

Heavy metals assessment and sensory evaluation of street vended foods

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Abstract

In this study, the level of lead and cadmium present on the most often consumed street vended foods available around the University of Santo Tomas, España, Manila, as well as the effect of exposure to environment on the amount of these heavy metals on street vended foods were determined using Atomic Absorption Spectrophotometry (AAS) after dry ashing (AOAC No. 999.11). The sensory characteristics of a selected street vended food were also evaluated on a time-dependent manner to determine effect of exposure to environment on the panellists' degree of liking using the 7-Point Hedonic Scale. Results of the study shows that the lead content in deep-fried breaded quail eggs (*kwek-kwek*) and steamed dumpling (*siomai*) were 0.23 to 0.28 µg/g and 0.53 µg/g, respectively. While the level of lead and cadmium in grilled chicken's small intestine (*isaw*) ranges between 0.54 to 2.1 µg/g for lead and 0.14 to 0.24 µg/g for cadmium. There was no significant difference among samples of grilled *isaw* in terms of appearance, aroma and general acceptability. This means that a consumer would not be able to detect newly grilled chicken's small intestine from those grilled that were already exposed to environment for a period of time. Moreover, a consumer can be at a higher risk in consuming grilled chicken's small intestine that was exposed to the environment for a given period of time as this would have higher amount of lead and cadmium, than chicken's small intestine consumed immediately right after grilling.

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Introduction

Street vended foods, or its shorter equivalent street foods, are defined as those ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers in the streets and other public places for immediate consumption or consumption at a later time without further processing or preparation (WHO, 1996; WHO, 2010). This definition includes meat, fish, fruits, vegetables, grains, cereals, frozen produced and beverages which are sold outside the authorized market areas for immediate consumption. In the Philippines, street vended foods are known for its unique flavour, appearance, variety and availability at low cost. Some of the well-known Philippine street-vended foods include fried sugar coated banana (*banana-cue*), fried sugar coated sweet potato (*camote-cue*), chickens' small intestines (*isaw*), chicken feet (*adidas*), chicken head (*helmet*), coagulated chicken or pork blood (betamax), breaded squid (*kalamares*), breaded quail egg (*kwek-kwek*), breaded chicken egg (*tokneneng*), one-day old chick, boiled duck egg with underdeveloped embryo (*balut*), fish ball, squid ball, kikiyam, dumpling (*siomai*), barbeque and many more.

On the other hand, street foods vending is famous to a large number of people as a source of inexpensive, convenient and often nutritious foods

for urban and rural poor; a source of attractive and varied foods for tourists and those economically advantaged individuals; and it also provides business opportunities for a very low capital. Street foods vending plays an important role in assuring food security for low-income urban populations (WHO, 2010). Commonly, street-food vendors are often poor, not adequately educated, and lack knowledge and appreciation on basic food safety; thus, street foods are perceived to be a major public health risk.

The major concern in street vended foods is their safety for consumption. This is due to the observed unsanitary practices of vendors during handling, preparation and selling of street foods. According to the study conducted by Manguiat and Fang (2013), samples of street vended foods were found to be unsatisfactory due to high levels of aerobic plate count, coliform, *Escherichia coli* and *Staphylococcus aureus*. The presence of specific microorganisms such as *Escherichia coli*, *Staphylococcus aureus* and *Salmonella* in street vended foods is indicative of the of ignorance on the part of the food handlers towards proper hygienic practices (Lues *et al.*, 2006). In addition, lack of basic infrastructures, such as provision of potable water supplies, hand-washing facility and decent toilet or urinal for the vendors, is another concern in street food vending operation.

Several researches had shown that street vended

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foods are the usual causes of food poisoning. Microorganisms in street vended foods such as *Salmonella* spp. and *Staphylococcus aureus* are considered health risks and are leading causes of foodborne infections (Harakeh *et al.*, 2005; Guven *et al.*, 2010). Reports are also available regarding the risks in consuming street vended foods that are contaminated with pathogenic bacteria such as *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens* and *Vibrio cholerae* (Hanashiro *et al.*, 2005; Mankee *et al.*, 2005; Cho *et al.*, 2011).

Majority of safety studies on street vended foods had focused on microbiological contamination in street vended foods, and only few had studied other aspects that could affect the quality and safety of such food. Street vended foods may not only be exposed to pathogenic microorganisms, but to hazardous chemicals as well. One aspect that is not widely studied is the possible presence of heavy metals in street vended foods at an unacceptable level which may eventually lead to serious health problems.

