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Microbiological Status of Foods Served in Food Vending Centers in the Cagayan State University

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Abstract

This study focused on the microbiological quality of foods served in the food centers of the Cagayan State University particularly in the Andrews Campus and Carig Campus. The microbiological quality of four kinds of ready-to-eat food samples sold were assessed in order to draw up strategies to improve the safety of these foods.

Keywords: Foods Served, Microbiological Quality, Microbiological

Introduction

Food safety is a major public health concern. This arises from the fact that foods for human consumption can be contaminated with naturally occurring pathogenic microorganisms whose presence cannot be readily detected organoleptically. Yet when the level of contamination reaches a considerable level food borne illnesses can occur. Food borne illnesses comprise a broad spectrum of diseases and are responsible for a substantial morbidity and mortality worldwide. In 2000, the World Health Organization (1) reported that globally 2.1 million people died from diarrheal diseases and that a great proportion of these cases can be attributed to contamination of food and drinking water. In 2005, an estimated 2 million deaths worldwide occurred due to gastrointestinal illness (2). More than 250 different food borne illnesses are caused by various pathogens or by toxins (3). Food borne illnesses result from consumption of food containing pathogens such as bacteria, viruses, parasites or the food contaminated by poisonous chemicals or bio-toxins (4).

Microbiological Assessment of Food Samples

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The microbial population of food samples was examined to assess the quality of foods served in the University canteens. The following parameters were used to describe the quality of food samples: total aerobic bacteria count, coliform count, fungal count and *S. aureus* count.

Total Aerobic Plate Count

Table 1. Mean total aerobic bacteria (TAB) (cfu/g) of food samples collected from canteens in University A.

Treatment (Food Sample)	Replicate			Mean	Rank
	R1	R2	R3		
T1 – Dinakdakan	55500	449750	80075	195108.33	1
T2 – Burger	5925	14075	45275	21758.33	4
T3 – Siomai	32125	22300	13075	22500.00	3
T4 – Juice	76825	286825	37550	133733.33	2

Table 1 shows the mean total aerobic bacterial count of food samples collected from canteens in University A. Dinakdakan was the food sample with highest value of TAB (1.95 x 105 cfu/g) followed by juice (1.33 x 105 cfu/g). Burger showed the least value of TAB (2.17 x 104 cfu/g) while siomai had 2.25 x 104 cfu/g. However, results of analysis of variance (ANOVA) revealed that there is no significant difference on the mean TAB of all tested food samples during the various sampling period (Appendix Table 1).

Table 2. Mean total aerobic bacteria (TAB) (cfu/g) of food samples collected from canteens in University B.

Treatment (Food Sample)	Replicate			Mean	Rank
	R1	R2	R3		
T1 – Dinakdakan	236225	52500	200200	162975.00	1
T2 – Burger	87250	34400	46750	56133.33	3
T3 – Siomai	14150	2250	196350	70916.67	2

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T4 – Juice	100150	2000	64825	55658.33	4

Table 2 shows the mean TAB of food samples collected from canteens in University B. Dinakdakan also had the highest value of TAB (1.62 x 10^5 cfu/g) followed by siomai (7.09 x 10^4cfu/g). Juice showed the least value of TAB (5.56 x 10^4cfu/g) while burger follows siomai with 5.61 x 10^4cfu/g. However, results of analysis of variance (ANOVA) revealed that there is no significant difference on the mean TAB of all tested food samples during the various sampling period (Appendix Table 2).

As shown in Figure 1, 2, and 3 the total aerobic plate count has the highest value (i.e., around 10^5cfu/g) as compared to other quantitative tests namely, coliform count, fungal count, and *Staphylococcus* count. Counts ranged from 2.25 x 10^3 – 1.93 x 10^5cfu/g were observed. Different levels of TAB are observed since the amount and type of microbe that 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 (5). Most food spoilage microorganisms are mesophilic, that is, they grow best at moderate temperature (around 25 – 40^{o}C) which was the prevailing temperature during the conduct of the study.

In both university canteens, dinakdakan was the food sample with the highest value of TAB. When the mean TAB of food samples collected from canteens of the two sites (University A and University B) were compared, results of t-test revealed that there is no significant difference on the level of TAB present on each food sample (Appendix Table 3). This implies that the same factors affecting the growth of microorganisms in both sites are prevailing at the time of sampling.

