International Journal of Tropical Medicine 10 (3): 10-16, 2015
ISSN: 1816-3319

The Correlation Between the Storage of Food Ingredients Before Preparation and Leftover or Unprocessed Ingredient Storage to *Escherichia coli* Contamination in Campus' Food Service

[1]Dewi Susanna, [2]Tris Eryando, [3]Aria Kusuma, [4]Yvonne M. Indrawani and [1]Zakianis
[1]Department of Environmetal Health, Faculty of Public Health, Universitas Indonesia,
FKM-UI Gedung C Lt. II Kampus Baru UI, 16424 Depok, Indonesia
[2]Department of Biostatistic, Faculty of Public Health, Universitas Indonesia,
FKM-UI Gedung B Lt. II Kampus Baru UI, 16424 Depok, Indonesia
[3]Center of Public Health Intervention Technology,
National Institute of Health Research and Development, Ministry of Health,
Indonesia, Badan Penelitian dan Pengembangan Kesehatan, Kemenkes RI,
Jl. Percetakan Negara No. 29, Jakarta
[4]Department of Nutrition, Universitas Indonesia, FKM-UI Gedung G Lantai 3,
Kampus Baru UI, 16424 Depok, Indonesia

Abstract: This study developed based on the findings from the previous study that revealed a high-level of *Escherichia coli* (*E. coli*) contamination in the Faculty of Public Health's cafeteria. The objective of the study was to find the correlation between food ingredients storage before they were prepared and cooked and the storage of leftover or unprocessed ingredients in canteens or cafeterias throughout a campus in a university located in Depok, West Java, Indonesia. The design of the study was a cross-sectional conducted in 2010. Food counters in the campus became subjects of the study and the entire food handlers totaling 173 persons became the respondents representing all food the sold. Laboratory examination performed on the sample of dishes served in the canteens or cafeterias to find out the Most Probable Number (MPN) of *E. coli*. As it turned out, more than half of the dishes sampled or around 59.54% contaminated with *E. coli*. The factor most closely linked to the contamination was the method for storing the leftover or unprocessed ingredient which consisted of poultry and 40 other types of leftover or unprocessed ingredients while the unprocessed poultry was properly stored and protected from *E. coli* contamination and during preparation and when served as dishes. Unfortunately, the other 40 types of unprocessed ingredients were facing a risk nine times higher to *E. coli* contamination during storage and therefore they still carried the risk when served as dishes in the cafeterias. The management of the campus's cafeterias should coordinate with the local Health Office and all food handlers involved in food preparation to improve and enhance the safety system ofall the food stored, prepared and served in canteens and cafeterias through out the campus.

Key words: Storage, food ingredient, leftover or unprocessed ingredient, cafeteria, *E. coli*

INTRODUCTION

In general, students and workers who work on and around campus would visit canteens and cafeterias and consumed food sold around and near their place of activities. Therefore, it is crucial that the management of food safety be the focus of all concerned parties to prevent the spread of food borne diseases. Diseases triggered by consumption of less than sanitary food had been inflicted quite a number of students and campus residents. Cafeterias or canteens around campus were usually nothing more than a location or in another word they were food court where a number of food vendors would congregate in a location provided by the faculty or campus. When a case of *Escherichia coli* (*E. coli*) contamination was found in sample of the food served and then it surmised that fecal-oral contamination could have occurred during thepreparation process. *Escherichia coli* were the bacteria observed as an indicator for the quality of hygiene and sanitation in the process of preparing the food.

Corresponding Author: Dewi Susanna, Department of Environmetal Health, Faculty of Public Health, Universitas Indonesia, FKM-UI Gedung C Lt. II Kampus Baru UI, 16424 Depok, Indonesia

The study on the food served in campus's cafeterias in 2009 revealed that spicy food with sambal or chili has the highest potential of *E. coli* contamination (90.15%), followed by dry food while the food with broth or soup has the least risk (38.89%). A study conducted on the Technical Campus in Addis Ababa, Ethiopia revealed that the diarrhea epidemic among the students caused by a particular dish in the lunch menu which previously was stored in a container contaminated with fecal matter (Aragaw *et al*., 2011). Another study conducted in a campus in Burkina Faso, Western Africa, showed that the bad hygiene habits of the food handlers who managed the food chain had contributed to a wide spread contamination of Salmonella, Coliform and Staphylococcal in raw meat.

