FOOD ACCEPTABILITY IN SCHOOL FOODSERVICE SYSTEMS

by

CHERYL S. JOHNSON

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INTRODUCTION

The mission of the National School Lunch Program (NSLP) since its inception in 1946 has been feeding school children nutritious, appealing lunches. Acceptance and consumption of foods affect the nutritional contribution of the lunch to the student (1). Current regulations require assessment of food acceptability to increase consumption of the school lunch (2). In a Report to the United States Congress in 1981, the Comptroller General (3) reported that many school foodservice programs are faced with increasing meal costs, declining student participation, plate waste, and unanswered questions about the nutrients in meals. Akin (4) found the following general factors to influence participation of the individual child in the NSLP: meal cost, meal "acceptability," food attitudes, and availability and prices of alternative food choices.

Many school districts have been faced with the question of how to establish new school foodservice facilities or expand existing ones. As a result, school foodservice is utilizing a number of different systems (5). Previous studies have indicated only slight differences among delivery systems in regard to nutritional value and microbiological quality of food (6-9). If proper foodservice procedures are followed, a consensus conclusion evolving from these studies is that all delivery systems are capable of producing foods of comparable nutritional value and microbiological quality.

Limited information is available on acceptability of foods from alternative food production and holding systems (10). Harper and his research team from Colorado State University (5) reported results of a

pilot study on menu item acceptability in four types of school foodservice delivery systems. They found that type of system affected students' food consumption. Foods prepared on-site had greater acceptability than foods prepared in a central facility and transported to satellite operations either in bulk or preportioned.

Objectives

Few quantitative studies on food acceptability have been reported, thus factors involved, such as flavor, appearance, temperature, amount served, and overall quality of the food need additional study. The overall objective of this research was to compare food acceptability using four different methods in satellite and on-site school foodservice systems. More specifically the objectives were:

- to compare consumption and acceptability of entree and vegetable menu items in on-site and satellite foodservice systems, and
- to investigate the relationship among different methods for measuring food consumption and acceptability.

Definitions

Pilgrim (11) grouped the methods for the study and measurement of food acceptance behavior into three classes: attitudes, sensory tests (hedonic tone or preference), and consumption studies (or the inverse, plate waste). In the case of food acceptance, consumption might appear to be the logical and objective criterion, and for many purposes, the operational definition of acceptance is consumption. To include the affective reactions, the criterion of food acceptance should be specified as "consumption with pleasure." Preference is sometimes used interchangeably

with acceptance. The two terms are related but they are not the same. Preference is only one factor involved in acceptability (12).

Acceptance is defined as an experience, or feature of experience characterized by a positive attitude or actual utilization (eating), measured by preference or liking for a specific food item. Preference is described as an expression of higher degree of liking, a choice of one object over others, or a psychological continuum of affectivity (liking-disliking) on which choices are based (12). Consumption is simply the amount of food eaten (11).

REVIEW OF LITERATURE

Foodservice Systems

Conventional Systems

The operational objective of conventional foodservice systems is to produce and serve food withon one foodservice operation while effectively utilizing all renewable and nonrenewable resources (7). Foods prepared in the conventional kitchen on-premise are distributed directly to an adjacent serving area (13). An advantage of conventional on-site foodservices is minimal distribution costs. Also, Searing (14) described the following positive aspects of on-site production in school foodservice: greater possibility of achieving educational goals, greater flexibility in type of menu, an increased variety of foods, better quality control, and personalized individual service. Disadvantages include problems with peaks and accompanying stress caused by meal period demands and uneven work distribution, which lowers productivity and increases labor costs (7).

Alternate Foodservice Systems

Foodservice operations are reacting to external and internal environmental stress, which is forcing the development of radically different systems (15). Foodservice organizations with many serving units have sought ways to curtail labor and other costs by centralizing production (13). Several factors have propelled school foodservice directors to accept the challenge of a central kitchen. Most of them revolve around three changes in the nation's social structure (16).

- School districts have come to realize the relationship between a good diet and the ability to learn in school.
- Integration programs that involve busing have undermined the neighborhood school concept which allowed children to walk home for lunch.
- Provisions for free or reduced cost meals have been developed (16).

Commissary Foodservice Systems. The evolution of commissary foodservice systems had been made possible by technological developments for sophisticated foodservice equipment. Alternate names have been given to these operations: central commissary, satellite, and food factory (7).

Commissary foodservice systems have centralized food procurement and production functions with distribution of prepared menu items to several remote areas for final production and service (13). Functions vary greatly with regard to management, food purchasing, type of equipment, amount of food prepared, and most other operations (17). The common factor of all commissaries is that the food production center and service areas are located in separate facilities. Therefore, the function of food distribution must receive considerable emphasis for the effective operation of these foodservice systems (13).

Menu items processed in the commissary may either be held in bulk or portioned. Three alternatives for holding following production are available: frozen, chilled, or hot-held (13).

The term "satellite" foodservice is sometimes used synonymously with commissary. If a distinction can be made between the two, it is that a satellite base kitchen is used to refer to an existing kitchen adapted for use to produce for several like-units in the same geographical area. It is thought of as being smaller, less sophisticated and not built

especially for large-scale centralized production. Prepared food is transported to service locations. A satellite serving unit is any facility to which food prepared centrally is delivered for service (13).

Advantages of the central kitchen include large volume purchasing, no need for duplication of equipment and personnel, reduced amount of supervision needed, uniformity of quality of products for all units, and increased productivity. Disadvantages relate to delivery and safety of foods. Food must be transported in such a manner that it is of good quality and appearance, and correct temperatures are maintained for safety. Also, specialized equipment is required for delivery, and gasoline for delivery may become a high cost factor (13).