Total Coliform Count

Table 3. Mean coliform count (cfu/g) of food samples collected from canteens in University A.

reatment (Food Sample)	**Replicate**			**Mean**	**Rank**
	R1	**R2**	**R3**		
T1 – Dinakdakan	32500	13975	24550	23675.00	3
T2 – Burger	1625	58475	91875	50658.33	1
T3 – Siomai	0	1125	450	525.00	4

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T4 – Juice	10250	38650	39875	29591.67	2

Table 3 shows the mean coliform count of food samples collected from canteens in University A. Coliform load was highest in burger (5.06 x 10^4cfu/g), followed by juice (2.95 x 10^4cfu/g), then dinakdakan (2.36 x 10^4cfu/g). Siomai registered the lowest value of coliforms with 5.25 x 10^2cfu/g. However, results of analysis of variance (ANOVA) revealed that there is no significant difference on the mean coliform count of all tested food samples during the various sampling period (Appendix Table 1).

Table 4. Mean coliform count (cfu/g) of food samples collected from canteens in University B.

reatment (Food Sample)	Replicate			Mean	Rank
	R1	**R2**	**R3**		
T1 – Dinakdakan	195325	5625	65050	88666.67	1
T2 – Burger	1325	1775	350	1150.00	4
T3 – Siomai	1175	175	30900	10750.00	3
T4 – Juice	6575	4775	48450	19933.33	2

On the other hand, Table 4 shows the mean coliform count of food samples collected from canteens in University B. Dinakdakan had the highest coliform count, followed by juice (1.99 x 10^4), then siomai (1.07 x 10^4cfu/g). The lowest coliform count was seen in burger with 1.15 x 10^3cfu/g. However, results of analysis of variance (ANOVA) revealed that there is no significant difference on the mean coliform count of all tested food samples during the various sampling period (Appendix Table 2).

Based on Table 3 and 4, the results of coliform contamination of the four food samples were at level of 5.25 x 10^2 up to 8.86 x 10^4cfu/g. Samples that had the highest coliform contamination were burger and dinakdakan collected from University A and University B, respectively. However, when the mean coliform counts of food samples collected from canteens of the two sites (University A and University B) were compared, results of t-test revealed that there is no significant difference on the level of coliforms present on each food sample (Appendix Table 3). This implies that the same factors affecting the growth of microorganisms in both sites are prevailing at the time of sampling.

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It was observed that in the university canteens surveyed, most foods served are pre-cooked, placed in open aluminum serving plates or pots, and displayed either in food cabinets or on top of tables, and do not need to be heated before consumption. As such these carry potential risk of microbial contamination due to circulating air-borne microorganisms as well as by improper food handling by the staff during the canteen services.

The presence of microorganisms in foods represents a microbiological risk for consumers (6). In this investigation, the high number of total aerobic bacteria in the samples suggest lack of hygienic practices, and the presence of coliforms may indicate fecal contamination which might be due to inappropriate processing, probably at one or other stage of preparation or from the materials used. Coliforms might appear in every phase of preparation as reported. (7).

Fungal Count (Yeast and Mold)

Table 5. Mean fungal (yeasts and molds) count (cfu/g) of food samples collected from canteens in University A.

reatment (Food Sample)	Replicate			Mean	Rank
	R1	R2	R3		
T1 – Dinakdakan	14750	132175	105150	84025.00	1
T2 – Burger	4075	1825	5425	3775.00	4
T3 – Siomai	60500	8250	4450	24400.00	2
T4 – Juice	24225	6325	2825	11125.00	3

Table 5 shows the mean count of fungi (yeasts and molds) present in the food samples. Fungal counts ranged from 1.82 x 10^3 – 8.40 x 10^4cfu/g in foods collected from canteens in University A. As in TAB and coliform count, dinakdakan showed the highest fungal contamination (8.40 x 10^4cfu/g) while burger registered the least fungal count (3.77 x 10^3cfu/g). Results of ANOVA revealed that there is no significant difference of the fungal counts of foods served in the canteens in University A (Appendix Table 1).

