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Microbiological status of various foods served in elementary school based on social economic status differences in Karawaci Region, Tangerang District – Indonesia

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Abstract: Food can be easily contaminated by microorganisms in public places such as schools, sidewalks, festival areas and others; since it is widely exposed to the air. The purpose of this research was to determine the safety level of various foods served at three selected elementary schools according to their social economic status. Microbiological assay was conducted on fifteen kinds of food. Sample obtained from elementary school A were rice-with-chicken, meet ball, poffertjes, and noodle-with-chicken. Samples obtained from elementary school B were fried breaded-vegetable, banana chocolate, french fries, burger, and noodle-with-chicken. While the last, samples taken from elementary school C were batagor, dumpling, burger, fried banana and tempura. Total aerobic bacteria (APC), yeast and mold (YM), coliform bacteria, and *Staphylococcus aureus* (SA) were quantitatively analyzed, while qualitative test was conducted for Salmonella sp. The results showed dumplings had the highest contamination as the APC level reached approximately 10^5 cfu/g. The presence of *Salmonella* sp. was only found in foods obtained from elementary school C. In addition, metal contamination test was also performed within this study by means of Atomic Absorption Spectroscopy (AAS) method, which in conclusion that there was not any harmful metal found to contaminate those various foods.

Keywords: Food, microorganism, contamination, food safety, heavy metal

Introduction

Food is one of human's primary needs besides clothing and house. Food holds an important role in human's lives, thus a high level of food safety is needed to ensure that human is safe from diseases or dangers that come from foods. According to Indonesia Food Law No. 7 1996, food safety is defined as a condition and needed efforts to avoid foods to be contaminated from biological, chemical contamination agents and other substances that could disturb, harm and endanger human health. Therefore, in the market food safety is a predictor for well-educated consumers to buy a certain food (Michaelidou and Hassan, 2008). Though contamination could be from biological and chemical substances, most of foodborne diseases (~90%) are mainly caused by microbial contamination (Purtiantini, 2010). Water, soil, air, utensils, and human body are sources of microbial contamination.

According to Winarno (2004), it is highly possible that school and its surrounding cleanliness level may affect negatively safety level of foods microbiologically. Schools which are high in social economic status have a tendency of having a cleaner environment as compared to the lower social economic status ones. In Indonesia, according to National Agency of Drug and Food Control (NA-DFC) by the program of Integrated Food Safety System states the responsibility on food safety status in Indonesia belongs to all citizens (NA-DFC, 2011). Therefore, within this study, we have initiated to map and to get spot picture of food safety level of different elementary schools in Karawaci region, Tangerang district based on social economic status. Elementary schools A, B, and C are three elementary schools located in three separated places in Lippo Karawaci region, Tangerang district. The elementary school A has the highest social economic status with school fees of IDR 1,750,000 per month; the elementary school B has school fees of IDR 500,000 – 800,000 per month; whilst elementary school C has the lowest social economic status where this school does not charge their students any tuition fees. This study was not surveillance activity since it was only based on our awareness and initiative to determine microbiologically the safety level of various foods served in elementary schools. They were chosen based on social economic status differences.

Materials and Methods

Materials

Samples were various foods taken from three elementary schools in Karawaci region, Tangerang district, such as rice-with-chicken, meet ball, poffertjes, and noodle-with-chicken from elementary school A; fried breaded-vegetable, banana chocolate, french fries, burger, and noodle-with-chicken from

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elementary school B and; batagor, dumpling, burger, fried banana and tempura from elementary school C.

For microbiological analysis, chemicals used were microbiological grade, such as NaCl (Merck 137017), plate count agar (PCA, Sigma-Aldrich 70152), tartaric acid with purity 99% (TA, Sigma-Aldrich 483796), potato dextrose agar (PDA, Sigma-Aldrich 70139), eosin methylene blue agar (EMBA, Sigma-Aldrich 70186), mannitol salt phenol red agar (MSPRA, Sigma-Aldrich 63567), lactose broth (LB, Sigma-Aldrich 70142), tetrathionate broth (TB, Sigma-Aldrich 88151), rappaport vassiliadis medium (RV, Sigma-Aldrich R0773), xylose lysine deoxycholate agar (XDLDA, Sigma-Aldrich 95586), bismuth sulfite agar (BSA, Sigma-Aldrich 95388), crystal violet solution, ethanol pro analysis, safranin, iodine solution, and peroxide 0.5%.

Questionnaire Making and Distribution

Questions listed in the questionnaire were (1) type of gender; (2) grade of the student; (3) consumption frequency; (4) most popular food to be consumed; (5) student opinion on food and environmental hygiene at the canteen of each school, ill experiences, and also foods that cause disease. The distribution of questionnaire was following random multi-phased method. Number of respondents who filled the questionnaire must represent the total number of student population at each school. Students who filled the questionnaire in A and C elementary schools were consisted of students from grade 4 until 6, while at B elementary school, the questionnaire was filled by students from grade 1 until 6.