As a rule, the sequence of food procession begin with the receiving of the ingredients, followed by storing, preparation, cooking and serving. In each phase of the process without a proper management there was a real potential for contamination and a risk that certain microorganisms would breed and grow on food that was not stored properly. A Directive by the Indonesian Minister of Health (Keputusan Menteri Kesehatan, Kepmenkes) No. 942/MENKES/SK/VII/2003 on the guidelines of hygiene and sanitation in preparing food for sale, stipulates that food courts that sell food to the public must have managers. The manager charged with maintaining the sanitation as well as general cleanliness of the facilities. Attachment to the aforementioned Directive also outlines the training materials that must be mastered by a food court manager and the food handlers including aspects related to the safety of stored and served food.

Aspects related to food storage as well as those related to leftover or unprocessed ingredients were the focus in food safety. Observations made during the storing phase include the following; the actual storage container in which the ingredientwere stored, storage temperature, duration of storage and separation of cooked and uncooked food to prevent cross-contamination. The safe temperature to store food is anywhere below 5°C or somewhere above 60°C. A safe and proper storage would significantly decrease the possibility of pathogen bacteria growing and breeding in food. Until now, a thorough observation had never been carried out to the food vendors operating on campus, therefore, this study was expected to reveal the correlation between the storage of fresh unprocessed ingredient before preparation and cooking and served to the customers and the storage of the leftover or unprocessed ingredient.

MATERIALS AND METHODS

This study carried out using a cross-sectional design and it conducted on food sold by food vendors in the campus of a state university located in Depok, West Java. The dependent variable in the study was *E. coli* contamination found in the food served by the food vendors. Statistical observation were made on the independent variables which consisted of storage management of the ingredients before processing and storage management of any unprocessed ingredients and their correlation with *E. coli* contamination in the food served by the food vendors. Variables related to storage management consisted of the actual storage container in which the ingredient were stored, storage methods for keeping fruits, vegetables, rice/grains, fish, poultry, egg and beef and any other container that might be used to store ingredient, fridge cleanliness and how often the fridge was cleaned. The observed variables of unprocessed ingredient storage include, among others, the actual storage container in which the ingredient were stored, storage methods for keeping fruits, vegetables, rice/grains, fish, poultry, egg and beef and any other container that might be used to store ingredient. Other unprocessed ingredient were classified into 2 groups, i.e., unprocessed group I consisted of 75 food items (liquid sugar, meatballs, rice noodle/vermicelli, porridge, herbs and seasonings, peanut seasoning, cincau/grass jelly, squid, melinjo, ice blocks, cincau/grass jelly ice, grape juice, ribs, soy sauce, young coconut, kolang kaling, krecek, kwetiauw noodle, macaroni, chocolate rice/chocolate flakes, noodle, chicken noodle, instant noodle, cow lungs, pasta, rice cake, bread, coconut milk, tomato ketchup, siauwmay, syrup, soun, sausages, milk, tofu, tempe/soybean cake, shrimp) and unprocessed group II consisted of 40 food items agar-agar, meatballs, selasih/basil seeds, seasonings, basic kitchen seasonings, ice blocks, sugar, mushrooms, soy sauce, cheese, kerupuk/crackers, kolang kaling, noodle, otak-otak/grilled fish cake, herbs, sea weeds, coconut milk, vegetable, jam/fruit preserve, syrup, soun, spaghetti, milk, tofu, tempe/soybean cake, flour, wheat flour, shrimp and squid, stored in a low-risk container.