Table 6. Mean fungal count (cfu/g) of food samples collected from canteens in University B.

reatment (Food Sample)	Replicate	Mean	Rank

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	R1	R2	R3		
T1 – Dinakdakan	10650	7500	6150	8100.00	3
T2 – Burger	3625	13275	2525	6475.00	4
T3 – Siomai	11500	9225	13000	11241.67	2
T4 – Juice	16300	4025	16400	12241.67	1

On the other hand, as shown in Table 6 fungal counts in foods collected from canteens in University B ranged from 2.52×10^3 – 1.63×10^4cfu/g. Juice was found to have the highest fungal contamination (1.22×10^4cfu/g) while burger showed the least (6.47×10^3cfu/g). Results of ANOVA also revealed that there is no significant difference of fungal count of foods served in the canteens of University B (Appendix Table 2).

All food samples collected from both university canteens were found to be contaminated with yeasts and molds. However, dinakdakan was found to have the highest yeast and mold contamination (4.1×10^3cfu/g) in University A in all weeks sampling. Burger had the lowest yeast and mold contamination in both University canteens. However, when the mean fungal counts of food samples collected from canteens of the two sites (University A and University B) were compared, results of t-test revealed that there is no significant difference on the level of fungi present on each food sample (Appendix Table 3). This implies that the same factors affecting the growth of microorganisms in both sites are prevailing at the time of sampling.

A closer look at the raw data (Appendix Table 1) revealed that foods served in some canteens in the university do not have fungal contamination. This can be explained by the fact that most yeasts and molds prefer a slightly acidic environment. Fruits and vegetables can provide a lower pH, however, no foods of these kinds were surveyed in this study.

The presence of fungi particularly molds in the food samples can be attributed to their mode of reproduction as they disperse in the form of spores which is abundant in the environment and can be introduce through dust and soil (8). Their presence in these food samples is of serious public health concern as some fungal species have been implicated with the production of mycotoxin (9).

Prevalence of Pathogens in Foods

As much as possible foods must be free from contamination. The presence of *E. coli* and *S. aureus* in food demonstrates a potential health risk as these organisms are pathogenic and have been implicated in food borne diseases.

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Table 7. Distribution of bacterial pathogens in food samples served in the canteens of University A.

Bacterial Isolate	Food Sample				Number (%) Occurrence
	Dinakdakan (n=12)	Burger (n=12)	Siomai (n=12)	Juice (n=12)	
Staphylococcus aureus	10	10	12	7	39/48 (81.25%)
Escherichia coli	2	0	0	1	3/48 (6.25%)
Total Isolates	12	10	12	8	42

Table 7 depicts the occurrence of possible pathogens in the food samples tested from the canteens of University A. Between the 2 pathogens detected, *S. aureus* (81.25%) was more prevalent than *E. coli* (6.25%). Dinakdakan and siomai had the highest level of contamination with 12 (28.57%) isolates each. Juice had the lowest level of contamination with 8 (19.05%) isolates. *S. aureus* was detected in all food types while *E. coli* was detected in dinakdakan and juice only. (10)

Table 8. Distribution of bacterial pathogens in food samples served in the canteens of University B.

Bacterial Isolate	Food Sample				Number (%) Occurrence
	Dinakdakan (n=12)	Burger (n=12)	Siomai (n=12)	Juice (n=12)	
Staphylococcus aureus	11	7	7	7	32/48 (66.67%)
Escherichia coli	2	0	0	0	2/48 (4.17%)
Total Isolates	13	7	7	7	34

Table 8 depicts the occurrence of possible pathogens in the food samples tested from the canteens of University B. Between the 2 pathogens detected, *S. aureus* (66.67%) was more

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prevalent than *E. coli* (4.17%). Dinakdakan had the highest level of contamination with 13 (38.24%) isolates while burger, siomai and juice had a level of contamination with 7 (20.58%) isolates each. *S. aureus* was detected in all food types while *E. coli* was detected in dinakdakan only. (11)

Comparing the prevalence of food pathogens in the canteens, University A recorded the highest number of isolates with 42 (87.5%) as compared to University B with 34 (70.83%) isolates.

Table 9. Mean *Staphylococcus* count (cfu/g) of food samples collected from canteens in University A.

Treatment (Food Sample)	Replicate			Mean	Rank
	R1	R2	R3		
T1 – Dinakdakan	73675	185500	55500	104891.67	1
T2 – Burger	1025	725	4750	2183.33	4
T3 – Siomai	33025	13825	8275	18375.00	2
T4 – Juice	6575	7600	0	4725.00	3

Table 9 shows the mean *S. aureus* count of food samples collected from canteens in University A. Dinakdakan was the food sample with highest value of S. aureus (1.04 x 10^5cfu/g) followed by siomai (1.83 x 10^4cfu/g). Burger showed the least value of *S. aureus* (2.18 x 10^3cfu/g) while juice had 4.72 x 10^3cfu/g.