Nowadays, hundreds of pollutants are discharged into the environment, among these, heavy metals are regarded as serious pollutants (Altındağ & Yiğit, 2005). The risk associated with the exposure of food product to heavy metals had aroused widespread concern in human health. Contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain (Hussain *et al.*, 2012). Since these metals are bio-accumulated, it is necessary to study the concentrations of heavy metals in street foods in order to assess the levels of exposure of the consumer to toxic metals. Thus, this study aimed to determine the level of heavy metals, specifically lead and cadmium that may be present on the most often consumed street vended foods identified by 150 randomly selected students of the University of Santo Tomas, España, Manila. This study also intended to assess the effect of exposure to the environment on the amount of lead and cadmium, and on different sensory characteristics of street vended foods.

Materials and Methods

Determination of consumers behaviour over street vended foods

A survey was conducted to assess the consumers' behaviour in the consumption of street vended foods. Survey forms were given to 150 randomly selected students of the University of Santo Tomas (UST), España, Manila. The forms basically consisted of the following questions: Which among the street vended

foods available around UST do you consume most often? How often do you consume street vended food? And how many do you consume? Factors affecting students' decision in consuming street vended foods over those foods being sold inside the university, and students' awareness on associated health risk in the consumption of street vended foods were also asked during the survey.

Sample collection and heavy metals analysis

From the results of the survey, the three most often consumed street vended foods available around UST were identified and were sampled for heavy metals analysis. Sampling was conducted between 1:00 PM to 4:00 PM on the same day. For deep-fried breaded quail eggs (*kwek-kwek*) and grilled chicken's small intestines (*isaw*), samples were taken at zero hour – right after frying or grilling, and two hours after frying or grilling and exposure to the environment; for steamed dumpling (*siomai*), samples were taken only at zero hour or right after steaming. *Kwek-kwek* and *siomai* samples were collected from 2 different food stalls located nearest the gate of UST along P. Noval Street and Dapitan Street, respectively; while grilled *isaw* samples were collected on a food stall located along P. Noval Street. Each sample was placed on a sealed plastic bag and labelled with the name of the food followed by "0H" and "2H" indicating zero hour and two hours after frying or grilling and exposure to the environment, respectively.

Collected samples were submitted to a testing laboratory. Food samples collected at different locations were composited, and the amount of lead (Pb) and cadmium (Cd) present on the samples were analyzed using Atomic Absorption Spectrophotometry (AAS) after dry ashing (AOAC, 2000).

Sensory evaluation and statistical analysis

Sensory evaluation was conducted to determine the effect of exposure to environment on sensory characteristics of grilled chicken's small intestines (*isaw*). Sampling of grilled *isaw* took place between 4:00 PM to 6:00 PM on food stall located at P. Noval Street. Samples were collected at zero hour – right after grilling, one hour and two hours after grilling and exposure to the environment, and placed in sealed plastic bag and labelled with "0H", "1H" and "2H" respectively. Samples for evaluation were placed in plastic cups in approximately 5 g per cup immediately after collection; each cup had a unique three-digit number code. Coded samples were presented to 11 semi-trained panellists, and panellists were asked to evaluate the samples in terms of appearance, aroma and general acceptability using a

7-Point Hedonic Scale, “7” being “Like Very much” and “1” as “Dislike Very much”. Data from sensory evaluation were statistically analysed using the One-Way Analysis of Variance (ANOVA) at 5% level of significance to determine if a significant difference occur among samples.

Results and Discussion

A survey was conducted to determine the most consumed street vended foods among the 150 randomly selected students, who are consumers of street vended foods, from the different colleges/faculties/departments of the University of Santo Tomas (UST), España, Manila, with age ranging from 16 to 29 years. Based on the survey, the three most often consumed street vended foods available around UST were deep-fried breaded quail eggs (*kwek-kwek*), steamed dumpling (*siomai*) and grilled chickens’ small intestines (*isaw*). Other street vended foods being consumed by the respondents as reflected on Figure 1 were fried chicken skin, breaded chicken eggs (*tokneneng*), fried green pepper stuffed with ground meat (*dynamite*) and fried ground meat wrapped in lumpia wrapper (*lumpiang shanghai*). Chicken balls, boiled duck egg with underdeveloped embryo (*balut*), coagulated chicken or pork blood (*betamax*), pig’s ear (*tenga ng baboy*), chicken large intestines (*bituka ng manok*) were some of the street vended foods also available around UST but were not chosen by the respondents during the survey. Among all the available sauces used as dips for street vended foods, vinegar with slices of garlic and onion, sweet sauce, and sweet-spicy sauce were the most preferred by the respondents. Sweet sauce is prepared by heating a mixture of water, sugar, and starch giving it a viscous texture, while sweet-spicy sauce is basically a sweet sauce with added chilli pepper. Other respondents also indicated their preference on sauces made from the mixture of vinegar, sweet and sweet-spicy.

