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Microbiology and Chemical Contamination Analysis of School Snacks in Bekasi

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ABSTRACT

Elementary school children are accustomed to consuming snacks available in the school environment, sold by street vendors. The snacks consumed by school children can determine the health condition of school children due to the risk of chemical and microbiological contamination contained in these snacks. This study aimed to analyse the quality of elementary school snacks based on food safety aspects in Bekasi City. The study design was experimental study. The samples used were snacks available at four elementary schools in East Bekasi. The sample analysis included examination of Escherichia coli, Salmonella sp, borax, formalin, rhodamine B, metanil yellow, saccharin, and cyclamate with repeated examinations for each sample. The number of samples was 33 snacks. The examination results reported E. coli content in AJ iced tea (3.1 X 102; 1.4 X102) and pudding (1.4X102). All samples were declared as safe from the substances, including borax, formalin, rhodamine B, and metanil yellow. Meanwhile, saccharin content beyond the safe limit was found in es gayung mangga (mean 157.46 mg/kg), es gayung coklat (mean 118.11 mg/kg), and es teh MH (mean 131.44 mg/kg). Cyclamate content beyond the limit was found in es doger (mean 844.01 mg/kg), es lilin (mean 485.55mg/kg), es gayung coklat (mean 942.28 mg/kg), es teh MH (mean 498.05 mg/kg). From this study, it was concluded that not all elementary school snacks have been declared to meet the safe criteria according to SNI and BPOM Regulations. It is suggested to have a routine evaluation and education by the school or health officers regarding snacks available sold by street vendors in the school environment.

Key Messages:

- Snack samples were collected in East Bekasi District. The analysis carried out included examination of Escherichia coli, Salmonella sp., borax, formalin, rhodamine B, metanil yellow, saccharin and cyclamate showed 2 samples were contaminated with Escherichia coli, saccharin content beyond the safe limit was found in 3 samples, and cyclamate content beyond the limit was found in 5 samples.

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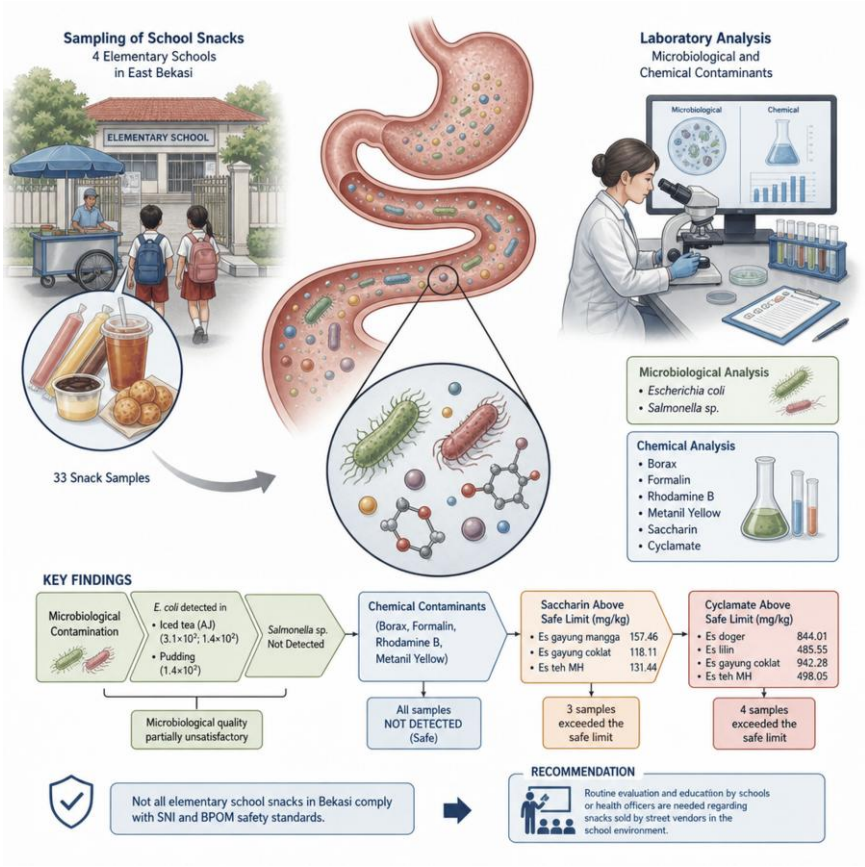
GRAPHICAL ABSTRACT



