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Composition of Waste Generated in School Foodservice Operations in Andong Area

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ABSTRACT

The purposes of this study were to quantify and compare the kind and amount of solid waste generated in two school foodservice operations located in urban and rural areas. A waste stream analysis was conducted to quantify and characterize the kind of waste in the production and service parts of each operation. The SPSS 10.0 for window was used for data analysis. Non-parametric test (Mann-Whitney) was adopted to determine if significant differences exist in amounts of waste generated in the urban school and the rural school. An average of 415 meals, including 43 adult meals, were served daily in the urban school, while an average of 177 meals, including 24 adult meals, were served daily in the rural school. Food waste generated in the production part in the urban school composed approximately 87% and 45%, while that in the rural school composed 71% and 28% by weight and volume, respectively. Waste per meal was not significantly different between the urban school and the rural school in the production part except the cardboard waste. The total waste per meal at lunch was 154g or 465ml in the urban school and 51g or 334ml in the rural school. Students in the urban school discarded significantly more food waste and milk than students in the rural school did. The research results suggest that school foodservice dietitians should evaluate the acceptability of menu items based on food waste per meal, and assess the feasibility of implementing a plan for recycling packaging waste and composting organic waste. (*J Community Nutrition* 4(2) : 130~135, 2002)

KEY WORDS : waste · production part · service part · recycling · composting.

Introduction

While South Korea is generally in short supply of both natural resources and agricultural produce, the foodservice industry in Korea is not efficiently utilizing such limited resources. The Korean population is generating approximately 5 million tons of food waste annually (KFRI 2001). Food waste occupies 25.4% among all the solid waste and average weight of food waste is approximately 0.25kg/day/person (Foodwaste 2002). According to the government report published in 2000, the value of the foods wasted in Korea was 14,500 billion won per year while Korea imported foods worth 10,000 billion won per year (KFRI 2001).

Especially, the foodservice industry is generating a relatively large proportion of solid waste out of the food raw materials at an increasing pace. At the moment the Korean food service industry is gradually realizing the significance of this problem but is still having difficulty in coming up with an effective solution. Not only is excessive food waste costly in terms of food and labor cost, it also creates environmental problems. As local landfills have reached their capacity limits and communities are transporting their waste to landfills further away, the cost of disposal has increased significantly.

It will be a more and more important problem to manage food wastes generated in school foodservice organizations. School foodservice dietitians are primarily responsible for achieving this goal while planning and serving meals that satisfy students nutritional requirements with limited resources (Martin, Conklin 1999). If students do not eat all food that they are served, even though the meals are planned properly, they will not consume adequate nutrients and food and labor will be wasted (Harper et al. 1997 ; Read, Moosburner 1985).

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To establish an appropriate program for collection, recycling, and reduction of the waste, obtaining information on the composition of the solid waste is crucial. Waste characterization studies have been performed in schools to quantify waste generated (Ghiselli et al. 1995 ; Shanklin et al. 1999), to assess the effect of management decisions to change kind of milk packaging (Hollingsworth et al. 1992 ; Hollingsworth et al. 1995), and to determine waste disposal cost for different kinds of serviceware (Hackes et al. 1999). Shanklin et al. (2000) conducted a waste stream analysis to quantify the amount of organic waste in a rural school foodservice with offer vs serve. Elementary students discarded approximately 50% less food waste with offer vs serve system.

Published literature on the waste stream analysis in the school foodservice is scarce in Korea in spite of the importance of the subject, except a recent study on waste generation in elementary school foodservice operations in Seoul (Choi 1999).

The purposes of this study were to quantify and compare the kinds and amounts of solid waste generated by two school foodservice operations located in urban and rural areas.

Methods

A study on understanding the waste at school lunch program was done from June to July 2000 in 2 elementary school' foodservice operations in the Andong area. The population of the Andong area is 182,082 and the size is 1,519.77km^2 (the population of Seoul : 10,331,244 ; the size of Seoul : 605.53km^2), as of 2001. The facility in the urban school and the rural school served an average of 415 and 177 meals per day, respectively.