Frequency of consumption and amount of street vended foods being consumed by the respondents were also assessed through the survey, and results were shown on Figure 2. Based on the results of the survey, only 2% of the respondents were consuming street vended foods every day, and 3% of the respondents were consuming at least 13 pieces or sticks of street vended foods each time.

Factors affecting respondents preference on street vended foods was also determined. Affordability, palatability and accessibility were found to be the major factors on the respondents’ preference on street vended foods over those foods available on food chains and restaurants inside and around UST. Other

Table 1. Lead and Cadmium Concentrations (µg/g) of most often consumed street-vended foods around UST

Heavy Metals	Breaded Quail Eggs (<i>Kwek-kwek</i>)		Dumpling (<i>Siomai</i>)	Grilled Chickens’ Small Intestine (<i>Isaw</i>)	
	0 hour	2 hours	0 hour	0 hour	2 hours
Lead (Pb), µg/g	0.2345 ± 0.0235	0.2790 ± 0.0343	0.5295 ± 0.0571	0.5400 ± 0.0293	2.1000 ± 0.0996
Cadmium (Cd), µg/g	N.D	N.D	N.D	0.1431 ± 0.0054	0.2398 ± 0.0167

N.D – Not Detectable; Detection Limit is 0.02 µg/g

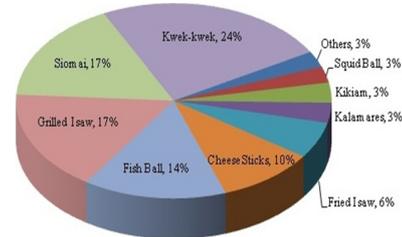


Figure 1. Most often consumed street-vended foods by UST students.

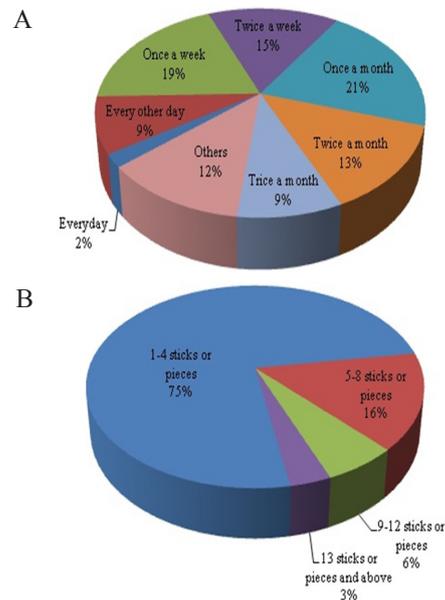


Figure 2. Consumption rates of UST students for street vended foods. A – frequency of consumption; and B – amount of street-vended foods being consumed by the students.

factors were accounted to convenience in eating, satiety value and nutritive value of street vended foods. In terms of respondents’ awareness on food safety, 98 % of the respondents were aware on the potential health risk associated in the consumption of street vended foods. The health risks identified by the respondents’ were hepatitis, diarrhea and other diseases caused by bacteria such as *Salmonella* spp. and *Escherichia coli*.

Despite of the conveniences of street vended foods, too much consumption may lead to serious health problems due to microbial and chemical contamination. However, respondents were only aware of the potential health risk that are related to microbial contamination, none of the respondents were aware of the chemical hazards such as heavy metals that street vended foods may contain. Two

Table 2. Mean Scores of sensory evaluation of grilled chickens' small intestines (*isaw*) samples for appearance, aroma and general acceptability.

Sensory Characteristics	Grilled Chickens' Small Intestine (<i>isaw</i>)		
	0 hour	1 hour	2 hours
Appearance	4.64 ^a	4.82 ^a	4.45 ^a
Aroma	4.45 ^a	4.36 ^a	4.54 ^a
General acceptability	4.73 ^a	4.54 ^a	4.64 ^a

of the most toxic heavy metals that may be present to foods at certain levels are lead (Pb) and cadmium (Cd). In this study, the amount of lead and cadmium that may be present on three most often consumed street vended foods available around UST were determined; also, the effect of exposure of these street vended foods to the environment on the amount of heavy metals was determined.

Results indicated on Table 1 are mean values of three trials. Based on the analysis conducted, Pb is present among all the street vended foods that were tested, while Cd for kwek-kwek and siomai were not detected. Though the result for Cd analysis for kwek-kwek and siomai may be favourable, it does not indicate absence, but rather indicate that Cd may still be present in the food samples but the concentrations were below the detection limit of 0.02 µg/g. One stick or four pieces of kwek-kwek weighs around 50 g, and would initially contain 11.725 µg of Pb and would slightly increase to 13.95 µg upon exposure to environment for two hours.