Studies of Alternate School Foodservice Systems. Food delivery systems used in school lunch programs were evaluated by a research team from Colorado State University under a contract from the United States Department of Agriculture (USDA)/Food and Nutrition Service (FNS) (5, 8, 18, 19). A total of 16 schools participate in the study, four schools using each of the four types of delivery systems:

(a) conventional on-site school food preparation and service;

(b) food preparation in a school system's central kitchen followed by hot bulk transport to satellite schools;

(c) food preparation in a school system's central kitchen followed by chilled transport of the preportioned food to satellite schools;

(d) purchase of frozen preportioned meals which were heated to serving temperature in individual schools.

The specific objective of the study was to compare the systems with regard to nutritional and microbiological quality of the food items, costs, and food acceptability.

Using the combined data, on-site preparation and service had significantly higher acceptability than did chilled preportioned delivery or frozen preportioned delivery. Within each delivery system, foods served at some schools had higher acceptability than food at others. These differences point to potential improvements which could be made in all delivery systems (5).

In regard to nutritional value, variations in nutrient levels associated with different food delivery systems rarely were significant. The results suggest that all delivery systems are capable of placing food with comparable nutritional value on the serving line if proper foodservice practices are followed (8).

Facilities used to prepare and serve meals varied among delivery systems. Frozen preportioned delivery had the lowest facilities utilization, while central production with hot bulk delivery had the highest utilization. On-site preparation and central preparation with hot bulk delivery had nearly the same space and costs per meal because they differed little in the manner in which they were operated (18).

No differences in total meal costs were noted among the alternate delivery systems. Labor requirements for on-site and hot bulk delivery were higher than those associated with preplated meals. Costs of food and utensils used in preplated meal service were higher than on-site or hot bulk delivery meals (19).

Effect of Temperature and Holding Times on Food Quality

One common characteristic of central commissaries is that they are usually physically removed from locations they serve. This results in

what Sell (17) refers to as a "thermic break," a period between preparation and service that requires preservation of cooked foods and transporting them to the serving locations. When food is subjected to hot holding conditions, quality can be affected by temperature, humidity, and length of holding time (7). Only a meager amount of data is available on the effect of temperature and length of holding on the retention of quality (temperature, appearance, taste, consistency) (9, 20-22).

The three criteria of a desirable food product are appearance, palatability, and temperature (21). Using these criteria, Blaker et al. (21) evaluated products which were held on steam tables for varying lengths of time and at different temperatures at four different establishments. The investigators found that when food was brought to the steam table at 160°F, the temperature gradually dropped over a period of 45 minutes or longer when the steam was turned down or off and the food remained uncovered. Nevertheless, the temperature remained above 140°F during that time. Mashed potatoes, rice, noodles, and sliced meats showed signs of deterioration after long holding periods at 150 to 160°F. A combination of time and temperature had a greater effect on the appearance and palatability of green vegetables than either time or temperature alone. They concluded that long holding periods will result in mushy, discolored products, and a loss of nutrients.

Cremer et al. (22) found that time and temperature conditions during phases of product formulation were generally acceptable but highly variable with wide ranges in time and temperature indicating critical areas for control. Lapsed time between formulation and distribution of a food is not a constant applicable to all establishments, but will vary with type of operation and layout of the foodservice.

Jansen et al. (8) found that food served at the proper temperature and with good color, texture, and flavor was consumed better by students than that served at lower temperatures. The food also had higher nutritional quality and was safer from a microbiologic standpoint.

In a study by Avens et al. (9), systems were compared on the basis of relative frequency of improper food temperature. In the foodservice with central preparation and hot bulk delivery, the frequency of improper food temperature was highest; but improper food preparation techniques and food handling abuses were characteristic of individual schools and not uniquely characteristic of any particular food preparation and delivery system or systems.

Measurement of Food Acceptability

Hedonic Scales

Pilgrim (23) reported preference to be an important indicator of food consumption and an expression of the degree of like or dislike of a specific item. He proposed that preference not only predicts the average amount of food consumed, but also the proportion of persons accepting a food.

Food preference is an attitudinal behavior involving how much one likes or dislikes a food. Two questions consistently have emerged in food preference measurement: "How much do you like a food" and "how often do you want to eat a food?" (24).

Hedonic scales seek to measure a degree of liking. A large number of different hedonic scales have been used (Table 1).

Preference Scales. Several studies have used small numbers of hedonic scale categories. Hall and Hall (25) simply asked whether foods

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Table 1: Hedonic scales of food preference

authors	reference no.[1]	no. of scale points	response categories
Hall and Hall (1939)	25	2	Dislike, unfamiliar
Abbott et al. (1952)	26	2	Acceptable, dislike, not tried
Einstein and Hornstein (1970)	27	3	Like a lot, like, dislike, do not know
Lamb et al. (1954)	28	3	Well-liked, indifferent, disliked, seldom or never eaten
Eppright (1950)	29	5	Very good, good, moderate, dislike, tolerate
Kennedy (1952; 1958)	30,31	5	Very good, good, moderate, tolerate, dislike, never tried
Peryam et al. (1960)	32	9	Like extremely, very much, moderately, slightly, neither like nor dislike, dislike slightly, moderately, very much, extremely

[1]Refers to number in list of references at end of paper.

were "disliked" or "unfamiliar," and Abbott et al. (26) used a two-point scale of "acceptable" and "dislike," plus "not tried." Einstein and Hornstein (27), in their large survey in college foodservice, used a three-point scale of "like a lot," "like," and "dislike," plus "do not know." The three-point scale used by Lamb et al. (28), "well-liked," "indifferent," "disliked," plus "seldom or never eaten," is balanced around neutral. According to Lamb (28), with small numbers of categories, the tendency for truncation (avoiding scale end points) could affect the data seriously.

