

Evaluation of Microbiological Quality and Hazardous Food Additives in Elementary School Snacks in Samarinda City, Indonesia

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Abstract

School snacks are an important source of energy and nutrients for children, but they may pose biological and chemical safety risk if not properly controlled. In Indonesia, the use of hazardous additives such as borax, formalin, rhodamine B and methanil yellow in foods remains a serious public health concern. To address this issue, the National Agency of Drug and Food Control (BPOM) has intensified food safety monitoring and enforcement, particularly in school environments. This study aimed to identify the presence of *Escherichia coli*, *Salmonella*, and hazardous food additives, including borax, formalin, rhodamine B, and methanil yellow, in school snacks sold around SDN 005 Dr.Sutomo Samarinda Ulu. A descriptive laboratory survey was conducted with sampling from in three school canteens and two street vendors, yielding a total of 12 food and beverage samples examined at the Samarinda City Regional Health Laboratory. Microbiological tests were performed using the multiple-tube fermentation method, while chemical testing was conducted using qualitative methods. Laboratory analysis showed that all samples tested negative for *E.coli* and *Salmonella*. Furthermore, chemical analysis confirmed the absence of borax, formalin, rhodamine B, or methanil yellow in all samples. These findings suggest that the school snacks tested were free from both microbiological contamination and prohibited chemical additives. Overall, school snacks sold around the SDN 005 Dr.Sutomo Samarinda Ulu are relatively safe for children's consumption, reflecting the effectiveness of school and health center supervision in ensuring food safety. However, continuous monitoring and education remain essential to sustain safe food practice among students and vendors.

Keywords: School snacks; food safety; *Escherichia coli*; hazardous food additives.

Introduction

Schools are public facilities that can be found in both urban and rural areas, and they serve as the venue for teaching and learning processes at every level of education. Based on law No. 20 of 2003, education combined with culture, science, and technology is an important element in national development, serving as the main foundation for achieving the nation's ideals. (Kemendikbudristek, 2022). Generally, school-aged children spend about a third of their day at school. This considerable amount of time leads them to frequently eat lunch at school, and their busy schedules often make them choose to buy snacks at school to meet their nutritional needs (Aini, 2019).

Snacks play an important role in meeting children's nutritional needs; however, the presence of harmful biological and chemical elements can pose serious health risks (Handayani & Agustina, 2018). Safe food should be produced according to standards, free from harmful microorganisms and chemical additives to maintain its quality and nutritional value (Safira et al., 2023). Recognizing this, the government issued Indonesian Minister of Health Regulation No.2 of 2023 concerning hygiene and sanitation requirements for school children's snack, which emphasizes that snacks must be free from hazardous substances and microbiological contamination such as *Escherichia coli* and *Salmonella*, which pose a risk of causing digestive disorders and even death in (Kementerian Kesehatan, 2023).

One of the issues that is still frequently encountered in Indonesia is the circulation of food that does not meet safety standards, which is triggered by the public's low level of knowledge and concern for food quality. It is not uncommon for these food products to contain harmful additives such as *formalin*, *borax* and *rhodamine B*, which pose a risk to health. These substances are known as food additives (BTP) or food additives in international terms (Mahmudah, 2023). Research conducted in Banyuwangi City on 15 food samples found that 10 samples (66,7%) consisting of meatballs, crackers, and *tahu walik* were proven to contain *borax* (Nurlailia et al., 2021) Meanwhile, another study at SDN.70 Banda Aceh showed that three beverage samples tested using the MPN (Most Probable Number) method were contaminated with *Escherichia Coli bacteria* exceeding the threshold, although six food samples tested using the TPC (Total Plate Count) method were proven free *E.Coli* contamination (Safira et al., 2023).

Based on description, the research question in this study is whether the snacks sold in school canteens and by street vendors around the school contain *Escherichia Coli* bacteria and harmful additives such as *Rhodamine B*, *Methanil Yellow*, *borax* and *formalin*. The purpose of this study is to identify the presence of *Escherichia Coli* and *coliform bacteria*, as well as to detect the use of harmful additives in snacks consumed by school children. Thus, continuous evaluation of school snack safety is essential to ensure the protection of children's health and to support the government's policy on safe and nutritious food environments in schools.