The study was conducted for five consecutive days (the urban school : June 26 − 30, the rural school : July 3 − 7) respectively, while a pilot study was first conducted in June 23, 2000 in the urban school. To reduce the waste difference resulting from the difference of menus, we requested the dietitians of the two schools to adopt as similar menus as possible among their regular menus.

The methodology used to analyze the solid waste stream in this study was the same as described by Ferris (1995). That is, a waste stream analysis was conducted involving the collection and sorting of solid waste in the production and service parts of two foodservice operations to determine the quantity and kind of waste. Production wastes were sorted into the following seven categories : food waste, plastic, paper, cans, cardboard, styrofoam and miscellaneous waste. The service wastes were sorted into food waste, milk, milk cartons. Students drank a carton of milk in the classroom before lunch and placed their milk cartons on a designated tray. A milk supplier took back milk cartons the next day after service.

An electronic digital scale (KAS Model DL-100) was used to measure the weight of each item. The volume of waste was determined using a volumetric tool for all items excluding cardboard. The volume was determined by placing the calibrated volumeter on top of the waste in a 50 ℓ (13.2 gallon) container (Rubbermaid) and reading the scale graduated in liters. The volume of cardboard was calculated based on the weight of these items. The conversion factor and formula (EPA, 1997) was used to convert the weight of cardboard to volume (liters). The volume of cardboard was calculated using the following formula :

$$\text{Volume of cardboard (l)} = \text{Wt of this item (kg)} / 0.453 \times 3.79 \div 100 \times 200$$

The Statistical Package for the Social Sciences (version 10.0, 2000, SPSS Inc., Chicago, IL) was used for data analysis. Mann-Whitney, a non-parametric test, was adopted to determine if there were any significant differences in the amount of waste between the urban school and the rural school students.

Results and Discussion

Total waste of production part during the five days period was 113.2kg in weight (391.8l in volume) in the urban school and 54.1kg (311.2l) in the rural school. The daily average, therefore, was calculated as 22.6kg (78.4l) in the urban school and 10.8kg (62.2l) in the rural school.

Table 1 illustrates waste per meal in the production part in the urban and the rural school. A total of 54.2g/meal or 189ml/meal of production waste was generated in the urban school, while 60.8g/meal or 351ml/meal was generated in the rural school. The weight of production waste per meal at hand was higher than those of a central food processing center (27g/meal) in a metropolitan school foodservice (Shanklin et al. 1999) and of a rural school food service (45g/meal ; Shanklin et al. 2000) shown in the previous studies conducted in the USA. The volume of production waste per meal at hand was less than that of a rural school

Table 1. Comparison of solid waste per meal in production part of school foodservice operations Mean ± S.E.

Waste component	Urban school		Rural school	
	Weight(g)	Volume(ml)	Weight(g)	Volume(ml)
Food	47.1 ± 7.6	84.1 ± 22.1	43.0 ± 11.6	96.9 ± 24.6
Packaging				
Can	0.5 ± 0.3	5.1 ± 2.5	0.8 ± 0.5	2.3 ± 1.6
Plastic	2.5 ± 0.7	31.0 ± 4.6	3.7 ± 1.3	30.9 ± 5.3
Paper	1.3 ± 0.6	18.6 ± 8.7	1.5 ± 0.9	16.6 ± 10.2
Cardboard	1.8 ± 1.6	30.2 ± 27.3	11.3 ± 3.7*	189.1 ± 61.2*
Styrofoam	0.3 ± 0.2	18.6 ± 12.4	0.3 ± 0.3	14.5 ± 14.5
Miscellaneous	0.6 ± 0.3	1.2 ± 0.5	0.2 ± 0.2	0.9 ± 0.9
Subtotal	7.1 ± 2.0	104.7 ± 42.6	17.7 ± 5.2	254.3 ± 74.9
Total	54.2 ± 7.1	188.8 ± 47.5	60.8 ± 15.1	351.1 ± 86.0