INTRODUCTION

Food safety is a global issue with significant implications for human health (1). Foodborne diseases are becoming increasingly common and pose a significant health problem worldwide (2). Elementary school children are a growing age group that requires quality food. However, this age group is particularly vulnerable to consuming risky foods. Risky foods are foods that have the potential to contain pathogenic microorganisms or other contaminants that can cause foodborne illness and support the growth of harmful microbes if not handled properly (e.g., temperature, storage, cooking). Pathogens generally grow in raw foods, but can still grow if the food is not properly processed(3). Risk foods are also foods or drinks that nutritionally contain high levels of added sugar and unhealthy fats, which, if consumed excessively and consistently, can increase the risk of developing non-communicable diseases (4). These risky foods include foods high in calories, fat, and sugar, and those that do not meet food safety standards. A study conducted in Bekasi City found that elementary school children typically obtain snacks from the canteen and street vendors around their elementary schools. Examples of commonly consumed snacks include flour-based snacks such as *cilok* (poked tapioca), *cireng* (fried tapioca starch), *cilor* (fried tapioca starch with eggs), *batagor* (fried fish dumplings with tofu), *sempol* (chicken skewer sausages), and others. Furthermore, school children commonly consume packaged foods and sweetened drinks from packages and are served directly by vendors (5). Furthermore, food contamination can occur during food handling through contact between food handlers and processed or unprocessed food, ready-to-eat dishes, or through contact with dirty work surfaces or equipment (6).

Another study conducted by a research team in Bekasi City also found that snacks consumed by school children contain high calories (7). In this study, the quality of snacks was assessed from the nutritional content aspect, but had not yet been examined from the food safety aspect. The food safety aspect is a food quality parameter to indicate that food is safe to consume, such as being free from contamination. Research in Bantul Regency using snack samples showed that of the types of meatballs tested, 15.3% tested positive for borax, and 25.5% tested positive for formalin. In addition, 46.7% were

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reported to contain rhodamine B. Of the elementary schools sampled, only 50% did not record any findings of hazardous chemicals (8). In addition to being free from chemical contamination, safe snacks must also be free from microbiological contamination. Research in Padang City found that there were still meatball snacks containing *Escherichia coli (usually abbreviated as E. coli)* above the threshold. This bacteria is a pathogenic bacteria or bacteria that can increase the risk of digestive infections (9). Besides *E. coli*, the type of bacteria to avoid in snacks is *Salmonella* sp. (6). Similar research has also shown bacterial contamination exceeding the threshold (10,11). Factors influencing the risk of contamination include the unsanitary nature of the cooking utensils and equipment used by those handling children's snacks at school (11).

A study conducted in Surabaya found that frequent snack consumption among elementary school children was associated with diarrhoea. Those who purchased snacks at school more than four times per week were 4.4 times more likely to develop diarrhoea than those who consumed them less than four times per week. Furthermore, high-risk snacks included peanut sauce and sauces, such as *cilok* (fried meatballs), *cireng* (fried meatballs), *batagor* (fried meatballs), and others (12).