Identification and Classification of Food Sample Population

The samples used were various foods served in the canteen of elementary school A which is a school with the highest social economic status, elementary school B having middle social economic status, and whilst elementary school C has the lowest social economic status as compared to the two schools pre-mentioned above. Identification of sample population was done by taking a note of every single food sold in those three different schools. The food sample that has been noted would be used for classification of sample population found in each school. Moreover, food samples which were found in those three schools were classified by ways of how the food is usually processed by the seller. Samples found in those three schools were classified into fresh, processed, and street food.

Food Sampling

The samples were taken from the canteen of each school. The sampling was done after school break time which is usually 11.00 am. The food sampling was periodically performed 4 times for 4 weeks. Sampling at elementary school A was done every Tuesday, for elementary school B was Monday and for elementary school C was every Wednesday.

Environmental sanitation test was also conducted while food sampling was being done. This was carried out by letting petri dish contained solidified PCA exposed to air at each school for 5-10 min. The petri dish was then incubated in incubator at 37°C for 48 h.

Samples Preparation

Foods that had been taken from each school were inserted into a cool box and taken to the laboratory. For sample preparation, those foods were put into an HDPE bag and crushed using a stomacher. About 50 g of food material were weighed and added with 450 ml of NaCl (0.85%) solution. Afterward, samples were inserted again into stomacher to be homogenized for 2 min. Samples were diluted as to meet the requirement of calculation which could give the number of colonies at range of 25-250. Colony number determination was based on rules from FDA BAM (Food and Drug Administration, Bacteriological Analytical Manual) by FDA (2008).

Microbiological Analysis

Microbiological analysis was performed quantitatively and qualitatively. Total aerobic bacteria (Chaisowwong, 2007), yeast and mold (Edema *et a*l., 2008), coliform bacteria (Lee *et al*., 2009), and *S. aureus* (Aneja, 2005) were quantitatively determined, while qualitative assay was conducted for *Salmonella* sp. (Andrews *et al*., 2007).

Metal Contamination Analysis (Cu, Zn, Pb and Hg)

Metal contamination analysis was following Anggraeni (2009). This data used as supporting material for the safety level of those various foods in terms of chemical substances.

Results and Discussions

Determination of Respondents and Student Consumption Frequency at Elementary School A, B, and C

Total and percentage of respondents and student frequency consuming various foods served at canteen of elementary schools A, B, and C in a week long were presented in Table 1. Total questionnaire distributed

was 283, 296, and 120 students for each elementary school A, B and C, respectively. From Table I could be concluded that students from those three schools have had consumed various foods served in their canteens at least once in a week. This phenomenon found to be the main reason to conduct this study. The safety level of those foods has to be determined to ensure there will be no outbreak in the future term.

Table 1. Total, gender and consumption frequency of students

Category of questions		Total responses			Percentage (%)		
		Elementary school			Elementary school		
		A	B	C	A	B	C
Type of gender	Male	128	144	60	45,23	48,65	50
	Female	155	152	60	54,77	51,35	50
Grade	I	-	32	-	-	10,81	-
	II	-	40	-	-	13,51	-
	III	-	50	-	-	16,89	-
	IV	98	58	30	34,63	19,60	33,33
	V	107	63	30	37,81	21,28	33,33
	VI	78	53	30	27,56	17,91	33,33
Consumption frequency	< 1 time	38	78	4	13,43	26,26	3,33
	1 – 3 times	119	151	13	42,05	50,84	10,83
	3 – 4 times	59	22	14	20,85	7,41	11,67
	Every day	67	46	89	23,67	15,49	74,17

Analysis of Food Hygiene Level, Environment Hygiene Level, and Diseases

On the Table 2 showed the level of food and environment hygiene at elementary school A, B, and C. The elementary school A has the highest level of canteen cleanness in terms of environmental hygiene. About 75.27% or as many as 213 out of 283 students gave positive response to the school canteen of elementary school A; while for elementary school B and C possessed 71.23% and 61.67 % of students' response for school cleanness at level of less clean. Though the worse level of canteen environmental hygiene was at elementary school C, the students thought the level of various foods served in the canteen was acceptable in terms of food cleanness, indicated by 67.5% of total students stated the foods served were clean. For the canteen of elementary school A still possessed the highest level of food hygiene as high as 87.63% and the last food served in canteen B concluded to be dirty by 68.04% of response. Those results mentioned above were in agreement with Easa (2010) that dirtiness of environment could cause microbial contamination since air, water and even human is the source of microorganisms. This was supported by the probability of foodborne found in each school. The number of the students at elementary school C was the highest to experience illness after consuming the foods served from the canteen, up to 118 students and least found at elementary school A, as many as 25 students. Types of diseases students experienced were vomit, diarrhea, headache, fever, cough, typhus, and stomachache.