Mean ± S.E = Mean ± Standard Error * : Indicate a significant difference at $p < 0.05$ (Mann-Whitney test)

Table 2. Weight and volume of wastes per meal in service area of an urban school foodservice operation

		Day 1	Day 2	Day 3	Day 4	Day 5	Daily average (Mean ± S.E.)
Food waste	Total Wt(g)	128.3	153.3	207.8	111.5	105.3	141.2 ± 18.7
	Total Vol(ml)	121.4	125.3	198.8	111.0	108.4	133.0 ± 17.0
	Wt without liquid(g)	53.5	47.5	119.5	47.2	65.3	66.6 ± 13.8
	Vol without liquid(ml)	32.5	51.8	136.1	42.7	63.9	65.4 ± 18.4
	Wt of liquid(g)	64.9	93.7	88.7	72.6	48.1	73.6 ± 8.3
Milk	Wt(g)	7.6	5.9	3.8	4.0	1.5	4.6 ± 1.0
	Vol(ml)	7.4	5.8	3.7	4.0	1.5	4.5 ± 0.9
Milk carton	Wt(g)	8.4	8.4	9.6	9.7	5.9	8.4 ± 0.8
	Vol(ml)	314.5	325.3	289.2	434.3	274.7	327.6 ± 28.1
Total	Wt(g)	144.3	167.6	221.2	125.2	112.7	154.2 ± 19.1
	Vol(ml)	443.3	456.4	491.7	549.3	384.6	465.1 ± 27.2

Mean ± S.E = Mean ± Standard Error

Menus served Day 1 : Boiled glutinous millet rice, Soybean sprout soup, Pork red pepper bulgogi, Lettuce native, Squid vegetable salad, Glutinous rice cake, Milk

Day 2 : Pan broiled kimchie rice, Cucumber soup, Hard boiled soybean curd, Broiled dried fillet, Strawberry shake, Radish kimchie, Milk

Day 3 : Bibimbab, Eggplant soup, Steamed chicken, Hard boiled potato, Pan broiled red pepper paste with beef, Sweet rice beverage, Milk

Day 4 : Jajangbab, Sea tangle soup, Pan broiled Glutinous rice cake, Radish pickles, Tomato juice, Milk

Day 5 : Boiled rice, Hot beef soup, Fish cutlet, Tangle vinegar salad, Kimchie, Watermelon, Milk

food service in the previous study (719ml/meal ; Shanklin et al. 2000). This might be attributed to the fact that the food waste ratio is higher in Korea while the packaging waste ratio is higher in the USA. Another study (Choi 1999) conducted in Korea on a school foodservice operation where 714 persons were served daily showed a production waste of 50g/meal or 320ml/meal, which showed not a meaningful difference with this study.

Waste per meal was not significantly different between the urban school and the rural school in the production part excluding the cardboard. The difference in amounts and kinds of packaging materials discarded between the urban school and the rural school was related to the difference in delivery practice of the food suppliers, that is the supplier for the urban school used plastic boxes to contain the food materials which would later be taken back by the supplier while the supplier for the rural school used cardboard boxes which would be discarded.

Food waste in the production part in the urban school and the rural school composed approximately 87% and 71% of the total production waste by weight and 45% and 28% by volume, respectively. In the previous studies conducted in a rural school foodservice in the USA (Shanklin et al. 2000), for comparison, food waste in the production part constituted

approximately 32% by weight and 9% by volume of the total production waste. The reason for the higher food waste ratio in Korea is mainly because unprocessed food materials are used in most of the school foodservice facilities in Korea. It is strongly recommended to introduce a centralized food processing system where processed food materials are distributed to and used by the individual foodservice facilities. The waste generated in the processing part could be treated more efficiently.