The data collectors recruited from the Faculty of Environmental Health stream students. They chosen based on their expected competence, i.e., to reduce the potential bias sometimes made by data collectors. Prior to collecting the necessary data, all data collectors given training in interview techniques, training on observing and collecting samples by the laboratory staff and the researcher. The sample consisted of one hundred and seventy three foods and beverage items from different

food vendors throughout campus. The 50 g from each dish sampled taken for analysis. The sample dishes purchased from each vendor who was also the respondents in this study. The served food mixed thoroughly using the actual spoon used during serving. The collected sample taken aseptically to ensure that the analyzed sample would represent the food's actual condition. Meanwhile, for food that served without a spoon, it mixed using the actual utensil used when preparing the food. Analysis of the sampled food carried out in the Laboratory of Environmental Health of the University of Indonesia.

Analysis of *Escherichia coli* contamination in the food done using a Membrane Filter Method where in the initial stage the sampled food was prepared accordingly and in the second stage was the filtration process using the membrane filter.

The collected data were then processed and grouped categorically, followed later by bivariate and univariate analysis. Bivariate analysis was done to see the correlation between each independent variables to the dependent variable, i.e., *E. coli* contamination found in the food servedusing χ^2-test with level of significance 0.05 (α = 0.05). Multivariate analysis was done using logistic regression test to find out which of the variable was the most related to *E. coli* contamination in the food and beverage served throughout campus.

This research was a part of research granted by Directorate Research and Public Services of Universitas Indonesia through Cluster Research Grant. Part of this grant already published on Makara Journal of Health Research volume 18 number 1 entitled "Relationship between selection and processing food with *Escherichia coli* contamination on food stall serving". The other one is under consideration to publish in the same journal with title "The Correlation Between Eating Utensils and Place of Sales in the Contamination of *Escherichia coli* in Food Sold at Campus Food Stalls", thus the method of analysis *E. coli* and some parts of the results are the same.

RESULTS AND DISCUSSION

More than half (59.54%) of the sampled food and beverage served by the vendors were contaminated by *E. coli* and 40.46% of the sample were not contaminated. The result of bivariate analysis on the storage of unprocessed ingredient illustrated in Table 1.

Table 1: The correlation between variables of ingredient storage before processing and the storage of unprocessed ingredientto *E. coli* contamination in the foods served throughout the campus

	E. coli contamination					
Variable (s)	Yes = 103 n (%)	No = 69 n (%)	Total n (%)	p-values	OR	95% CI
Ingredient storage prior to processing						
Has a storage to keep food						
No	24 (60.0)	16 (40.0)	40 (100)	1.00	1.03	0.49-2.11
Yes	79 (59.4)	54 (40.6)	133 (100)			
Has other storage place beside a refrigerator						
No	51 (57.3)	38 (42.7)	89 (100)	0.65	0.83	0.45-1.52
Yes	52 (61.9)	32 (38.1)	84 (100)			
Storing fruit in the fridge						
No	5 (62.5)	3 (37.5)	8 (100)	0.56	1.14	0.26-4.93
Yes	98 (59.4)	67 (40.6)	165 (100)			
Storing vegetables in the fridge						
No	34 (57.6)	25 (42.4)	59 (100)	0.84	0.89	0.47-1.68
Yes	69 (60.5)	45 (39.5)	114 (100)			
Storing grains in the freezer						
No	36 (60)	24 (40)	60 (100)	1.00	1.03	0.54-1.95
Yes	67 (59.3)	46 (40.7)	113 (100)			
Storing fish in the freezer						
No	1 (50)	1 (50)	2 (100)	0.65	0.67	0.04-10.99
Yes	102 (59.6)	69 (40.4)	139 (100)			
Storing poultry meat in the freezer						
No	16 (47.1)	18 (52.9)	34 (100)	0.15	0.53	0.25-1.13
Yes	87 (62.6)	52 (37.4)	171 (100)			
Storing eggs in the refrigerator						
No	18 (58.1)	13 (41.9)	31 (100)	1.00	0.93	0.42-2.04
Yes	85 (59.9)	57 (40.1)	142 (100)			
Storing meat in the freezer						
No	3 (75)	1 (25)	4 (100)	0.47	2.07	0.21-20.32
Yes	100 (59.2)	69 (40.5)	169 (100)			
Storing non-perishable ingredients in the refrigerator						
No	33 (61.1)	21 (38.9)	54 (100)	0.91	1.10	0.57-2.12
Yes	70 (58.8)	49 (41.2)	119 (100)			