Methods

This study employed a descriptive laboratory survey conducted at SDN.005 Dr.Sutomo, located in the Samarinda Ulu District, Samarinda City. The purpose of this survey was to describe the microbiological and chemical quality of school snacks commonly consumed by students.

Sampling was carried out using a purposive sampling technique, focusing on food and beverage products that were most frequently purchased and consumed by students during school hours. Sampling activities were conducted at three school canteens located within the school premises and two street vendors operating outside the school fence.

A total of 12 samples ($n = 12$) were collected, consisting of six food items (chocolate cup cake, risoles, yellow rice, fried rice, nugget, and vermicelli) and six beverage or sweet snack items (cone ice, red candy, mixed ice cream, yellow candy, meatball skewer, and spaghetti). Sampling was performed on February 25, 2025, and each sample was placed in a sterile container, labeled, and transported under refrigerated conditions to maintain its integrity.

Laboratory examinations were conducted at the Samarinda City Regional Health Laboratory from February 25 to 28, 2025. Microbiological tests were performed using the multiple-tube fermentation method to detect the presence of *Escherichia coli* and *Salmonella*. Chemical tests for borax, formalin, Rhodamine B, and methanil yellow were conducted using qualitative analytical methods based on standard procedures established by the Indonesian National

Standard (SNI) and the Ministry of Health guidelines. The results were presented descriptively to provide an overview of the safety and quality of snacks sold within and around the school environment.

Results

a. Examination of *Escherichia coli* Bacteria in School snacks

To assess the hygienic quality of school snack, a contamination test for *Escherichia coli* was performed on various food samples collected from the canteen of SDN 005 Dr. Sutomo Samarinda Ulu. The results are presented in Table 1.

Table 1. Results of *Escherichia coli* contamination test on snacks sold at the canteen of SDN.005 Dr.Sutomo

No	Type of Sample	Type of Test	Test Results	Standard Limit	Unit	Test Method
1	Chocolate Cup cake	MPN <i>Escherichia Coli</i>	0	<3.6	MPN/gram	Multiple-tube fermentation
2	<i>Risoles</i>	MPN <i>Escherichia Coli</i>	0	<3.6	MPN/gram	Multiple-tube fermentation
3	Yellow Rice	MPN <i>Escherichia Coli</i>	0	<3.6	MPN/gram	Multiple-tube fermentation
4	Fried Rice	MPN <i>Escherichia Coli</i>	0	<3.6	MPN/gram	Multiple-tube fermentation
5	Nugget	MPN <i>Escherichia Coli</i>	0	<3.6	MPN/gram	Multiple-tube fermentation
6	Vermicelli	MPN <i>Escherichia Coli</i>	0	<3.6	MPN/gram	Multiple-tube fermentation

Primary Data : Laboratory test results from the Regional Health Laboratory of Samarinda City, 2025

Based on the laboratory examination present in the Table 1. It was found that all six types of snack samples tested: chocolate cup cake, *risoles*, yellow rice, fried rice, nugget and vermicelli showed a result of 0 MPN/gram for *Escherichia coli*. This value is below the maximum permissible limit of <3,6 MPN/gram. The examination was conducted using the multiple tube fermentation method, which is the standard procedure for detecting the presence of *Escherichia coli*.

These results indicate that all samples that were examined from the canteen of SDN 005 Dr. Sutomo, Samarinda Ulu, were free from *Escherichia.coli* contamination. Furthermore, they were categorized as safe foods for children to consume.

b. Examination of *Salmonella* in School snacks

To determine the microbiological safety of school snacks, a contamination test for *Salmonella* was conducted on various food samples collected from the canteen of SDN. 005 Dr. Sutomo Samarinda Ulu. The results are presented in Table 2.