Five point scales have been reported by Kennedy (30, 31) in studies of California boys and girls and by Eppright (29), who also used "never tried" and "allergic" categories. A consensus among these researchers was that the naming of the scale categories made the psychological distances between scale points hard to define.

The best known rating scale is the nine-point hedonic scale, "like extremely" to "dislike extremely," developed for studies conducted by the U.S. Army Quartermaster Corps on preferences as predictors of army food acceptability (32). The nine-point scale was chosen after determination that increasing scale length did not significantly increase test time nor decrease test reliability but did increase the amount of information obtained (33). Hedonic scales other than the nine-point scale have not been analyzed for reliability or validity. The nine-point scale was found by Moskowitz and Sidel (34) to yield data that are highly reproducible and correlate well with ratings of stimuli other than names on a survey.

Peryam and Pilgrim (35) differentiated between use of the hedonic scale for rating a list of foods presented by item name only and for rating foods actually served. In the first usage, the scale is a measure of attitude. In cases where food items themselves are the stimulus, the scale becomes a sensory test pertaining to the affective realm.

College Studies. Researchers have used food preferences as indicators of attitudes and as measures of food acceptability. Many of the early studies on food preferences were concerned with eating habits of college students. Using a list of 150 foods, Hall and Hall (25) asked students to indicate those foods that they did not know or disliked intensely and

their reasons for the decision. Results of the study showed that certain foods were unfamiliar or disliked by a large number of students and that students often rated the same foods as disliked and unfamiliar.

Using a checklist of 61 foods, Schuck (37) asked South Dakota college students to rate their degree of like or dislike using a four-point scale. Results of the study showed that milk was highly accepted, most fruits and meats ranked second, and vegetables were least acceptable. Reasons given for not liking certain foods were related to taste, odor, appearance, unfamiliarity, and family attitudes and practices.

Warren (36) studied factors influencing food preferences of college students. Students' degree of like or dislike of 334 foods were analyzed using a seven-point scale. Foods disliked most were dark green and yellow vegetables, combination meat dishes, organ meats, cooked cereals, canned fruit, and buttermilk. Best liked foods included meats without extenders, bread, and milk.

Freshmen at Fresno State College in California completed questionnaires indicating their degree of like or dislike of 152 food items. A comparison between women and men showed that women had more food likes while men had more dislikes. Foods liked by both sexes were milk, fresh fruit, and chicken. Commonly disliked foods included beets, hominy, and kidney beans (38).

Wiley and Vaden (39) used a five-point scale to obtain a hedonic preference rating of entree items in a residence hall foodservice. Items well liked included roast beef, steak, barbequed spare ribs, chef's salad, bacon-lettuce-tomato sandwich, and chicken noodle soup. Disliked items were unfamiliar to many respondents.

Armed Forces Studies. Another major area of food preference research has focused on preferences of armed service personnel. Kamen (40) investigated refusal and nonconsumption of food items in the army. This research gave evidence that choices of food from the serving line were more indicative of food preference than consumption indexes of plate waste. Low preference was the most salient reason for not taking a food. Poor preparation and quality were the next most important reasons. Poor preparation and quality also were the most frequently checked reasons for not eating an entire portion.

The Quartermaster Food and Container Institute for the Armed Forces conducted a study of the preferences of army personnel in which soldiers were asked to indicate like or dislike of various foods using a nine-point scale (32). Breads were highly preferred as were fruits and desserts. Vegetables and soups were least preferred. Fish, lamb, meat combinations, and liver were the least liked meats.

School Foodservice Studies. Acceptability of school-served food items was assessed by Head et al. (41) using three methods: (a) a five-point hedonic scale; (b) a five-point scale on which students estimated the amount they had eaten, and (c) weighed plate waste. Reliability of the hedonic scale was highly significant, but the scale on which students estimated the amount they had eaten had a closer relationship to food consumption than did the hedonic scale.

Gutsch (42) used a list of 24 vegetables to study vegetable preferences of students at home and at school. The items were scored from 1, like a lot to 4, don't like. Potato products and corn were vegetables with the most positive preference scores. Preference scores were significantly more positive for "at home" ratings.

Gargano and Vaden (43) asked high school students to indicate their degree of like or dislike for entree items. The hot sandwich, hamburger sandwich, and Italian or Mexican main dishes were the entree categories most liked by the students. Unpopular items included fried and baked fish, salad plates, and casseroles, creamed, and extended main dishes.

Facial Hedonic Scale. Ellis (44) reported that problems in semantics have arisen with the use of descriptive hedonic scales. A modified hedonic method which minimizes confusion due to terminology is the facial hedonic scale or the "smiley" rating scale. Andrews (45), at Rutgers University, found that a scale based on five simple faces also could be used to evaluate how a person "feels" about a food. In this method, faces depict the degree of pleasure or displeasure experienced by the subject. A neutral face is the median interval. These scales may consist of five, seven, or nine faces (45-48). Facial hedonic scales have been used by Lachance (45) and Comstock et al. (49) to study food preferences of elementary and kindergarten children.

In a review of preference testing methodology, Ellis (44) found no published data on the reliability of this method, but its fairly widespread use indicates the method is well accepted among workers and is considered to be both reliable and sensitive. Wells (47) found that the facial method is easier for young children to use than methods using words or numbers. This method appears to allow good communication and respondents do not seem to have difficulty understanding what is required of them regardless of age, intelligence, education, or even the ability to speak English.

Food Action Scale. Schutz (50) developed an approach to food preference measurement called the Food Action Rating Scale (FACT Scale). He asked people to rank order 18 action statements representing affective attitudes toward foods. Nine were selected to give equal intervals:

> eat every opportunity; eat very often; frequently eat; eat now and then; eat if available; don't like--eat on occasion; hardly ever eat; eat if no other choices; and eat if forced.