Table 2. Student assessment on food and environment hygiene level at their school

Category of questions		Total responses			Percentage (%)		
		Elementary school			Elementary school		
		A	B	C	A	B	C
Environment Hygiene	Clean	213	53	11	75,27	24,20	9,17
	Less Clean	0	156	74	0	71,23	61,67
	Dirty	70	10	35	24,73	4,57	29,17
Food Hygiene	Clean	248	70	81	87,63	31,96	67,5
	Dirty	35	149	39	12,37	68,04	32,5

Microbiological Assays of Various Food Samples

Microbiological assays were conducted for 4 weeks. Quantitative test was conducted to obtain total aerobic plate, total coliform, total number of *S. aureus* and total yeast and mold. Various microbiological assay results carried out on the various foods served at those three elementary schools including standards and infection dose according to Indonesian National Standards were presented on the Figure 1, 2, and 3.

As shown in Figure 1, 2, and 3 the total aerobic plate has the highest value (i.e., around 10^5 cfu/g) as compared to other quantitative tests ranging from 3.1 x 10^3 -7.9 x 10^5 cfu/g. At elementary school C, dumplings was the food sample with the highest value of total aerobic plate (7.5 x 10^5 cfu/g) while fried banana had the lowest value of total aerobic plate (3.1 x 10^3 cfu/g). Different levels of total aerobic plate found since the amount and type of microbe grows in food are affected by natural properties of food such as pH, water activity, environment, storage, processing method and including cross contamination from environment, plant, animal, soil or water as reported by Sperber and Doyle (2009).

The total count of yeast and mold ranging 7.5 x 10^0-4.1 x 10^3 cfu/g. Noodle-with-chicken was the food sample with the highest yeast and mold contamination (4.1 x 10^3 cfu/g) found at elementary school B. Moreover, yeast and mold contamination was not found in fried banan , tempura at elementary school C; French fries fried breaded-vegetable, banana chocolate, burger at elementary school B, and only one food found to be contaminated in elementary school C, it was meat ball. The range of food moisture level for yeast and mold to live is wider than bacteria as reported by Winarno (2004). It could be seen from the various products served in the canteen contaminated by them.

Based on Figure 1, 2, and 3, the results of coliform contamination of fifteen food samples were at level of 1.6 x 10^5 up to 2.7 x 10^2 cfu/g. Sample that had the highest coliform contamination was noodle-with-chicken as much as 1.6 x 10^5 cfu/g. Coliform contamination was not found in banana chocolate and burger for the elementary school B. For the level

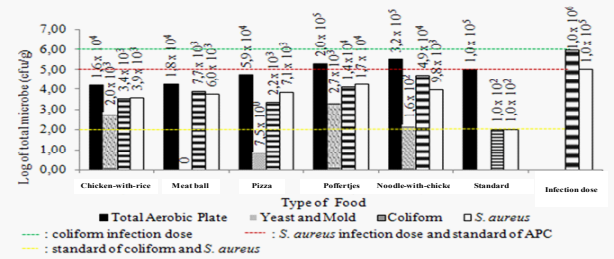

Figure 1. Microbiological analysis results of various foods served in the canteen of elementary school A

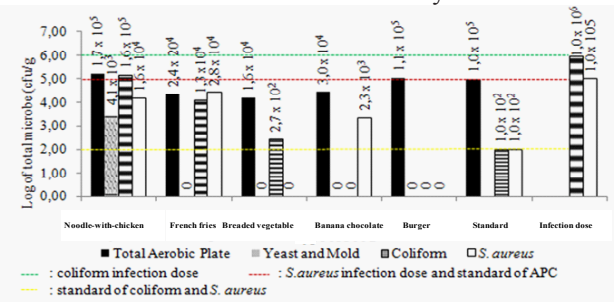

Figure 2. Microbiological analysis results of various foods served in the canteen of elementary school B

Figure 3. Microbiological analysis results of various foods served in the canteen of elementary school C

of *S. aureus* contamination approximately between 3.7 x 10^5 and 8.5 x 10^2 cfu/g. Dumplings at elementary school C was the sample with the highest *S. aureus* contamination as compared to elementary school B and C (3.7 x 10^5 cfu/g).

Qualitative test which conducted for *Salmonella* sp. only gave positive result in samples taken from the C elementary school, while qualitative test for *Salmonella* sp. in samples taken from A and B elementary schools gave negative results. Positive result of *Salmonella sp*. indicated the processing and sanitation to serve the foods in the canteen was not appropriate and letting Salmonella to grow. It corresponded with our pre-mentioned results on the worse environmental hygiene in elementary school C since *Salmonella* is the bacteria for indicating a certain sanitation level of an environment.