Results of analysis of variance (ANOVA) revealed that there is a significant difference on the mean *S. aureus* count of food samples during the various sampling period in University A (Appendix Table 1) at 5% level of significance. Moreover, results of Least Square Difference (LSD) test revealed that the dinakdakan had the highest value of *S. aureus* count, while burger, siomai and juice have comparable *S. aureus* count.

Table 10. Mean *Staphylococcus*count (cfu/g) of food samples collected from canteens in University Site B.

Treatment (Food Sample)	Replicate			Mean	Rank
	R1	R2	R3		

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T1 – Dinakdakan	41875	19425	79000	46766.67	1
T2 – Burger	9225	13550	1150	7975.00	3
T3 – Siomai	7450	2550	76200	28733.33	2
T4 – Juice	750	775	2150	1225.00	4

On the other hand, Table 10 shows the mean *S. aureus* count of food samples collected from canteens in University B. Dinakdakan was also the food sample with highest value of *S. aureus* (4.67×10^4 cfu/g) followed by siomai (2.87×10^4cfu/g). Juice showed the least value of *S. aureus* (1.22×10^3cfu/g) while burger had 7.97×10^3cfu/g.

Results of analysis of variance (ANOVA) revealed that there is no significant difference on the mean *S. aureus* count of all food samples during the various sampling period in University B.

The presence of *S. aureus* in foods suggests poor hygiene practices of canteen operators. (12) reported that the contamination by food handlers is the most common mode of transmission of this germ. (13) established that food contamination might have resulted from man's respiratory passages, skin and superficial wounds which are his common sources.

In the present study, the high staphylococcal count obtained from the food samples could be due to poor hygiene practices, particularly deficient of aprons and caps and improper food handling. This microbe could also have been introduced by the canteen staff as *S. aureus* are found on the skin and in the nose and throat of most healthy people. In addition, the use of unclean kitchen paraphernalia such as chopping boards and knives during the preparation of the food can also be possible source of contamination, as in the case of dinakdakan and burger. The sauce as well as its container which is used in the preparation of burger can also be a possible source of contamination as spoiled ingredients or unclean materials harbor a lot of microorganisms introduced by the food handlers as well as from frequent handling by the customers. The use of untreated water or spoiled milk can also be responsible for the prevalence of *S. aureus* which was observed in the juice samples.

Summary of Findings

All food samples showed microbial contamination with all microbial groups considered in this study. However, mean microbial counts showed variability between and among the food samples surveyed in the canteens of the two university campuses. Among the food samples, dinakdakan had the highest mean microbial count, particularly in terms of total aerobic bacteria (TAB) and *S.*

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aureus in both campuses. Coliform count was highest in dinakdakan from University B. Siomai had the least microbial count in University A, in terms of all the microbial parameters assessed. In all food samples examined, TAB was the most predominant group of microorganisms present.

When the two campuses (University A and University B) were compared in terms of mean microbial counts, University A had the highest microbial value in terms of TAB, fungi and *S. aureus*. Coliform count was highest in University B.

In terms of the prevalence of pathogenic bacteria, *S. aureus* was most prevalent in food samples from canteens in University A. All food samples were contaminated with *S. aureus*. However, it is highest in dinakdakan.

In terms of the prevalence of indicator microorganism, *E. coli* has very low prevalence in the food samples examined. It was generally observed in dinakdakan food samples.

However, results of statistical analyses revealed no significant differences in microbial counts between and among food samples in University A and University B.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

1. Food samples, regardless of food category, are susceptible to contamination from most groups of microorganisms.
2. The presence of microorganisms in fully cooked foods is an indicator of post-processing contamination or inadequate cooking.
3. Foods served in the canteens of CSU Andrews and CSU Carigconstitute a likely potential hazard to human health.
4. The collection site and time of sampling do not have a significant effect on the levels of microbial contamination in food.
5. The presence of pathogenic microorganisms, such as *S. aureus*, is the best criterion for assessing the microbial quality of food samples as it has potential health risks implications.
6. Dinakdakan is the food sample that carries a high potential risk of transmitting pathogenic microorganisms.

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Conflict of interest, Ethical Statements

No conflict of interest, ethical statements

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