The standard deviation and mean difference of the Food Action Scale and nine-point hedonic scale were very similar and the correlation of the means was 0.97.

Van Riter (51) used a scale based on home use of vegetables including scale categories: "never served at home," "one or more of my family disliked the food," "prepared differently at home." She believed that these categories assess important factors in food preference determination.

Assessment of Food Consumption

Food consumption and its inverse, plate waste, has been measured frequently. Little is known, however, about the accuracy and relative advantages of different measurement methods.

Weighed Plate Waste. Traditionally, plate waste has been measured by collecting a sample of trays at the end of a meal and separately weighing the leftovers from each food item on each tray. In 1975, the USDA/FNS published a procedure for measuring weighed plate waste that is used widely (52).

Weighed plate waste also was used to evaluate the effect of alternate delivery systems on food acceptability and plate waste in the Colorado State study. Harper et al. (5) collected five sample trays at random to

determine average serving size of the test menu items. Approximately 50 trays were collected from fifth and sixth grade students for weighing plate waste. Food acceptability was measured as the percentage of each menu item consumed. The average acceptability for each item by school and delivery system was calculated.

In 1978, Jansen and Harper (53) reported on food acceptability in the NSLP using the weighed plate waste method. Data were presented for plate waste in terms of the percentages of food items served that were consumed.

Individual weighed plate waste provides accurate and detailed information on each child and each food item; however, workers in the field purport that it has disadvantages that decrease the number of situations in which it can be applied (41, 49). The method requires a great deal of space for holding trays and scraping and weighing the waste, it is time consuming and a costly procedure, and it is usually impractical to measure individual plate waste for more than 50 or 100 children at a meal. Due to these disadvantages, researchers have employed two general strategies: aggregate measures of plate waste and indirect measures of plate waste which include visual estimation and self-reported consumption.

Aggregate Plate Waste. Aggregate measures simplify the data collection process because plate waste is weighed after all scraping is complete. Food waste from all children is scraped into separate containers for each food item and mean percentage waste per child is calculated for each food item at each meal. For this method, weight is retained as the measure of waste, but it is aggregated across children and sometimes across food items. Aggregate selective plate waste has been used in school lunchroom

studies by Carver and Patton (54) and Guthrie (55) and is also the method recommended by Comstock et al. (49) for an economic study of the NSLP.

According to Comstock et al. (49), aggregate waste can be weighed much faster than individual waste and it still provides an accurate measure of total or mean waste, yet does not provide enough information in some studies. If plate waste is aggregated across food items, determination of which food items were responsible for a change in the amount of plate waste is impossible. When plate waste is aggregated across children, many interesting questions at the individual level cannot be addressed. For example, aggregate waste measures cannot be used to correlate individual children's food preferences with their food waste to determine the extent to which preferences predict waste.

Observational Plate Waste. In the visual method, observers rate each food item on each child's tray as the tray is turned in at the end of a meal. The observers are trained to recognize average serving sizes of each food item and to make judgments of the amount remaining on a child's tray.

Acredolo and Pick (57) employed visual estimation in their evaluation of a school lunch program. The following four-point scale was used: nothing eaten, whole portion eaten, one bite eaten, more than one bite but not the whole portion eaten. Inter-observer reliability was reported to be between 88 and 93 percent. No comparisons between weights and visual measures of waste were reported.

Lachance (56) recommended that school foodservice workers visually estimate waste on a five-point scale (all, 3/4, ½, ¼, none) but gave no information on the accuracy of the procedure. He found the visual

technique to be more conducive to the needs of school foodservice in terms of available time, simple equipment, and the quantity of data that can be obtained in a short time. The procedure developed by Lachance was used in the Comptroller General's studies designed to obtain estimates of plate waste in innovative lunch programs for their 1981 report to the Congress (3).

Chmielinski and White (58) conducted a study designed to measure the validity of visual estimation. A four-point scale was used: 0, ½, 2/3, all food remaining. Inter-observer reliability was measured at 90 percent. A nonparametric comparison between visual estimates and actual weighed waste showed 80 percent agreement.

In the study by Comstock et al. (49), school research coordinators visually estimated plate waste for each child who ate school lunch by assigning one of the following codes to each food item: 5, if a full portion remained; 4, if nearly a full portion remained but at least one bite was eaten; 3, if three-quarters of a portion remained; 2, if one-half of a portion remained; 1, if one-quarter of a portion remained; and 0 of none remained. They found that trained data collectors can make visual estimations of plate waste that correlate highly (0.93) with percentage waste.

Stallings et al. (59) used weighed plate waste to validate the visual assessment, measured on a five-point scale. Actual weights were compared with assessed percentages based on visual data to establish concurrent validity. Correlation values ranged from a high of 0.987 to a low of 0.576 for various foods. Food preference, measured by amount consumed, from most to least was fruit, roll, milk, meat, starchy vegetable, and green vegetable.

Self Reported Consumption. Self reported consumption is similar to visual estimation except that children are asked to rate their own consumption from memory shortly after leaving the cafeteria. Child ratings have been studied less frequently than visual estimation (41, 49).

Head et al. (41) asked students in grades 4 to 6 and 10 to 12 to rate their food consumption on a five-point scale. Correlations between individual weighed plate waste and child ratings were reported to be "usually high" but exact values were not reported. They recommended considering child ratings as a measure of consumption when the accuracy of weighed individual plate waste is not needed. They estimated child ratings to require one-fourth the labor hours of weighed individual plate waste.

Comstock et al. (49) found that child ratings of food consumption correlate highly with percentage waste (0.74), though not as highly as visual estimates and weighed plate waste. Children's ratings are accurate when compared with percentage waste for low levels of waste. Indirect measures of consumption/plate waste provide data on individuals and offer attractive savings in time and space.