Table 2. Results of Salmonella contamination test on snacks sold at the canteen of SDN.005 Dr.Sutomo

No	Type of sample	Type of Test	Test Results	Standard Limit	Unit	Test Method
1	Chocolate Cup cake	<i>Salmonella</i>	Negative	Negative	-	Multiple-tube fermentation
2	<i>Risoles</i>	<i>Salmonella</i>	Negative	Negative	-	Multiple-tube fermentation
3	Yellow Rice	<i>Salmonella</i>	Negative	Negative	-	Multiple-tube fermentation
4	Fried Rice	<i>Salmonella</i>	Negative	Negative	-	Multiple-tube fermentation
5	Nugget	<i>Salmonella</i>	Negative	Negative	-	Multiple-tube fermentation
6	Vermicelli	<i>Salmonella</i>	Negative	Negative	-	Multiple-tube fermentation

Primary Data: Laboratory test results from the Regional Health Laboratory of Samarinda City, 2025

All six snack samples (chocolate cup cake, *risoles*, yellow rice, fried rice, nugget and vermicelli) tested negative for *Salmonella*. The analysis, conducted using the multiple-tube fermentation method, showed that none of the samples exceeded the permissible standards. These findings indicated that the snacks sold at the canteen of SDN 005 Dr. Sutomo, Samarinda Ulu, were free from *Salmonella* contamination and can be considered microbiologically safe for schoolchildren's consumption.

c. Examination of Borax in School Snacks

To evaluate the chemical safety of school snacks, a *borax* contamination test was conducted on various food samples collected from the canteen of SDN 005 Dr. Sutomo Samarinda Ulu. The results are presented in Table 3.

Table. 3 Borax Contamination Test Results in School Snack

No	Type of Sample	Type of Test	Test Results	Standard Limit	Unit	Test Method
1	Meatball Skewers	Borax	Negative	Negative	-	Qualitative
2	Spaghetti	Borax	Negative	Negative	-	Qualitative

Primary Data : Laboratory test results from the Regional Health Laboratory of Samarinda City, 2025

Both snacks sample tested (meatball skewers and spaghetti) showed negative results for *borax* using qualitative test method. These findings indicate that no hazardous food additives in the form of *borax* were detected. Therefore, snacks sold at the canteen of SDN.005 Dr.Sutomo, Samarinda Ulu can be considered safe from harmful chemical contamination and relatively safe for schoolchildren's consumption.

d. Examination of Formalin in School Snacks

To assess the presence of hazardous preservatives, a formalin contamination test was performed on various food samples collected from the canteen of SDN 005 Dr. Sutomo Samarinda Ulu. The results are presented in Table 4.

Table. 4 Formalin Contamination Test Results in School Snacks.

No	Type Sample	Type of Test	Test Results	Standard Limit	Unit	Test Method
1	Pentol bakso	Formalin	Negative	Negative	-	Qualitative
2	Spaghetti	Formalin	Negative	Negative	-	Qualitative

Primary Data: Laboratory test results from the Regional Health Laboratory of Samarinda City, 2025

Both snack sample (meatball skewers and spaghetti) tested negative for formalin using a qualitative method. This indicates that no hazardous food additives were used in their processing, suggesting that snacks sold at the canteen of SDN.005 Dr.Sutomo are safe for children's consumption.

e. Examination of Rhodamine B and Methanil Yellow in School Snacks

To identify the use of prohibited synthetic dyes, a contamination test for *Rhodamine B* and *Methanil Yellow* was conducted on various food samples collected from the canteen of SDN 005 Dr. Sutomo Samarinda Ulu. The results are presented in Table 5.

Table 5. Rhodamine B and Methanil Yellow Contamination Test Results in School Snack

No	Type Sample	Type of Test	Test Results	Standard Limit	Unit	Test Method
1	Cone Ice	<i>Rhodamine B</i>	Negative	Negative	-	Qualitative
2	Red Candy	<i>Rhodamine B</i>	Negative	Negative	-	Qualitative
3	Mixed Ice Cream	<i>Rhodamine B</i>	Negative	Negative	-	Qualitative
4	Yellow Candy	<i>Methanil Yellow</i>	Negative	Negative	-	Qualitative

Primary Data : Laboratory test results from the Regional Health Laboratory of Samarinda City, 2025

All snack samples (cone ice, red candy, mixed candy, and yellow candy) tested negative for *Rhodamine B* and *Methanil Yellow*. These results indicate the absence of hazardous synthetic dyes in the samples examined. However, since the study was limited to a small number of samples collected from selected vendors, the findings cannot be generalized to all school snacks. Further monitoring and broader sampling are recommended to confirm the overall safety of school snacks regarding food additive contamination.