Currently, there is no research analyzing snack quality based on food safety aspects in elementary schools in Bekasi City. While no studies have specifically analyzed the use of saccharin and cyclamate in Bekasi City, a recent study in Bekasi Regency documented the presence and patterns of use of these artificial sweeteners in local beverages such as *es campur* and *es dawet*, indicating the presence of artificial sweetener use in the Bekasi area (13). This supports our focus on saccharin and cyclamate as chemical hazards relevant to the local food safety context. Also, a study conducted in two sub-districts in Bekasi City (Medan Satria and Jati Asih) evaluated the relationship between street food hygiene and sanitation practices and E. coli contamination in school snacks (14). The findings revealed the presence of E. coli in street food sold in Bekasi schools. This indicates that pathogen indicators may be present in locally consumed foods and are likely to pose a risk in our food safety assessment. Previous research has limited findings to environmental factors in schools that may influence snack consumption patterns and determine nutritional content. Therefore, the researcher intends to conduct an analysis of the quality of elementary school snacks based on food safety aspects in Bekasi City.

METHODS

This research has passed the ethical review of the Research Ethics Commission of Muhammadiyah University of Purwokerto with the number KEPK/UMP/185/VII/2025. This study consists of an analysis of snack quality based on food safety aspects. The food safety aspects used consist of analysis of hazardous food additives (chemical contamination) and analysis of pathogenic bacteria (microbiological contamination). Testing was conducted by sampling snacks, namely the most frequently consumed foods and drinks, based on previous research. Samples were tested with chemistry and microbiology analysis. Chemical testing carried out included testing for rhodamine-B, borax, formalin, saccharin, and cyclamate. Microbiological contamination testing carried out included testing for *Salmonella* sp. and *E. coli.*

The snack samples tested were at least 100 g for food and 300 ml for beverages. During sampling procedure, researchers did not specify actual sample weights, but it was adequate for minimum weight for laboratory test. The samples were stored at low temperatures to prevent further contamination during testing. Each snack was tested in duplicate (double testing for each sample) from the same vendors. It intented to obtain two experimental results. Snack samples were collected in East Bekasi District using purposive sampling, at four school locations in four sub-districts, based on previous research. The snack samples studied were those commonly consumed by students in previous study (7). There were four study-site, including Margahayu, Bekasi Jaya, Aren Jaya, and Duren Jaya. Sampling was based on sample availability and ease of sampling in the four school environments. The number of vendors varied across schools. Vendors were selected based on the availability of snacks for sale. For example, in Bekasi Jaya, sample of the study were *es kepal coklat* (chocolate shaved ice), *es lilin* (ice lolly), *es mambo* (ice pop), teh kemasan botol (bottled tea*)*, *martabak manis* (sweet thick pancake), *kue cubit* (pinch cake), *siomay* (dumpling), *cilok* (poked tapioca), and es the (iced tea). In Duren Jaya, example of samples were *mie goreng* (fried noodles), *sempol* (chicken skewer sausages), *telur gulung* (rolled eggs), *sosis gulung* (rolled sausages), latiaw, *matabak telur* (savory folded pancake), and es teh (iced tea). In Aren Jaya, example of

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samples were *susu kemasan cup* (cup milk), *puding* (pudding) *cireng* (fried tapioca starch), and *es teh* (iced tea). In Margahayu, example of samples were *es doger* (shaved ice drink made from coconut milk, palm sugar, syrup and various fillings such as young coconut, cassava tape, black sticky rice tape, sago pearls, and jackfruit), *permen kapas* (cotton candy), *batagor* (fried fish dumplings with tofu), *es gayung mangga* (mango flavored iced drink), *es gayung coklat* (chocolate flavored iced drink), and *es teh* (iced tea). Iced tea samples were taken from each location, then during the analysis the samples were given initials such as BJ iced tea, DJ iced tea, AJ iced tea, and MJ iced tea.