Studies of Food Consumption in the NSLP

Many studies have been published over the past 10 years on assessments of the NSLP. Few studies have reported amounts of plate waste by food component. Also, few quantitative studies of plate waste in the school lunch program have been conducted.

Carver and Patton (54) conducted a series of studies in 1958 on plate waste in a school lunch program. The initial study covered the overall waste to assess children's eating habits. The greatest amount of waste was contributed by first grade students. The second phase of the study

was to determine the source of waste; they found that vegetables contributed the greatest amount of waste.

Green (60) studied plate waste in four Louisiana high school lunch programs and found that a large amount of waste occurred with vegetables and fruits. Martin (61) investigated the attitudes of students toward hot and cold lunches as measured by consumption. Plate waste for the elementary school students ranged from 16 to 20 percent of the weight of the complete meal and for the secondary students from 10 to 11 percent.

Doucette (62) surveyed schools in Hawaii and recorded the percentages of senior high school students who ate all, part, or none of the food served in four food categories. Twenty-two to 45 percent of the children did not consume any of their vegetables and fruits as compared to 2 to 10 percent of the students who did not consume any of their milk and meat.

In 1975, Altschul (63) reported the findings of a comprehensive review of the information available on food waste from school lunch. Altschul reported that the different terminology in studies made comparisons difficult. Also, experimental designs could not be replicated among studies and different methods and sample sizes were used. In his summary, Altschul stated that the literature on school lunch plate waste, generally, is sparse, anecdotal, and journalistic and does not meet scientific standards. He found that simple methods for measuring, monitoring, and reporting the extent of waste are needed to permit comparisons between schools.

Jansen et al. (64) compared acceptability of lunches planned according to the requirements of the Type A pattern with those planned by a manual Nutrient Standard Method, which they developed. They found that acceptability ratings correlated reasonably well with actual consumption.

No significant differences were found in either ratings or consumption as a function of menu planning method. The positive correlation between the food ratings, as determined in the classroom before the meal and students' consumption patterns, as determined by plate waste suggests that rating information can be utilized effectively by the menu planner to select menu items with high acceptability. Milk beverages had the highest ratings and consumption. Salads and vegetables were rated low and consumed least by students.

Walling (65) conducted a study in the Albuquerque Public Schools and found an overall plate waste of 25.1 percent. For individual items, Walling reported a waste of 12.7 percent for meat, 52.5 percent for vegetables, 29.4 percent for fruits, and 5.8 percent for milk.

In 1976, Harper et al. (5) reported the findings of a pilot study to assess, audit, and evaluate food delivery systems in 16 elementary schools. The foodservice system did affect the acceptability of menu items served during the test. Acceptability was defined as the percentage of the average serving which was consumed. When the means for acceptability were adjusted for serving size, the acceptability of ground beef and spaghetti, boiled peas, chocolate pudding, and baked beans varied significantly depending on the foodservice system. Overall, lunches prepared and served on-site had higher acceptability than chilled or frozen preportioned delivered lunches. A variety of factors appeared to be responsible for these differences including appearance of foods, monotony of menus, food preparation difficulties, taste of foods, portion size, and overall lunch quality.

Gutsch (42) found that corn, green beans, green peas, succotash, sauerkraut, asparagus, relishes, and broccoli resulted in the least plate

waste in a study offering choices to increase acceptability of vegetables in the school foodservice program. Consumption of vegetables tended to be greater when choices were offered.

Garrett and Vaden (66) compared plate waste measured during an experimental period using student-selected menus with that from a control period when a district-wide menu was served. Mean ounces of plate waste per meal per student decreased during the experimental period. Vegetables and salads were discarded less often during the experimental period than during the control period.

In 1978, Jansen and the Colorado State research team (53) determined plate waste in 29 elementary schools and 29 high schools participating in the NSLP. Their data showed that student acceptability ratings correlated well with consumption figures. Milk had the highest acceptability with 88 and 94 percent consumed in the fifth and tenth grade, respectively. They reported that most entrees and starches were well accepted and that three-fourths or more of the portion typically was consumed. Consumption of vegetables and salads was lower, ranging from one-third to half of the portions actually being consumed.

Davidson (67) found that lunch plate waste occurs at substantially different levels in public elementary schools using identical food delivery systems. He reported that plate waste results from both intrinsic and extrinsic influences and that physical and cultural environment are important factors in determining the level of food acceptance.

Food acceptability was assessed in high schools using four alternate methods of menu planning: Type A "Offer vs Serve," Type A, Basic 4, and Free Choice. Free choice resulted in a significant reduction of total plate waste. Consumption of poorly accepted items was bimodally

distributed. For example, for cooked and raw vegetables and salads, 10 to 20 percent of the students ate 10 percent or less of the food served and 40 to 60 percent ate 90 percent or more (68).

Distributions of both serving size and plate waste data from school lunches were analyzed and discussed in terms of implications for plate waste measurement in a recent study (69). Portion size of food items varied widely between trays except in the beverage category. Relative standard deviations of serving size were as large as 42 percent of the mean. The serving size data suggest changes in the procedure to obtain mean serving weights. The data show that weighing 10 rather than four or five samples of some foods will lead to a much higher probability of an accurate estimate of the actual mean serving size. Distribution curves of percentage plate waste were similar in shape for all foods and supported previous findings of "U-shaped" distributions. Percentage waste of a given food item was best characterized by the proportion of individuals who consumed all or almost all of a serving (wasted 10 percent or less), and the proportion who consumed none or almost none of a serving (wasted 91 percent or more). This indicates that the mean may not be a representative measure of individual plate waste, at least for elementary school children.

In 1979, Lilly et al. (1) conducted a pilot study of food and nutrient consumption in the NSLP to provide an estimate of the magnitude of plate waste in school foodservice, to identify those foods most acceptable among children and types of foods that result in the largest amount of plate waste, and to provide statistical analysis of the nutritional quality of the lunches consumed. For those studies in which consumption of various food categories is reported, milk had the highest acceptability

and consumption rate of any food. Raw and cooked vegetables had the least acceptability and rate of consumption.