Discussion

Microbiological Safety of School Snacks

Escherichia coli is a rod-shaped bacterium commonly found in the human digestive tract and serves as a biological indicator of sanitation quality in food and water. Optimal growth occurs at 37–44°C, and contamination beyond acceptable limits indicates poor hygiene practices (BPOM RI, 2019). Food contaminated with *E. coli* or *Salmonella* can cause gastroenteritis and other digestive disorders, making their presence a critical concern for school food safety.

The absence of *Escherichia coli* and *Salmonella* in all snack samples indicates relatively good hygiene and sanitation practices among school canteen vendors. However, this finding should be interpreted with caution, as they are based on a limited number of samples collected within a single time frame. These results differ from a study in the Baqa Community Health Center area of Samarinda Seberang, which detected *E. coli* contamination in fried meatballs (*pentol goreng*) and durian ice (*es durian*. T) (Utama, 2022). The differences may be attributed to variations in processing, raw material handling, and water quality used by vendors.

A study by Astuti et al. (2020) found that 51.5% of school food vendors in Semarang failed to meet proper sanitation standards, highlighting the continued risk of microbiological contamination in school food environments. This suggests that even though current findings show hygiene conditions, the potential for contamination remains if sanitation standards are not consistently implemented. Therefore, continuous hygiene education and regular food safety monitoring are essential to sustain safe food handling practices among vendors and to protect school children from potential foodborne illnesses (Astuti et al., 2020).

Chemical Additives and Food Safety Compliance

According to the Regulation of the Minister of Health of the Republic of Indonesia No.033 of 2012, borax and formalin are prohibited as food additives due to their harmful effects on health (Kementrian Kesehatan RI, 2012). The absence of borax and formalin in all tested samples suggests improved compliance with food safety regulations. Nevertheless, illegal use of such additives has been reported in other regions, indicating that continuous monitoring remains necessary. Similar findings were also reported in a study that showed a decrease in the illegal use of borax and formalin following strengthened public health supervision and school-based awareness campaigns (Bilgic et al., 2024).

Nonetheless, past studies have shown that the illegal use of borax and formalin persists in some regions of Indonesia. Trader in Surabaya and Banyuwangi were found to continue using these to improve food texture, appearance, and shelf life (Mahmudah, 2023; Nurlaila et al., 2021). A study in Kenjeran District, Surabaya, revealed that 100% of tested food samples contained borax, while 13.3% tested positive for formalin. These findings emphasize that although this study's results are favorable, continuous laboratory surveillance and regulatory enforcement remain essential to prevent chemical hazards in children's food environments.

Synthetic Dyes and Their Health Implications

The chemical analysis in this study revealed that all snack samples (cone ice, red candy, mixed candy, and yellow candy) tested negative for *Rhodamine B* and *Methanil Yellow*, indicating the absence of banned synthetic dyes in the tested products. These results are consistent with findings by Asmi et al. (2023), who also found that school snacks in Samarinda were free from prohibited dyes, suggesting that food safety education and monitoring may have contributed to this positive outcome.

However, studies from other regions indicate that the illegal use of *Rhodamine B* remains prevalent, particularly in informal food sectors, due to its bright color and low cost (Saputri et al., 2018). The compound is known to be toxic and carcinogenic, containing chlorine and aromatic structures that are resistant to hepatic metabolism, potentially leading to accumulation and systemic toxicity in the body (Asmi et al., 2023). Therefore, while the current findings are encouraging, they should be interpreted with caution, as they are based on a limited number of samples collected within a specific time frame.