E. coli testing was carried out with EMBA (Eosin Methylene Blue Agar) conducted based on AOAC 2009.06, while Salmonella testing was carried out with SSA (Salmonella Shigella Agar), conducted based on ISO 6579-1:2017. The interpretation of the results was concluded following the Indonesian National Standard (SNI) 7388:2009 concerning the Maximum Limits of Microbial Contamination in Food. The microbial analysis was carried out on 13 products of drinks and 21 products of school snacks. Testing for borax, formalin, rhodamine B, and metanil yellow was conducted using a rapid test. Limit of detection were following: borax 50 µg/ml, formalin 20 µg/ml, metanil yellow 2 µg/ml, and rhodamine B 1,5 µg/ml. The procedure using a rapid test is a follows: Take 5 grams of the sample, homogenise with aquades and then centrifuge until large particles are settled, take 1 ml clear solution and then drop the solution into the reagent kit (card or tube). Meanwhile, saccharin testing used High Performance Liquid Chromatography (HPLC), and cyclamate used spectrophotometry. This method is commonly used for testing. This method uses a wavelength with UV detection 230 – 254 nm. The following analytical procedure: first was sample extraction, for example, soft drink, continued with filtration process until 0,45 µm, and then injection to HPLC, determination of saccharin and cyclamate chromatogram peak, and then quantification with a standard curve (15). Interpretation in the use of food additives is drawn referring to the Indonesian Food and Drug Authority (FDA) or Badan Pengawas Obat dan Makanan (BPOM) No. 11 of 2019 concerning food additives (16), and No. 22 of 2023 concerning Raw Materials Prohibited in Processed Food and materials prohibited from being used as Food Additives (17).

RESULTS

The research results are presented in the attached table. Table 1 shows that samples containing *E. coli* (exceeding the Most Probable Number/APM of *E. coli* according to SNI 7388:2009, which is negative/100 ml) were *es teh AJ* (iced tea AJ) from one of four total vendors, also *puding* (pudding). In the *puding (*pudding), it was found that one of the puddings from the duplicate examination carried out contained *E. coli* while the other samples did not. The duplicate was carried out at the same food vendor so that contamination during portioning or serving of the pudding could be possible. Table 1 also shows that all samples met SNI requirements in terms of being free from *Salmonella* sp. No samples showed the presence of *Salmonella* sp.

Table 1. Result of *E. coli* and *Salmonella* sp. Analysis

Sample name	*E. coli*		*Salmonella* sp.[b]	
	Sample 1	Sample 2	Sample 1	Sample 2
Susu kemasan gelas	(-)	(-)	(-)	(-)
Es doger	(-)	(-)	(-)	(-)
Es teh BJ	(-)	(-)	(-)	(-)
Batagor	(-)	(-)	(-)	(-)
Sosis gulung	(-)	(-)	(-)	(-)
Nasi kuning	(-)	(-)	(-)	(-)
Susu kemasan kertas	(-)	(-)	(-)	(-)
Martabak telur	(-)	(-)	(-)	(-)
Es mambo	(-)	(-)	(-)	(-)
Kue cubit	(-)	(-)	(-)	(-)
Dalgona	(-)	(-)	(-)	(-)
Cilor	(-)	(-)	(-)	(-)
Cilok	(-)	(-)		
Siomay	(-)	(-)	(-)	(-)
Martabak manis	(-)	(-)	(-)	(-)
Cireng	(-)	(-)	(-)	(-)
Es kepal	(-)	(-)	(-)	(-)

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Sample name	*E. coli*		*Salmonella* sp.[b]	
	Sample 1	Sample 2	Sample 1	Sample 2
Es lilin	(-)	(-)	(-)	(-)
Latiaw	(-)	(-)	(-)	(-)
Permen kapas	(-)	(-)	(-)	(-)
Teh pucuk	(-)	(-)	(-)	(-)
Puding	1.4 x 10^2	(-)	(-)	(-)
Kerupuk seblak	(-)	(-)	(-)	(-)
Kerupuk singkong	(-)	(-)	(-)	(-)
Es mangga	(-)	(-)	(-)	(-)
Es coklat	(-)	(-)	(-)	(-)
Es teh MH	(-)	(-)	(-)	(-)
Es teh AJ	3.1 x 10^2	1.4 x 10^2	(-)	(-)
Telur gulung	(-)	(-)	(-)	(-)
Seblak	(-)	(-)	(-)	(-)
Sempol	(-)	(-)	(-)	(-)
Mie goreng	(-)	(-)	(-)	(-)
Pentol	(-)	(-)	(-)	(-)
Takoyaki	(-)	(-)	(-)	(-)
Cilung	(-)	(-)	(-)	(-)