Most studies (41, 53, 64) of food acceptability, determined either by consumption or by preference ratings reflect a consistent pattern. Milk rates highest with a greater percentage consumed than any other item. Salads and vegetables invariably are consumed least.

As a result of the summary report (63) on plate waste and in an effort to improve food consumption in the NSLP, the USDA/FNS has initiated and/or implemented many activities. These include (a) proposing revisions in meal requirements, (b) implementing offer versus serve, (c) encouraging on-site food preparation, (d) implementing training programs for foodservice personnel, and (e) implementing nutrition education programs. The late Senator Humphrey stated publicly "we must increase our efforts to improve the quality and acceptability of food offered to children."

METHODOLOGY

Research Site

The two school lunch delivery systems studied were conventional on-site food preparation and food preparation in a secondary school base kitchen followed by hot bulk transport to satellite service units at elementary schools. The study was conducted in eight elementary schools (Table 2) of a district in a medium-sized midwestern city. Nine elementary schools, one middle school, and one senior high school comprise the district. Schools in the same district were used due to funding and time limitations. Also, greater control was achieved by dealing with only one management system. Four schools have on-site food preparation and service, and four satellite schools receive food from a base kitchen. Three of the satellite schools receive food from the middle school and one satellite receives food from the high school.

The school foodservice director is responsible for overall administration and coordination at the district level. A cook manager at each school manages food production and service.

Centrally-planned, non-cyclical menus are written one month in advance of service. Every two weeks the cook managers meet with the foodservice director to discuss menus and make recommendations.

Prior to collection of data, approval was sought from the district foodservice director and the elementary school principals. An explanatory memorandum was prepared by the researcher and transmitted to the principals by the foodservice director with a request that they approve involvement in the study.

Table 2: Characteristics of the eight schools selected for study

schools	school number	system[1]	enrollment[2]	approved applications[3] free (N)	approved applications[3] reduced price (N)	approved applications[3] % free and reduced	characteristics of school population (SES)[4]
Lee	1	0	309	24	20	14.0	predominately middle and upper middle
Woodrow Wilson	3	0	298	71	37	36.2	predominately low and low middle
Northview	5	0	522	87	47	25.0	primarily low middle
Ogden	7	0	142	54	41	66.9	predominately low
all on-site schools			1271	236	145	29.9	
Eugene Field	2	S	231	22	13	15.0	predominately middle and upper middle
Theodore Roosevelt	4	S	323	57	21	24.1	mixture of low, middle, and upper middle
Marlatt	6	S	500	18	17	7.0	primarily middle and upper middle
Bluemont	8	S	215	62	14	40.0	mixture of low and low middle
all satellite schools			1269	159	65	17.7	
all schools in district			2540	395	210	23.8	

[1] 0 = On-site, S = Satellite.

[2] October 1981 figures.

[3] October 1982 figures.

[4] SES = socioeconomic status.

Subsequent meetings were scheduled with each principal at the eight elementary schools. A memorandum to each of the teachers being asked to assist with the study and a specific description of the teacher's role in the project were given to the principals at these meetings for distribution (Appendix A). Rosters for each of the participating classes were requested, which were provided by the principals prior to data collection.

Research Design

The design characteristics of the food consumption study are summarized below.

- Eight elementary schools (four satellite, four on-site) in the same school district were used.
- Data collection occurred at one satellite and one on-site school per test day.
- Data were collected on two different days at each school.
- Students in grades four and five were test subjects.
- Four entrees and four vegetables were the test menu items.
- Menus were constant across schools tested on the same day.

The eight schools, four satellite and four on-site, were paired according to size and socio-economic factors. A split plot design was used to establish menu item-school combinations. Data were collected in each school on two different days, approximately three weeks apart. Data collection occurred at one satellite and one on-site school per test day.

Menu items included four frozen vegetables and four entrees selected in consultation with the foodservice director. The vegetables studied were broccoli, peas, carrots, and mixed vegetables. Frozen vegetables were selected for study because they are most vulnerable to changes in quality during holding. Hamburger pie, fish, spaghetti with meat sauce

and beef patties were the entree items studied. These entrees are used widely in school foodservice. Each vegetable-entree combination was served on two days in two different pairs of schools (Table 3). To reduce

Table 3: Data collection schedule and menu items served at each school

date	school no.	school	type[1]	entree	vegetable
Nov. 17	1	Lee	O	spaghetti and	peas
	2	Eugene Field	S	meat sauce	
Nov. 18	3	Woodrow Wilson	O	beef pattie	carrots
	4	Theodore Roosevelt	S		
Nov. 24	5	Northview	O	hamburger pie	broccoli
	6	Marlatt	S		
Nov. 25	7	Ogden	O	fish	mixed
	8	Bluemont	S		vegetables
Dec. 8	5	Northview	O	spaghetti and	peas
	6	Marlatt	S	meat sauce	
Dec. 9	7	Ogden	O	beef pattie	carrots
	8	Bluemont	S		
Dec. 15	1	Lee	O	hamburger pie	broccoli
	2	Eugene Field	S		
Dec. 16	3	Woodrow Wilson	O	fish	mixed
	4	Theodore Roosevelt	S		vegetables

[1] O = On-site
S = Satellite.

variability in response, the entire menu remained constant on each of the two days the vegetable and entree combination was studied. Complete menus are listed in Table 4.