Table 1: Continue

Variable (s)	*E. coli* contamination: Yes = 103 n (%)	No = 69 n (%)	Total n (%)	p-values	OR	95% CI
Storing perishable ingredients in the refrigerator						
No	21 (67.7)	10 (32.3)	31 (100)	0.41	1.54	0.67-3.50
Yes	82 (57.7)	60 (42.3)	142 (100)			
Clean the freezer						
No	97 (58.4)	69 (41.6)	166 (100)	0.15	0.23	0.03-1.99
Yes	6 (85.7)	1 (14.3)	7 (100)			
Storage of unprocessed ingredient						
Has a storage to keep food						
No	23 (53.5)	20 (46.5)	43 (100)	0.45	0.72	0.36-1.44
Yes	80 (61.5)	50 (38.5)	130 (100)			
Has other storage place beside a refrigerator						
No	8 (72.7)	3 (27.3)	11 (100)	0.28	1.88	0.48-7.35
Yes	95 (58.6)	67 (41.4)	162 (100)			
Storing fruit in the refrigerator						
No	8 (72.7)	3 (27.3)	11 (100)	0.28	1.88	0.48-7.35
Yes	95 (58.6)	67 (41.4)	162 (100)			
Storing vegetables in the refrigerator						
No	15 (57.7)	11 (42.3)	26 (100)	1.00	0.91	0.39-2.13
Yes	88 (59.9)	59 (40.1)	147 (100)			
Storing grains in the freezer						
No	36 (60)	24 (40)	60 (100)	0.65	0.68	0.04-10.99
Yes	67 (59.3)	46 (40.7)	113 (100)			
Storing fish in the freezer						
No	7 (43.8)	9 (56.3)	16 (100)	0.28	0.49	0.18-1.39
Yes	96 (61.1)	61 (38.9)	157 (100)			
Storing poultry meat in the refrigerator						
No	9 (62.5)	12 (37.5)	21 (100)	0.15	0.46	0.18-1.17
Yes	94 (59.4)	58 (40.6)	152 (100)			
Storing eggs in the refrigerator						
No	10 (58.8)	7 (41.2)	17 (100)	1.00	0.97	0.35-2.68
Yes	93 (59.6)	63 (40.4)	156 (100)			
Storing meat in the refrigerator						
No	4 (75)	1 (25)	5 (100)	0.33	2.79	0.31-25.48
Low-risk	99 (59.2)	69 (40.5)	168 (100)			
Storing other ingredient (1) in the refrigerator I						
No	13 (56.5)	10 (43.5)	23 (100)	0.93	0.87	0.36-2.10
Yes	90 (60)	60 (40)	150 (100)			
Storing other ingredient (2) in the refrigerator II						
No	10 (90.9)	1 (9.1)	11 (100)	0.03	7.42	0.93-59.33
Yes	93 (57.4)	69 (42.6)	162 (100)			

*No: also means no unprocessed/no left over; n: no. of observation; OR: Odds Ratio and CI: Confidence Interval

Table 2: Variables selected as candidates for multivariate analysis on the variables of food ingredients storage before preparation and unprocessed ingredients storage for regression model of *E. coli* contamination found in food and beverages served in campus cafeterias

Variables	β	p-values	OR	95% CI
Before serving				
Clean up freezer	-1.26	0.25	0.28	0.03-2.45
Storage of leftover or unprocessed ingredient				
Poultry in the refrigerator	-0.94	0.06	0.39	0.15-1.05
Other ingredient II	2.22	0.04	9.16	1.08-77.50
Constants	-1.64	0.14	0.19	

OR: Odds Ratio and CI: Confidence Interval

The next analysis was a multivariate analysis to find which one of the variables wasthe likely culprits to *E. coli* contamination in the food served. In the initial stage, variables were selected as candidates to undergo multivariate analysis by observing whether the value of their p = 0.25, before taking them further to logistic regression analysis. The following is the variables selected as candidates (Table 2).