Overall microbiological tests showed elementary school C found to have the lowest food safety level. It was based on results of total aerobic plate and the presence of *Salmonella* sp. which was only found from samples taken from elementary school C. This concluding remark was supported by the results of environmental sanitation test which was conducted at those three schools. The result can be seen in Table 3.Environmental sanitation test data could not be presented at the elementary school C since the colony fell out of range. However, although most students in elementary school B marked the canteen environmental as less clean (71.23%), the elementary school B had the highest sanitation quality as seen on the Table 3.

Table 3. Environmental sanitation test at A, B, and C elementary school

Week	Elementary School		
	A	B	C
Week I	144	21	NA
Week II	156	18	NA
Week III	157	15	NA
Week IV	158	24	NA

Note: Determination was not performed (Not Analyzed, NA) since the colony fell out of range (>250 colonies).

Based on Figures 1, 2 and 3, high level of microbial contamination could come from improper sanitation practices at the canteen during the processing and selling period. As reported by Ahmed *et al*. (2008), lack of good sanitation practices and proper storage will increase microbial contamination. Microbial contamination can also be caused by microbes that naturally grow at those foods. Moreover, according to Easa (2010), Udo *et al*. (2009), Uzeh *et al*. (2009), Elmacioglu *et al*. (2010), Bukar *et al*. (2010) and Ahmed *et al*. (2008), it was found that various pathogenic bacteria existed in food contained of meat, vegetable, flour, spices, tomato and egg. A similarity of raw material ingredients between those studies compared to this research could be one of presumptions of microbial contamination in samples from A, B, and C elementary schools.

Since the Food Law No. 7 1996 contains penalty good manufacturing practices of handling food products is a must. According to National Agency of Drug and Food Control (NA-DFC) by the program of Integrated Food Safety System, the education and socialization of food safety practices for sellers of foods around the campuses and school canteens have been being promoted each year (NA-DFC, 2011). However, since many of those sellers are not well-educated the program is going to be problematic. Therefore, the results of this study could be used as 'driving force' to push those sellers to be more carefully to handle foods served in the canteen when they are exposed to the air.

Chemical Contamination: Cu, Zn, Pb, and Hg Metal Contamination

Types of metal contamination tested within this study were copper (Cu), lead (Pb), zinc (Zn), and mercury (Hg). The results showed the level of metal

Table 4. Metal contamination assays of various foods and maximum standard according to Indonesia national Standard (SNI, 1992) and Handayani *et al.* (2010)Equastere, crentis tenihilius

Type of Food	Type of Metal Contamination							
	Cu (ppm)	Max. Standard (ppm)	Zn (ppm)	Max. Standard (ppm)	Pb (ppm)	Max. Standard (ppm)	Hg (ppb)	Max. Standard (ppm)
Rice-with-chicken	1.53	10	5.62	40	0.09	1.00	1.10	0.03
Meat ball	1.40		6.41		0.07	1.00	0	0.03
Pizza	1.21		25.44		0.02	1.00	0	0.03
Poffertjes	1.32		16.34		0.16	1.00	0	0.03
Noodle-with-chicken	1.63		13.61		0	1.00	0	0.03
Noodle-with-chicken	0.88		6.40		0.14	1.00	0.33	0.05
French fries	0.93		3.55		0.28	2.00	0	0.03
Fried breaded-vegetable	1.56		5.56		0.13	0.5	0	0.01
Banana chocolate	2.15		15.81		0.72	1.00	0.77	0.05
Burger (B)	1.51		12.56		0.28	1.00	0	0.003
Batagor	1.29		8.77		0.14	1.00	0	0.05
Dumplings	1.94		4.83		0.14	0.3	13.58	0.5
Burger (C)	1.67		19.32		0.00	1.0	0	0.03
Fried banan	0.62		2.40		0.18	0.25	0	0.03
Tempura	0.74		2.14		0.07	1.0	0.02	0.03

concentration was exceeding the number stated in the standard as it can be seen in Table 4. The metal had highest contamination amongst others was Zn. Possible source of higher contamination of Zn was from utensils that were used to process those foods.

Conclusions

Microbiological assay results from fifteen samples taken from elementary school A, B, and C showed socio-economic status in fact did not have a direct effect on to microbial contamination. Sanitation practices by the worker and environmental sanitation quality were factors that cause microbial contamination. This was proven by results of the study showing microbial level of foods served in the canteen elementary school A and B did not have a significant difference, although both of them had a different socio-economic status.

Our awareness through this study brings our university to give periodical training about standard operational procedure and good manufacturing practices for canteen staffs and workers that could give a positive impact in increasing food safety level.

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