Fourth and fifth graders were selected to represent elementary school children because, as found by Christakis et al. (70), upper elementary

Table 4: Complete school lunch menus on data collection days

dates	menu
Nov. 17, Dec. 8	Italian spaghetti and meat sauce seasoned green peas Italian blue plums hot Italian bread milk
Nov. 18, Dec. 9	breaded beef pattie tater tots buttered carrot coins chilled mixed fruit cup buttered wheat germ roll milk
Nov. 24, Dec. 15	hamburger pie whipped potato topping and cheese buttered broccoli apple wedges buttered cinnamon puff milk
Nov. 25, Dec. 16	breaded fish fillet with tarter sauce crisp french fries with catsup seasoned mixed vegetables fruit cup homemade whole wheat bun milk

students reflect development through the primary years. The postulation was that maturity level, cognitive skills, and reading ability of this age group would facilitate data collection.

Development of Instruments

Acceptability Tray Card

The acceptability tray card was adapted from that used in Dade County, Florida, Public Schools in a study comparing Type A and Computer-Assisted Nutrient Standard Menus (71). The final instrument (Appendix B)

was comprised of questions on students' attitudes about the appearance, taste, temperature, and amount served of the menu items. This instrument was designed to investigate why students accepted or rejected a particular menu item.

Classroom Cards

Five, color-coded cards were developed to obtain data on food acceptability in the classroom after the students had eaten lunch (Appendix C). Two orange student information cards were developed. The first day of data collection students filled in a more detailed card and the second day they completed the card asking if they had eaten school lunch. The green card was a measure of self reported consumption and the blue card included a hedonic rating scale. The tan card was a familiarity measurement instrument. The cards were color coded to assist teachers in giving instructions and to help the students in understanding the way to provide the data requested.

Student Information Card. The general information card (Card 1) (Appendix C) was adapted from that used in the Garrett and Vaden study (66) concerning the influence of student selected menus on participation, plate waste, and student attitudes. The final instrument contained questions including biographical data, students' reasons for eating school lunch, frequency of eating, attitudes about school lunch, and whether or not the student ate the school lunch the day of data collection.

An additional student information card (Appendix C) was developed for the second day of data collection at each school. This card contained only one question asking whether or not the student had eaten school lunch that particular day.

Self Reported Consumption. This study used an instrument (Card 2) developed by Comstock et al. (49) to measure self-reported consumption (Appendix C). Students were asked to rate their food consumption on a six-point scale: all, a lot, half, a little, just tasted, none.

Facial Hedonic Rating Scale. The hedonic rating scale (Card 3) (Appendix C) was adapted from that used in studies by Lachance (48) and Comstock et al. (49). It consisted of a facial, five point scale; scale points were great, good, so-so, bad, and awful.

Familiarity Measurement. Previous studies by Gutsch (51) and Van Riter (42) pertained to preferences of students for food items at home and at school. The concept for the familiarity measurement instrument (Card 4, Appendix C) was derived from the Gutsch and Van Riter studies. This instrument was designed to investigate how familiarity with a food item affects acceptance. Questions included whether the student ate the menu item at home, at school, both places, or not at all, and if the menu item was ever served in the student's home.

General Information Form

A general information form (Appendix D) was developed for recording average serving sizes, observer comments on food quality, and the complete menu. Also, participation data were obtained from the foodservice manager and school secretary at each school.

Plate Waste Record

The plate waste record (Appendix E) was designed to record observational and weighed plate waste data. Hanson scales[1] with a capacity of 500 grams by 1 gram increments were used to weigh plate waste. The scales were tested for accuracy before they were used in data collection using standardized weights. The scales could be tared to account for the weight of the paper plate by adjusting a knob on the front of the scale.

Temperature and Holding Times

A card (Appendix F) was developed for collecting times and temperatures at specific points in the data collection procedure: end of preparation, point of shipment, arrival at satellite school, beginning of service, service to classes, and end of service. Thermometers[2] used for the study had a temperature range of 100-220°F.

Research Team

The research team consisted of four Institutional Management graduate students; two were research coordinators and two served as research assistants. Their job titles and responsibilities follow.

Research Coordinator -- responsible for set up and organization; recording weighed plate waste, observational plate waste, and average serving sizes; distributing classroom cards and tray cards; and recording food temperatures and holding time data.

Research Assistant -- responsible for assisting with weighed plate waste.

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[1]Hanson Dietetic Scale, Model 1440, Shibuta, Mississippi.

[2]Taylor Instruments Company, Rochester, NY.

Pilot Work

Methodology for this study was developed after consultation with the foodservice director for the school district. Specific data collection procedures are detailed in Appendix G.

The research coordinators attended the regularly scheduled meetings of the cook managers during the data collection period. At those conferences, copies of all procedures and data collection instruments were reviewed by the cook managers. Also, the research coordinators scheduled data collection times and visitations for establishing specific procedures at each school and cook managers were given instructions for taking accurate food temperatures (Appendix G).

Training for the food consumption study was designed to maximize the opportunity to apply necessary skills for accurate plate waste observation and weighing (Appendix G). The first part of training included a visit by the research team to each school to review logistics and procedures with the foodservice personnel and the principals.

Members of the research team participated in a training session for the weighed plate waste procedure at an elementary school prior to the actual data collection. Procedures for weighing plate waste were standardized among team members.

Training for the observational plate waste measure involved practice in determining various remaining portions of four food items--spaghetti and meat sauce, peas, mixed vegetables, and broccoli--in two separate sessions at a university residence hall. These were food items selected for measurement in the study. Observational accuracy and interobserver agreement were assessed since it was necessary to obtain consistency of

ratings among observers (Appendix H). A total of 163 observations were recorded. Observers agreed in 154 instances.

A pilot study to standardize procedures was conducted in the one elementary school which would not be used in the actual study. The pilot study provided additional practice for observational and weighed plate waste procedures and an opportunity to perform the complete methodology.