After obtaining the variables candidates above, the next step was logistic regression analysis (Table 3). It meant that storing leftover poultry meat in a refrigerator without a proper protection against *E. coli* contamination

Table 3: Result of the final multivariate analysis on the variables of food ingredients storage before preparation and unprocessed ingredients storage that closely related to *E. coli* contamination found in food and beverages served in campus cafeterias

Food processed variables	β	p-values	OR	95% CI
Storing poultry in refrigerator	-0.986	0.05	0.37	0.14-1.00
Other ingredients (II)	2.247	0.04	9.46	1.13-79.44
Constant	-1.670	0.13	0.19	

OR: Odds Ratio and CI: Confidence Interval

and the storage of perishable ingredients carried a high-risk that was nine times riskier to *E. coli* contamination in the food served in canteens and cafeterias throughout UI's campus.

Result of the study revealed that more than half of the sample food examined in the study contaminated with *E. coli*. *Escherichia coli* contamination gave a strong indication of a lack in food safety system. The occurrence of *E. coli* contamination in the food served throughout the campus's canteens and cafeterias revealed the weakness in the existing food safety system. *Escherichia coli* lives in the oral cavity, esophagus, stomach, colon, rectumandanus; it leads a facultative aerobiclife. This bacterium is the cause of numerous food borne diseases.

In addition to observing *E. coli* contamination in the food served throughout the campus's canteens and cafeterias, the study also focused on the management of ingredients and the leftover or unprocessed items. The study found two significant factors that correlate closely with the exposure to *E. coli* contamination in the food served in cafeterias throughout university's Depok Campus, i.e., leftover poultry meat and the other 40 types of leftover or unprocessed ingredients (group II) as previously mentioned in the result of this study.

Some of the food served were prepared and cooked on site in the canteens or cafeterias. The storage of leftover or unprocessed ingredients referred to the storage of part of the ingredients that already been used during preparation of the food. The restoring of ingredients done because those ingredients were not completely used. The storage method of leftover poultry related to *E. coli* contamination in the food served. It able to protect the ingredient against contamination in another words, a low-risk storage method carried more risk to exposure of *E. coli* contamination in the food served. Presumably this was related to the fact that this study did not take into account the microbiological quality of the leftover poultry to be stored. Consequently, it was not known whether the leftover ingredient was still safe or whether it already contaminated by microorganism before taken to storage. There was a distinct possibility that the leftover poultry already contaminated by *E. coli* or other micro-organisms when that leftover ingredient was taken out of storage to be prepared and served as dishes in canteens or cafeterias. Therefore, even though the leftover ingredient was stored in a fridge (low-risk storage method), it still correlate to *E. coli* contamination in the food served.

Several items must be taken into account in processing raw poultry. The most important things are duration and storage temperature. If fresh poultry is stored in a freezer at -18°C, it could be safely stored for not more than a year. If fresh poultry is stored in a fridge (not a freezer) at 4°C then it could only be stored for 4 days. Raw poultry is one of the perishable ingredients. Raw poultry meat should not be left too long in room temperature (dangerous temperature zone), since temperature between 5-60°C are dangerous temperatures for food. Raw poultry meat stored in room temperature would provide an ideal breeding ground for the growth of microorganism.

Leftover or unprocessed ingredients would be exposed more than once to the dangerous temperature zone between 5-60°C. The explanation is as follows; the leftover poultry meat has to go through the same procuring-storing-preparation-restoring-preparation cycle. Even worse, the ingredient might have to go pass a riskier path, i.e., storing-preparation-being left exposed to room temperature (dangerous temperature zone) for an undetermined time-and stored again-and taken out again to be prepared. When the ingredient was taken out of the storage, it would be exposed to room temperature which would provide an ideal breeding ground for the growth of microorganism in food.