[a]Method used: AOAC 2009.06; reference SNI 7388:2009 concerning the Maximum Limits of Microbial Contamination in Food
[b]Method used: ISO 6579-1:2017; reference SNI 7388:2009 concerning the Maximum Limits of Microbial Contamination in Food

Chemical tests for borax and formalin preservatives also yielded negative results. Table 2 shows no detectable traces of borax or formalin in any of the foods. Similar results can be seen in Tables 4 and 5, namely that no food was proven to use the dangerous food additives rhodamine B and metanil yellow.

Table 2. Result of the borax and formalin test

Sample name	National Standard[a]	Borax qualitative test[b]		Formalin qualitative test[c]	
		Sample 1	Sample 2	Sample 1	Sample 2
Batagor	(-)	(-)	(-)	(-)	(-)
Sosis Gulung	(-)	(-)	(-)	(-)	(-)
Martabak manis	(-)	(-)	(-)	(-)	(-)
Latiaw	(-)	(-)	(-)	(-)	(-)
Kerupuk Seblak	(-)	(-)	(-)	(-)	(-)
Kerupuk Singkong	(-)	(-)	(-)	(-)	(-)
Kerupuk Ubi	(-)	(-)	(-)	(-)	(-)
Seblak	(-)	(-)	(-)	(-)	(-)
Pentol	(-)	(-)	(-)	N/A	N/A

[a]National standard : reference the Regulation of the Head of BPOM No. 22 of 2023 concerning Raw Materials Prohibited in Processed Food and materials prohibited from being used as Food Additives
[b]Method used: rapid test
[c]Method used: rapid test

Table 3. Result of metanil yellow dan rhodamine B test

Sample name	Metanil yellow[b]			Rhodamin B[c]		
	National Standard[a]	Sample 1	Sample 2	National Standard	Sample 1	Sample 1
Sosis Gulung	(-)	(-)	(-)	(-)	(-)	(-)
Nasi Kuning	(-)	(-)	(-)	(-)	(-)	(-)
Latiaw	(-)	(-)	(-)	(-)	(-)	(-)
Kerupuk Seblak	(-)	(-)	(-)	(-)	(-)	(-)
Kerupuk Singkong	(-)	(-)	(-)	(-)	(-)	(-)
Kerupuk Ubi	(-)	(-)	(-)	(-)	(-)	(-)
Seblak	(-)	(-)	(-)	(-)	(-)	(-)
Pentol	(-)	(-)	(-)	(-)	N/A	N/A

[a]National standard : reference the Regulation of the Head of BPOM No. 22 of 2023 concerning Raw Materials Prohibited in Processed Food and materials prohibited from being used as Food Additives
[b]Method used: rapid test
[c]Method used: rapid test

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In addition to microbiological examinations, preservatives, and hazardous dyes, this study also tested the saccharin and cyclamate content of snacks. Table 4 shows findings that do not comply with Indonesian regulations, the saccharin and cyclamate content in snacks sold near elementary schools. Snacks containing saccharin were *es gayung mangga* (mango flavored iced drink), *es gayung coklat (chocolate flavored iced drink)*, and es teh MH (iced tea). All three samples contained saccharin levels exceeding the safe limit. Meanwhile, snacks containing cyclamate were *es doger* (shaved ice drink made from coconut milk, palm sugar, syrup and various fillings such as young coconut, cassava tape, black sticky rice tape, sago pearls, and jackfruit), *es lilin* (ice lolly), *es gayung coklat (chocolate flavored iced drink)*, and es teh MH (iced tea). All four samples were found to have levels above the safe limit.