Packaging waste in the urban school composed approximately 13% and 55%, while that in the rural school composed 29% and 72% by weight and volume, respectively. Cardboard and plastic items in the urban school and the rural school composed 61% and 85% by weight and 58% and 87% by volume of the total packaging materials discarded. It is therefore important to increase the recycling ratio of the cardboard and plastic items.

During the five-day study, total waste of the service part was 320.7kg in weight (964.7l in volume) in the urban school and 44.6kg (295.6l) in the rural school. An average total waste of the service part was 64.1kg (181.9l) in the urban school and 8.9kg (59.1l) in the rural school.

Table 2 illustrates daily weight and volume of waste per meal in the service part in the urban school and Table 3 illustrates that in the rural school.

An average food waste of 141g/meal (133ml/meal) was discarded in the urban school and 43.2g/meal (44.0ml) in the rural school, but the waste amounts of both schools varied a lot each day. The food waste per meal of the third day was approximately twice as much as that of the fifth day in the urban school. The food waste per meal was considerably higher on the first and the third day in the rural school. We

Table 3. Weight and volume of wastes per meal in service area of a rural school foodservice operation

		Day 1	Day 2	Day 3	Day 4	Day 5	Daily average (Mean ± S.E.)
Food waste	Total Wt (g)	54.2	39.7	51.7	35.9	34.5	43.2 ± 4.1
	Total Vol (ml)	56.5	42.0	55.4	31.1	35.0	44.0 ± 5.2
	Wt without liquid (g)	21.5	13.2	33.1	22.3	16.9	21.4 ± 3.4
	Vol without liquid (ml)	28.2	20.0	38.4	21.5	22.0	26.0 ± 3.3
	Wt of liquid (g)	31.9	24.3	17.8	18.1	16.9	21.8 ± 2.8
Milk	Wt (g)	2.3	0	2.5	1.0	1.2	1.4 ± 0.5
	Vol (ml)	2.2	0	2.5	1.0	1.1	1.4 ± 0.5
Milk carton	Wt (g)	7.6	5.7	5.4	6.8	4.5	6.0 ± 0.6
	Vol (ml)	378.5	243.4	245.8	293.8	282.5	288.8 ± 24.7
Total	Wt (g)	64.1	45.4	59.6	43.7	40.2	50.6 ± 4.8
	Vol (ml)	437.2	285.4	303.7	325.9	318.6	334.2 ± 26.8

Mean ± S.E = Mean ± Standard Error
Menus served
Day 1 : Boiled glutinous millet rice, Soybean sprout soup, Bulgogi, Lettuce native, Glutinous rice cake, Milk
Day 2 : Pan broiled kimchie rice, Cucumber soup, Hard boiled soybean curd, Broiled dried fillet, Mandarin orange, Radish kimchie, Milk
Day 3 : Bibimbab, Eggplant soup, Fried chicken, Pan broiled red pepper paste with beef, Sweet rice beverge, Milk
Day 4 : Jajangbab, Sea tangle soup, Fermented rice cake, Radish pickles, Tomato juice, Milk
Day 5 : Boiled rice, Hot beef soup, Fish cutlet, Tangle vinegar salad, Watermelon, Milk

Table 4. Comparison of solid waste per meal in service part of school foodservice operations Mean ± S.E.