Raw poultry meat is highly vulnerable to *E. coli* contamination. Some of contamination sources for meat and poultry at food vendors includes among others, butcher knives, organism thriving in the meat carcass, chicken intestine, food handlers' hands, container used to transport the meat, the surface of the shelves where the food is placed, the surrounding location where the animals were butchered and the animal's lymph nodes. As we could see in traditional markets or travelling vegetables sellers who also sell raw poultry meats, all the above sources for contamination are not properly managed to say the least. The knives used to butcher, clean the chicken digestive organs and cut the carcass is highly exposed to *E. coli* contamination from chicken intestine. Hands of the butcher or the person who sell the meat also contributed to the risk of *E. coli* contamination when they slaughter the chicken or when they cut the carcass and when they take the pieces to the shelves where the meat sold. The same is also true for the travelling vegetables sellers wherein the cutting board and knives they used are also highly exposed to *E. coli* contamination from the chicken they sold.

After the meat bought by the food vendors or food handlers, it would be taken to storage before preparation. Next when the ingredient taken out from storage, it would contact with the food handlers' hands, kitchen utensils such as cutting knives, cutting board used to prepare the dish. All of these factors would increase the risk of contamination if *E. coli* or other microorganism has contaminated the food handlers' hands and the surface

board where the ingredients placed. Temperature of the room where food was prepared also contributes to the breeding of *E. coli* in chicken carcass. This study did not sufficiently cover critical control points along the procurement path and storage of leftover or unprocessed ingredients. Hence, it was unable to elaborate on aspects such as temperature for the ingredients storage, thawing method, thawing temperature, duration when the ingredients exposed to room temperature. This study also did not take into account the level of *E. coli* contamination in the stored chicken carcass, thus, it could not elaborate on the safety of the stored chicken carcass with regard to *E. coli* contamination.

This study also revealed another factor with a significant correlation with *E. coli* contamination, the storage method of other leftover or unprocessed food ingredients (II). This unprocessed food ingredients (II) consisted of 40 types of ingredients such as jelly, liquid sugar, meatballs, selasih/basil seeds, seasonings, basic kitchen seasonings, ice blocks, sugar, mushrooms, soy sauce, cheese, kerupuk/crackers, kolang-kaling, noodle, otak-otak/grilled fish cake, herbs, sea weeds, coconut milk, vegetable, jam/fruit preserve, syrup, soun, spaghetti, milk, tofu, tempe/soybean cake, flour, wheat flour, shrimp and squid. Ten of those 40 ingredients classified as perishables they are shrimps/squids, tempe/soybean cake, tofu, milk, jam/fruit preserve, vegetables, coconut milk, otak-otak/grilled fish cake, kolang kaling and meatballs. Perishable food should not be left in contact with room temperature for >2 h and should be stored in a fridge at 4 or -18°C to keep them safe. Observation conducted during the study revealed that almost all the ingredients were stored in low-risk storage, i.e., fridge or dry container and not mixed with any other ingredients. However, even when the storage used to keep leftover or unprocessed ingredients were up to standard, it still did not guarantee that the stored ingredients would be free from microorganism contamination. This might be the result of other seemingly unrelated event for instance before the ingredients were taken back to storage there could be contact with the food handlers' hands, place where the food was being prepared, exposed to room temperature and unclean kitchen utensils contaminated with *E. coli*.

A study conducted on street food vendors in Hyderabad, India, revealed that microorganism (Sudershan *et al*., 2012) contaminated most of the food handlers' hands. Another study on fast food sellers in Andalusia, Spain, revealed a high level of *E. coli* contamination in the cutting boards and water faucets which indicates the procedures for maintaining the cleanliness of the utensil used and place where the food is prepared could be improved (Rodriguez *et al*., 2011). Other study conducted to observe the type of bacteria which include among others, *E. coli*, showed that among food handlers who keep long nails before they washed their hands, there were 4-8 species of bacteria found on their hands and 35% of them still contaminated even after they washed their hands. Furthermore, the researcher also found that the occurrence of recontamination after hand washing was the result of using unsanitary towel or using their own clothes to dry their hands (Dumavibhat *et al*., 1989). Nevertheless, this study did take into account the microbiological quality of the ingredients before restoring, the duration of contact with room temperature, cleanliness of the utensils and the food handlers' hands. Therefore, this study could not make a further elaboration whether the ingredients have been contaminated or not before restoring.