Table 4. Result of saccharine and cyclamate test

Sample name	National standard (mg/kg)	Saccharine[a]			Cyclamate[b]			
		Sample 1	Sample 2	Mean	National standard (mg/kg)	Sample 1	Sample 2	Mean
Susu kemasan gelas	≤ 80	0	0	0	≤250	0	0	0
Es doger	≤ 120	0	0	0	≤350	861,48	826,54	844.01
Es Teh BJ	≤ 120	0	0	0	≤350	0	0	0
Susu kemasan kertas	≤ 80	0	0	0	≤250	0	0	0
Es mambo	≤ 120	0	0	0	≤250	0	0	0
Dalgona	≤ 120	0	0	0	≤350	0	0	0
Martabak manis	≤ 170	0	0	0	≤600	0	0	0
Es Kepal	≤ 120	0	0	0	≤350	0	0	0
Es Lilin	≤ 120	0	0	0	≤350	487,00	484,11	485.55
Latiaw	-	0	0	0	-	0	0	0
Permen Kapas	-	0	0	0	≤500	0	0	0
Teh kemasan botol	≤ 120	0	0	0	≤350	0	0	0
Puding	≤ 100	0	0	0	≤250	0	0	0
Es Gayung Mangga	≤ 120	187,44	127,48	157.46	≤350	326,03	322,92	324.47
Es Gayung Coklat	≤ 120	101,88	134,34	118.11	≤350	945,98	938,58	942.28
Es Teh MH	≤ 120	135,21	127,67	131.44	≤350	493,52	502,59	498.05
Es Teh AJ	≤ 120	0	0	0	≤350	0	0	0

[a]National standard : reference BPOM Regulation No. 11 of 2019 concerning Food Additives
[b]Method used: HPLC
[c]Method used: spectrophotometry

DISCUSSION

Based on Government Regulation of the Republic of Indonesia Number 86 of 2019 concerning Food Safety, it explains that food safety is the conditions and efforts required to prevent food from possible biological, chemical, and other contaminants that can disrupt, harm, and endanger human health and do not conflict with religion, beliefs, and culture of the community, so it is safe for consumption. In samples of *es teh* and *puding* were found to contain *E. coli*, so the *es teh (*iced tea) and *puding (*pudding) are classified as unsafe for consumption (18). *E. coli* is a short rod-shaped bacteria (coccobacilli), gram-negative, measuring 0.4 µm – 0.7 µm x 1.4 µm, and some strains have capsules. There are pathogenic and non-pathogenic *E. coli* strains. Non-pathogenic *E. coli* is commonly found in the human large intestine as normal flora and plays a role in food digestion by producing vitamin K from undigested material in the large intestine. Meanwhile, pathogenic strains of *E. coli* can cause severe cases of diarrhoea in all age groups through the endotoxins they produce (19). Several factors can influence the presence of *E. coli* bacteria in food, including food processing, handling, food storage, serving methods, and equipment washing (20). Contamination from *E. coli* bacteria can cause foodborne or waterborne diseases. Infection with the STEC (Shiga toxin-producing *E. coli*) bacteria can trigger diarrhoea in sufferers, ranging from mild diarrhoea to bloody diarrhoea and even the life-threatening condition Hemolytic Uremic Syndrome (HUS) (21). Hygiene and sanitation aspects in the preparation of various snacks in the school environment require attention

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because these situations and conditions can influence exposure to the risk of food/drink contamination by E. coli microbiological contamination. Iced tea is a beverage that is often enjoyed by the general public, including school-age children, both as a snack and as an accompaniment to certain foods. Research by Wahyuningsih (2019) showed that 10 samples of iced tea drinks sold around the STIKes BCM Pangakalan Bun campus were identified as containing E.coli that were not suitable for consumption (22).