Waste component	Urban school		Rural school	
	Weight (g)	Volume (ml)	Weight (g)	Volume (ml)
Food waste				
Total	141.2 ± 18.7	133.0 ± 17.0	43.2 ± 4.1**	44.0 ± 5.2**
Without liquid	66.6 ± 13.8	65.4 ± 18.4	21.4 ± 3.4**	26.0 ± 3.3*
Wt of liquid	73.6 ± 8.3		21.8 ± 2.8**	
Milk	4.6 ± 1.0	4.5 ± 0.9	1.4 ± 0.5*	1.4 ± 0.5*
Milk carton	8.4 ± 0.8	327.6 ± 28.1	6.0 ± 0.6	288.8 ± 24.7
Total Waste	154.2 ± 19.1	465.1 ± 27.2	50.5 ± 4.8**	334.2 ± 26.8*

Mean ± S.E = Mean ± Standard Error
* : Indicate a significant difference at $p < 0.05$ (Mann-Whitney test)
** : Indicate a significant difference at $p < 0.01$ (Mann-Whitney test)

note that chicken was served on the third day in both schools. The dietitians need to determine whether this increase was related to the acceptability of the chicken served or the weight of the bones. The food waste per meal was meaningfully higher on the days when less preferred menu items were served.

Table 4 illustrates waste per meal in the service part in the urban school and the rural school.

An average of 154g/meal (465ml/meal) was discarded in the urban school, while an average of 51g/meal (334ml/meal) was discarded in the rural school. The students were consuming approximately 98 − 99% of their milk at school. As illustrated in Table 4, students in the urban school discarded significantly more food and milk than students in the rural school did. It should be noted that a dietitian was encouraging the students to minimize food waste at the discarding point in the rural school. The amount of service waste per meal in the rural school was less than that in a rural school food service with offer vs serve in the USA (95g/meal, 931ml/meal ; Shanklin et al. 2000) and in a metropolitan school food service in Korea (98g/meal, 510ml/meal ; Choi 1999). The weight of service waste per meal in the urban school was higher but the volume was less than that in a rural school food service in USA (Shanklin et al. 2000) and in a metropolitan school food service in Korea (Choi 1999). In another study of school foodservice in USA, Shanklin et al. (1999) reported that students in a metropolitan elementary school discarded 244g/meal or 2.1l/meal of waste.

Approximately 91% and 86% of the total waste by weight in the urban school and the rural school was food waste. The dietitian can use the waste/meal data to assess the acceptability of the combination of menu items served. Since acceptability influences both nutrient intake and food waste, the menu choices are a very important determinant of the success of the school foodservice program. It is also recommended for the dietitian to advise and direct the food behaviors of the students.

Summary and Conclusion

This study was conducted to compare the waste generated during 5 consecutive days in two schools, one school located in an urban area and another school in a rural area.

Waste per meal was not significantly different between the urban school and the rural school in the production part except the amount of cardboard. The difference in amounts and kinds of packaging wastes between the urban school and the rural school might be attributed to the difference in delivery practices of the food suppliers. The supplier for the urban school used plastic boxes to contain the food materials which would later be taken back by the supplier while the supplier for the rural school used cardboard boxes which would be discarded. Since the containers used for food materials delivery will directly influence the amount of waste, it is recommended for the dietitian to encourage the food supplier to adopt containers that could be reused. The food waste ratio is much higher in Korea than in the USA. because most school foodservice facilities in Korea purchase unprocessed food materials and process them themselves.

Students in the urban school discarded significantly more food waste and milk than students in the rural school did. Dietitians should continue to advise and encourage students to decrease plate waste and to develop ways to reduce the plate waste (such as more acceptable menus). Decreasing plate waste will result in more nutrient consuming by the students and reduction in expenses and solid waste generation

The implementation of a recycling and composting program is needed to reduce the quantity of solid waste transported to the landfill. With the implementation of the plastic and cardboard recycling, the school food service program will be able to divert these items from the landfill. With the diversion of these two materials, the school foodservice could also save money for waste disposal expenses. In addition to recycling, the feasibility of composting organic waste should be explored. Implementation of recycling or composting can also provide the schools with environmental education.

Teachers should be encouraged to provide environmental education that focuses on the reduction of food waste and resource conservation. It is also recommended that the dietitian evaluate acceptability of menu items by waste per meal and motivate students to reduce food waste. Results of this study can also be used to help increase the student awareness of the environmental impact of food wastes.

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