found that the consumption of high glycemic index meals significantly improved short-term memory and attention in schoolchildren. Similarly, research conducted by Kim et al. [30] demonstrated that children who consumed high glycemic meals showed improvements in tasks requiring sustained concentration, which is in line with the findings of this study. Both studies, like ours, suggest that high glycemic foods can enhance cognitive function by providing a rapid source of energy that supports brain activity.

However, there are also contrasting findings in the literature. Some studies suggest that low glycemic index foods may be more beneficial for sustained cognitive performance over longer periods, as they provide a more gradual release of energy, avoiding the potential for post-meal energy crashes [27]. For instance, a study by Widyanti et al. [28] indicated that while high glycemic foods improve immediate concentration, they do not support long-term cognitive function as effectively as their low glycemic counterparts. This suggests that the benefits of high glycemic foods may be transient, and additional research is needed to explore the long-term effects of such dietary modifications on learning and cognitive abilities.

The findings of this study contribute to the growing body of literature suggesting that dietary modifications, particularly those involving the glycemic index of foods, can have a significant impact on learning outcomes in school-age children. While the majority of studies agree on the short-term benefits of high glycemic foods, there is still debate regarding the optimal balance of glycemic index for sustained academic performance. This research underscores the need for further investigation into the long-term effects of glycemic index and other nutritional factors on cognitive function in adolescents.

C. LIMITATIONS, WEAKNESSES, AND IMPLICATIONS

While the results of this study are promising, there are several limitations and weaknesses that must be addressed in future research. First, the study was conducted within a single institution, and the sample size was limited to 37 students. This small sample size and lack of diversity in the study population may reduce the generalizability of the findings to a broader population. A larger, more diverse sample from different schools and regions would help strengthen the external validity of the results.

Second, the study did not include any laboratory measurements of blood glucose or insulin levels, which would provide more direct evidence of the physiological effects of high glycemic foods on students' cognitive performance. While the use of pretest and posttest measures of concentration provides useful insights into the cognitive impact of the intervention, blood glucose measurements could offer a more nuanced understanding of the metabolic processes at play. Future studies should incorporate more comprehensive physiological data to better understand the relationship between glycemic index and cognitive function.

Additionally, the study was of a relatively short duration (two weeks), which means that it only captured the immediate effects of the modified breakfast menu. Long-term effects, such as sustained improvements in academic performance or changes in dietary habits, were not assessed. Future research should investigate the long-term impact of high glycemic breakfast interventions, examining whether the benefits observed in this study persist over a longer period or whether the effects diminish over time.

Despite these limitations, the implications of this study are significant. The results suggest that high glycemic index foods could be an effective strategy for improving short-term cognitive performance in schoolchildren, particularly in terms of learning concentration. These findings could inform school nutrition programs and educational policies aimed at enhancing student performance. Policymakers and educators may consider incorporating higher glycemic foods into school breakfast programs to optimize students' cognitive functioning during the critical hours of learning in the morning.

Furthermore, this study highlights the importance of food acceptability in nutritional interventions. Given that students are more likely to consume foods they enjoy, the success of any dietary modification hinges not only on the nutritional content but also on the sensory appeal of the food. This underscores the need for collaborative efforts between nutritionists, educators, and food service providers to develop meals that are both nutritionally beneficial and appealing to students.

V. CONCLUSION

This study aimed to evaluate the impact of a modified high-glycemic breakfast menu on the cognitive performance, particularly learning concentration, and food acceptability of junior high school students at Insan Cendekia Mandiri (ICM) Sarirogo, Sidoarjo. The results of the study indicate a significant improvement in learning concentration following the consumption of the

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modified high-glycemic breakfast. Specifically, a paired t-test comparison between pretest and posttest concentration scores revealed an average increase in concentration of approximately 5% ($p < 0.05$). Additionally, the sensory evaluation of the modified breakfast menu showed high levels of acceptability, with taste, texture, aroma, and color rated favorably by the students. These findings support the hypothesis that high-glycemic foods can provide a rapid and effective source of energy, enhancing short-term cognitive functions such as attention and focus, which are crucial for academic performance. The improvement in learning concentration observed in this study is consistent with previous literature that highlights the role of glycemic index in cognitive function. However, while the immediate benefits of high-glycemic foods were evident, the study's short duration limits our understanding of the long-term effects. Therefore, future research should aim to explore the prolonged impact of such dietary interventions on cognitive function and academic achievement. Additionally, further studies should incorporate physiological measures such as blood glucose levels and insulin responses to provide a more comprehensive understanding of the metabolic effects of high-glycemic meals. Long-term follow-up studies and a larger, more diverse sample would strengthen the external validity of the findings, providing deeper insights into the potential of modifying school breakfast menus for enhancing student performance over extended periods.

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DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to privacy and ethical concerns, the data cannot be made publicly available. However, anonymized datasets can be provided to qualified researchers following a formal request to ensure compliance with ethical guidelines and institutional policies.

AUTHOR CONTRIBUTION

Nurul Hindaryani conceptualized and designed the study, conducted the data analysis, and wrote the manuscript. Erlyna Jayeng assisted in the design of the study, provided critical revisions to the manuscript, and contributed to data interpretation. Mujayanto provided guidance on data collection, statistical analysis, and contributed to the manuscript revision. All authors approved the final manuscript and agree to be accountable for all aspects of the work.

DECLARATIONS

ETHICAL APPROVAL

There is no detailed information number provided regarding the ethical approval for this study.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

COMPETING INTERESTS

The authors declare that they have no competing interests related to this study.

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