The path for the handling of leftover or unprocessed ingredients are as follows; storage-preparation-restore of leftover or unprocessed items-preparation. The safe, i.e., proper temperature for storing high-risk ingredients or perishable is <5°C for cold storage. The safe storage temperature for shrimps and squids is <4°C for a maximum duration of 1-2 days and -18°C for a maximum duration of 3-6 months. Before preparing the dish, the ingredients should be thawed first. It is highly recommended that the thawing process begin in the fridge, until the ingredients no longer frozen and then tshey could be taken out for further preparation. The leftover ingredients belonging to the high-risk group or perishable should be immediately stored at safe temperature (<5°C or >60°C). Another study conducted by the United States Food and Drugs Administration about the risk factors in Institutional Food Services such as schools, hospitals, restaurants and food retails in general during the period 1998-2008, revealed the prevailing lack of personal hygiene among the food handlers. The others were disregarding the best practices on storage duration and safe temperature and serving methods and contamination on the surface board where the food was prepared and in the utensils used.

Like the leftover poultry, any other leftover or unprocessed ingredients left exposed at room temperature would be a breeding ground for microorganism growth. Furthermore, we should also pay a close attention to the temperature of the fridge and freezer. Keep in mind that cold temperature will not kill any existing microorganism; it only delayed the growth and development. The recommended temperature for a freezer for storing meat, fish, poultry and other perishables is -18°C while the recommended temperature for a fridge is 4°C. This study did not make an exhaustive observation whether the

leftover or unprocessed ingredients were immediately stored at the safe and proper temperature or whether it was left exposed at room temperature for some time before putting it back in the cold storage. The study also did not observe with regard to *E. coli* contamination on cutting boards, knives and the actual surface board where the food was prepared. Therefore, the safety of those factors with regard to *E. coli* contamination was not known. Storage temperature, cleanliness of the food handlers' hands and the utensils used for preparing the food and the surface board used to prepare the food are the contributing factors in food contamination when they are not clean.

In addition to the ten perishables ingredients mentioned previously, there are also 30 other non-perishable ingredients, including, among others, seasoning. Reusing leftover seasoning used the next day is not recommended, unless the seasoning will be boiled with the other ingredients. Non-perishable items should be safer than perishable ingredients; however, there is always a possibility for contamination, if they are not handled properly. Pay attention to the storage's physical protection against pest, rats or insects as well as the cleanliness of the location and container used to store the ingredients.

Good personal hygiene of the food handlers, good sanitation and the availability of clean water and correct cooking procedures (cooking temperature >70°C) will break the chain of *E. coli* contamination in the food served by food vendors. Proper hygiene practices in canteens and cafeterias throughout University of Indonesia's campus will break the chain of *E. coli* contamination in the food served by food vendors caused by the lack of safety protocols at the supplier of raw ingredients used in canteens and cafeterias in UI's campus.

CONCLUSION

The study found two significant factors that correlate closely with the exposure to *E. coli* contamination in the food served in cafeterias throughout the campus. Fisrtly, leftover or unprocessed poultry was properly stored and protected from *E. coli* contamination and when served as dishes. Secondly, the other 40 types of unprocessed ingredients (group II) were facing a risk nine times higher to *E. coli* contamination during storage and therefore they still carried the risk when served as dishes in cafeterias.

RECOMMENDATION

The management of the campus's cafeterias should coordinate with the local Health Office and all food handlers involved in food preparation to improve and enhance the safety system of all food stored, prepared and served in canteens and cafeterias throughout the university. Food handlers expected to focus more on aspects related to food safety prior to storage, during storage and storing food ingredient properly. Ingredients that were easily spoiled or perishable must be stored in a fridge set at the correct temperature while the food handlers themselves should maintain their personal hygiene, keeping their cooking utensils clean and maintaining the cleanliness of dining areas in cafeterias throughout University of Indonesia's campus.

ACKNOWLEDGEMENTS

The researcher would like to thank the Diredtorate of Researc and Community Services Universitas Indonesia for bequeathing the grants through Cluster Competence Grant with contract No. 3429/H.R12/23PPM/2010. The same acknowledgement also extended to all team members who have provided their assistance in collecting and analyzing the data for this report. Special token of appreciation is given to Dita Sabariah dan Azizah who had help in study composition.

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