Although no Rhodamine B or Methanil Yellow was detected in this study, evidence from other regions highlights the ongoing risk of illegal dye use in school snacks. This underscores the need for broader and periodic sampling across multiple schools and vendors to ensure long-term monitoring and control. Sustained laboratory testing, combined with vendor education and enforcement, is essential to maintain dye-free and safe environments for schoolchildren.

Role of Education and Monitoring in Ensuring Food Safety

The importance of food safety education among street vendors has also been demonstrated in previous research. (Labao R.U., 2024) reported a significant relationship between food safety knowledge and hygiene practices among street vendors in Davao del Norte, Philippines. Their study found a significant relationship between food safety knowledge and hygiene practices among street vendors in Davao del Norte, Philippines. Their findings showed that vendors with greater understanding of foodborne diseases, cross-contamination, and temperature control were more likely to demonstrate proper hygiene behaviors. Increased food safety knowledge was strongly linked to improved hygiene performance and business outcomes, including better customer trust, reputation, and sales. This suggests that educational interventions not only enhance compliance but also yield positive socioeconomic impacts.

Despite these benefits, challenges persist. Souisa et al. (2019) in Ambon City reported that although many vendors understand the importance of hygiene, practical implementation remains inconsistent due to limited institutional supervision and lack of training access. This emphasizes the need for structured and continuous education, certification, and mentoring programs for both stationary and mobile food vendors.

The literature review conducted by Febrina et al. showed that most food samples studied in various regions still detect the presence of *Rhodamine B*, especially in snacks sold in informal settings such as meatballs, *siomay* and saugases. This conditions is concerning because the primary target of these snacks is elementary school children, who generally do not have sufficient knowledge regarding food (Saputri et al., 2018)

The positive results observed in this study may reflect the success of school-community health center partnerships and vendor mentoring initiatives. For instance, the mixed ice cream vendor supported by the National Amil Zakat Agency (Baznas) showed full compliance with food safety standards, with laboratory results confirming the absence of prohibited dyes such as *Rhodamine B* and *Methanil Yellow*. Such collaborative approaches have been shown to improve compliance with hygiene standards and enhance vendor awareness of foodborne hazards.

Developing and maintaining healthy school canteens are essential components of promoting children's nutrition and well-being. Utami et al. (2025) emphasized that safe and hygienic canteen environments contribute not only to children's physical growth but also to their long-term dietary habits. Strengthening regulations, vendor certification, and regular laboratory inspections are necessary to ensure continued compliance with food safety standards.

Additionally, restrictions on the sale of instant foods, sweetened beverages, and low-nutrient snacks within school environments should be implemented as part of preventive health strategies. Continuous monitoring, community engagement, and consistent enforcement can make food safety practices an integral part of the school system while fostering healthy eating behaviors from an early age.

Study Limitations and Future Directions

This study was limited by its small sample size and single observation period. Future research should include more schools and vendors, repeated sampling, and longitudinal monitoring to generate more representative data.

Conclusion

This study demonstrates that snacks sold out at the school canteen and by nearby street vendors around SDN.005 Dr. Sutomo Samarinda Ulu were free from *Escherichia coli*, *Salmonella*, and hazardous food additives, such as borax, formalin, Rhodamine B, and Methanil Yellow. These findings suggest that the school environment has implemented relatively good hygiene and food safety practices, likely supported by continuous education and supervision from the local health center.

However, the results should be interpreted with caution due to several limitations, including the sample size, single observation period, and limited study area. These factors may not fully represent the broader condition of school food safety across Samarinda or other regions. Environmental variations, vendor turnover, and differences in raw material sources could also influence contamination levels over time.

Therefore, future research should involve more schools and samples, covering both microbiological and chemical aspects to ensure comprehensive food safety assessment. Strengthening vendor certification, hygiene training, and collaboration among schools, health offices, and community health centers is essential. Continuous education and routine monitoring are key to maintaining safe and healthy school food environments.

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Author Contribution and Competing Interest

All authors contributed to the writing of this article.

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