Results of the analyses indicated the presence of Pb and Cd in high amount on grilled chickens' small intestine (*isaw*). Grilled *isaw* being sold around UST weigh about 10 to 20 g per stick, and would initially contain 5.4 to 10.8 µg of Pb and 1.431 to 2.862 µg of Cd, and these values would increase to 21 to 42 µg of Pb and 2.398 to 4.796 µg of Cd upon exposure of grilled *isaw* into the environment for two hours. A similar study conducted by Callano (2012) had shown that the concentrations of Cd and Pb on *kwek-kwek*, deep-fried breaded chicken proventriculus (*proben*), deep-fried fish balls and deep-fried breaded chicken intestines being sold around the University of Immaculate Conception in Davao City, Philippines range from 0.60 to 1.57 µg/g and 30 to 35 µg/g, respectively. The results of both studies indicate that the level of heavy metals such as Pb and Cd in street vended foods may vary depending on the location where these foods are being sold. Aside from air pollution, accumulation of Pb and Cd may be present in significant amount in the foods and drinks that the chicken consumed. The food and material that entered the digestive system of the body are primarily absorbed in the intestine. Due to the functions of intestines, heavy metals are usually absorbed and stored (Villar *et al.*, 2005).

Thus, it is not surprising that the chicken intestines have the highest content of both metals among street foods that were analysed.

According to the European Food Safety Authority Panel on Contaminants in the Food Chain (CONTAM), the tolerable weekly intake (TWI) for cadmium is maintained at 2.5 µg/kg body weight (EFSA, 2011). The current provisional tolerable weekly intake (PTWI) for Pb is 25 µg/kg body weight; however, it had been concluded by the CONTAM that the value for Pb was no longer appropriate (EFSA, 2010). Since these values were based on European population, the TWI or PTWI values for Filipinos could be lower.

Presence of heavy metals such as Pb and Cd in foods poses grave danger to public health and safety. Pb is a potentially toxic substance with no known physiological functions. Its toxicity affects the haematologic, renal and neurologic systems and there is no evidence for a threshold below which lead has no adverse effects, especially in children health (Mohammed *et al.*, 2013). Cd, on the other hand, is toxic to virtually every system in the animal body. Though Cd is almost absent in human body at birth, it accumulates with age. There are reports in which Cd accumulated in the kidney and liver over a long time that interacts with a number of minerals mainly zinc (Zn), iron (Fe), copper (Cu) and selenium (Se) due to chemical similarities and competition for binding stage (Hussain *et al.*, 2012). It is also reported that Cd can affect calcium (Ca), phosphorus (P) and bone metabolism in both industrial and people exposed to Cd in general environment.

Grilled *isaw* was also evaluated for its sensory characteristics such as appearance, aroma and general acceptability on a time dependent manner. Samples taken right after grilling "0H", one hour "1H" and "2H" after grilling and exposure to the environment were presented to 11 semi-trained panellists to indicate their degree of liking over the samples using the 7-Point Hedonic scale. Mean scores from the sensory evaluation for each sensory characteristic of the sample were presented on Table 2. Mean scores with different letters were significantly different at 5% level of significance.

Based on the results of sensory evaluation, panellists degree of liking over grilled chickens' small intestine (*isaw*) generally fall between "neither like nor dislike" to "like slightly" for appearance, aroma and general acceptability. In addition, there is no significant difference between samples, which means that exposure of grilled *isaw* to the environment up to 2 hours did not affect the panellists' degree of liking over the samples for all sensory characteristic evaluated. Given in Table 1, the amount of Pb and

Cd on grilled isaw increases upon exposure to the environment, a student or consumer can be at a higher risk in consuming grilled isaw that was exposed to the environment for a given period of time than a grilled isaw consumed immediately right after grilling.

Conclusion

Among the street vended foods tested, grilled chickens' small intestine (*isaw*) contained the highest levels of lead and cadmium that may be toxic to human health. Exposure to the environment contributed to the amount of heavy metals present in grilled isaw. Moreover, exposure of a grilled isaw for up to two hours to the environment did not significantly change its sensory characteristics in terms of appearance, aroma and general acceptability. The results of this study indicate that heavy metals contamination in grilled isaw require immediate and appropriate action to reduce health risk. It is therefore important to monitor and improve the environmental conditions as well as the source of material, and manner of preparation of grilled isaw and other similar street vended foods to effectively eliminate or reduce the level of heavy metals to an acceptable level and avoid bioaccumulation and its toxic effect in the body.

Since street foods vending is a growing industry and many people are into consuming street vended foods, an in-depth risk assessment of all street vended foods is recommended to be able to gather data and establish necessary program that would improve quality and safety of street vended foods.

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