Based on the borax and formalin test results, no sample was found to be classified as unsafe. The results of the study showed similar results to the tests conducted on snacks in elementary schools in Makassar City (23). Another study also reported similar results to this study. However, this study was conducted not in a school environment but near campus. Researchers tested snacks sold at the university, found that two of the nine samples contained borax, and none of them was positive in the formalin test(24). Based on a literature review study, 20 articles were obtained, which were then reviewed, and 12 articles were found to test for borax and formalin. Of the 12 articles reviewed, 5 reported positive test results for borax, 4 reported positive results for formalin, and 3 reported results that did not contain borax or formalin (25). According to the Regulation of the Head of BPOM No. 22 of 2023 concerning Raw Materials Prohibited in Processed Food and Materials Prohibited from being used as Food Additives, borax, formalin, rhodamine B, and metanil yellow are prohibited from being used or may not be present in food(17). This study demonstrated positive results regarding the safety of school snacks from the dangers of rhodamine B and metanil yellow. Several other studies have shown that vendors still sell snacks containing dangerous synthetic food colouring near elementary school area (8,26,27). Based on Irawan & Ani (2016), it was found that 66.7% of traders who use rhodamine B still have insufficient knowledge about rhodamine B and the dangers of its use (27). This means that the number of vendors who are aware of the ban on the use of rhodamine in school snacks is greater than those who already have good knowledge. This study found no samples containing rhodamine B or other hazardous food additives, so it is assumed that vendors have good knowledge.

Based on BPOM Regulation No. 11 of 2019 concerning Food Additives, maximum limits for saccharin and cyclamate are regulated in certain processed foods. Non-carbonated flavored drinks have a maximum saccharin content limit of 120 mg/kg and a maximum cyclamate limit of 350 mg/kg (16). In this study, foods/drinks have saccharin levels above the limit were mango-flavored ice dippers, chocolate-flavored ice dippers, and iced tea (1 of 4 locations). Cyclamate levels beyond the safe limit were found in ice pops, mango-flavored ice dippers, chocolate-flavored ice dippers, and iced tea (1 of 4 locations). Research conducted in a Study Group environment in Sidoarjo, East Java, found cyclamate content in sliced ice. The most common complaint after consuming these snacks was coughing. Cyclamate is said to be more affordable than granulated sugar. In addition, cyclamate has a stronger sweetness than granulated sugar (28). In contrast to the research conducted in Kendari, from the mixed ice snacks used as research samples, it was found that all samples using cyclamate showed levels within the normal limits determined by BPOM (29).

This study found no evidence of hazardous food additives being used in school snacks. These results align with research conducted in Salatiga and Samarinda. Previous research emphasized that, in addition to food safety aspects such as the use of safe food additives (BTP), there are still risks related to vendor hygiene and sanitation(30,31). This article demonstrates this by examining samples containing *E. coli* and *Salmonella* sp. above safe limits. In the pudding sample, only one sample showed unsafe results. This could be due to processing, such as pouring the mixture into plastic packaging. Furthermore, one iced tea sample was also found to contain *E. coli* above the safe limit. In this study, the saccharin and cyclamate content can also be considered in determining food safety. This is evident from the use of several sweeteners above the safe limit set by the government. For example, Es Doger did not contain *E. coli* or *Salmonella* sp., but was found to contain cyclamate three times the safe limit. Similarly, Es Teh AJ was declared unsafe based on microbiological parameters but safe due to the use of saccharin and cyclamate. Meanwhile, MH iced tea was declared safe based on microbiological parameters, but was proven to be unsafe when viewed from the saccharin and cyclamate content.

Based on testing, it was found that the cyclamate content in *es doger* reached 2-3 times the normal limit. Several previous studies found similar results, with sweetened beverages circulating in the

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community, such as boba drinks and coffee, known to contain cyclamate far above the normal limit (32,33). Research conducted in Iraq on diabetes mellitus patients and healthy subjects found that long-term cyclamate consumption can increase oxidative stress in both patients and healthy subjects. Consumption of this artificial sweetener can reduce glycemic control, increase the risk of atherosclerosis, and cause liver and kidney disorders (34). Research in mice showed that mice given low and high doses of cyclamate experienced significant increases in lipid profiles such as serum triglycerides, total cholesterol, and low-density lipoprotein. Furthermore, there was an increase in biochemical parameters indicating liver and kidney function, such as creatinine, AST, and ALT. This indicates an increased risk of consuming foods or beverages with high doses of cyclamate over a long period (35).

The present experimental study demonstrated the potential risks of food safety issues that could occur through food and beverages that are commercially available by local vendors surrounding the elementary schools in Bekasi City. Yet, we did not provide any particular analysis regarding the implications for school policies, since it may require a further step in the surveillance. Nevertheless, our results could gain more attention for further recommendations to schools for taking into action their monitoring and surveillance activities in collaboration with local sectors (e.g., education and health offices). Schools need to be more selective in providing permission to the local vendors. The education and training of hygiene and sanitation for the school canteen or even food vendors outside school is also needed. Additionally, our results could also persuade schools to be more active in giving education to students about healthy snacks for school children.

The limitation of the rapid test for borax and formalin is that the rapid test only provides a positive/negative result or an estimate, not a precise concentration. Different kits have varying sensitivities and specificities vary each kit has a different limit of detection(36). Food ingredients such as high-fat concentrated spices and dyes, or extreme pH can interfere with the kit's reaction and also, reagents are sensitive to temperature and shelf life (37). This also causes potential bias. Improperly stored kits can degrade the quality of results (38). Potential bias can occur due to sampling only being done at one time, which used to be in the morning, while food conditions can change in the morning or afternoon. For the saccharin and cyclamate test, potential bias can occur during sample preparation. For example, the sample is not homogeneous when the analyte concentration is determined. This cannot be observed directly by the researcher because the test is conducted by an external laboratory. For the microbial test, E. coli and Salmonella, a biochemical test was not carried out on the sample; this was to ensure that the bacteria that grew were actually *E. Coli* and *Salmonella sp*.

This study also shows limitation about geographic coverage of sampling, which may not be representative of the overall safety of school snacks across the city. The sampling was conducted only once, which may not capture temporal variations in chemical and microbiological contamination. Moreover, the study did not include verification of vendor hygiene and food handling practices, thus limiting the ability to link contamination findings to potential risk factors. Another limitation of this study is that we did not perform biochemical testing and only used selective media for the identification of *Escherichia coli* and *Salmonella* sp. Despite these limitations, the findings provide important preliminary evidence on the chemical and microbiological contamination of school snacks in Bekasi.

CONCLUSION

The findings of the study showed that all samples were classified as safe from chemical substances, including borax, formalin, rhodamine B, and metanil yellow. However, certain iced beverages were found to have saccharin content beyond the safe limit, and E.coli was also detected in the iced beverages (e.g., es teh AJ) and pudding samples. It is concluded that the snack quality in the school environment is still questionable and hence provide a potential risk of food safety issues through the hygiene and sanitation practices of the food vendors in Bekasi City.

The implication of the study warrants the concerns for the routine monitoring and surveillance program in alignment with national programs regarding the food safety of school children's snacks organized by the Ministry of Primary and Secondary Education and Food and Drug Administration or BPOM. Vendor training, water-source monitoring, and routine surveillance are recommended to prevent

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the same exposure in school children's snacks. Awareness and good practice to sell food for school children need to be increased so that the risk of food safety issues in the school environment could be eliminated. At the school level, we also recommend the nutrition education and such programs related to a healthy canteen and healthy snacks for students.

DECLARATION OF THE USE OF AI

The authors declare that no artificial intelligence (AI), AI-assisted technologies, or large language models (LLMs) were used in the conception of the study, data analysis, or the drafting, writing, and editing of this manuscript

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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