Meetings with fourth and fifth grade teachers were held at each school the afternoon preceding data collection. At this time, procedures were clarified (Appendix I) and materials were distributed.

Data Collection

Acceptability Tray Card

Before lunch, teachers distributed tray cards prerecorded with students' names, ID numbers, and menu items to be evaluated by those students eating school lunch. The teachers were provided with a script and posters (Appendix I) to instruct students how to complete the tray card. According to the script, students were asked to take a pencil to the lunchroom and to leave the card on the tray when they had finished eating their lunch.

Average Serving Size

Each day the research coordinator collected five trays at random from the serving line as the fourth and fifth grade students received their trays. The data collectors recorded weights of the vegetables and entrees from the full trays for each menu item on the general information form. Average serving sizes were later calculated from the five sample weights.

Observational Plate Waste

After the students finished their lunches, data collectors visually estimated plate waste for each tray which was accompanied by an acceptability tray card. The student ID number from the acceptability tray card was copied onto a plate waste data card. A code as developed by Comstock et al. (49) was then assigned to the remaining vegetable and entree menu items: 5, if a full portion remained; 4, if nearly a full portion remained, but at least one bite was eaten; 3, if three-quarters of a portion remained; 2, if one-half a portion remained; 1, if one-quarter of a portion remained; 0, if none remained.

Weighed Plate Waste

After the observational plate waste procedure, weighed plate waste was measured using the USDA recommended procedure (52). The vegetable and entree were each carefully separated and scraped with a rubber spatula onto clean paper plates. Weight of paper plate was tared before the food was scraped onto the plate. Data collectors recorded on the plate waste data card the weight to the nearest gram or "0" if none of the menu item remained.

Classroom Cards

Teachers distributed packets of four classroom cards to all students soon after they returned to the classroom after lunch. Students' names, ID numbers and the menu items to be evaluated had been prerecorded on the cards. Teachers were given a script to read and a set of posters to use when they instructed the students on how to complete the cards. Narratives and posters are shown in Appendix I. All students were given a packet of cards. If a student had not eaten school lunch that day, they

were instructed to stop at the end of the first general information card and hand in all the cards.

Holding Time and Temperature Measurements

Times and temperatures for the vegetable and entree menu item were recorded: when food preparation was complete; when food was shipped to the satellite school;[1] when food arrived at the satellite school;[1] at the beginning of the serving period; at the end of the serving period; when the fourth and fifth grade classes were served; at the end of the serving period. The research coordinator at each school collected the time and temperature data with the assistance of the cook manager.

Data Analysis and Design

The relationship of type of system and frequency of eating school lunch, students' reasons for eating school lunch, students' opinions of food quality, and students' assessment of frequency of serving the same food was examined using chi square. Chi square also was used to examine the relationship of these variables among the eight schools.

Percentage plate waste was evaluated by three methods: weighed, observed, and self report. Computation of plate waste variables is outlined in Table 5. Percent weighed plate waste was calculated for the vegetable and entree on each tray by dividing the weight of the edible food waste by the mean serving weight (Table 6).

$$\text{PCT-WAS} = \frac{\text{WGT}}{\text{SERVE}} \times 100$$

where PCT-WAS = plate waste in percent
SERVE = mean serving size, g.
WGT = individual student waste, g.

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[1]Recorded for satellite schools only.

Table 5: Variables computed for analysis of plate waste and acceptability data

variable	variable name	computation
individual student waste of the vegetable	WGT1	
individual student waste of the entree	WGT2	
vegetable average portion size	SERVE1	average weight of five vegetable servings
entree average portion size	SERVE2	average weight of five entree servings
vegetable percent weighed waste	PCT-WAS1	$100 \times \frac{WGT1}{SERVE1}$
entree percent weighed waste	PCT-WAS2	$100 \times \frac{WGT2}{SERVE2}$
combined percent weighed waste	PCT-WAS3	$100 \times \frac{WGT1 + WGT2}{SERVE1 + SERVE2}$
vegetable percent observational waste	PCT-OBS1	Code: 0 = 0% 1 = 25% 2 = 50% 3 = 75% 4 = 90% 5 = 100%
entree percent observational waste	PCT-OBS2	Code: 0 = 0% 1 = 25% 2 = 50% 3 = 75% 4 = 90% 5 = 100%
vegetable percent waste from self report data	PCT-SR1	Code: 0 = 0% 1 = 25% 2 = 50% 3 = 75% 4 = 90% 5 = 100%

Table 5: (cont.)

variable	variable name	computation
entree percent waste from self report data	PCT-SR2	Code: 0 = 0% 1 = 25% 2 = 50% 3 = 75% 4 = 90% 5 = 100%
rating for flavor from tray card	TASTE1	5 = Great 4 = Good 3 = So-So 2 = Bad 1 = Awful
rating for appearance from tray card	LOOK1	5 = Great 4 = Good 3 = So-So 2 = Bad 1 = Awful
rating for serving size from tray card	TAMOUNT1	1 = Too much 3 = Right amount 1 = Not enough
rating for temperature from tray card	TEMP1	3 = Just right 2 = O.K. 1 = Too cool
acceptability score of vegetables	ACCEPT1	Σ TASTE1 + LOOK1 + TAMOUNT1 + TEMP1
acceptability score of entrees	ACCEPT2	Σ TASTE2 + LOOK2 + TAMOUNT2 + TEMP2

Table 6: Mean serving sizes of menu items used as standard portion for computation of percentage plate waste

menu item	period 1		period 2	
	school no.	mean serving size[1]	school no.	mean serving size[1]
vegetables				
peas	1	44.0	5	32.8
	2	55.4	6	45.0
carrots	3	33.6	7	51.8
	4	38.2	8	55.2
broccoli	5	32.8	1	60.6
	6	36.8	2	47.0
mixed vegetables	7	33.8	3	37.2
	8	48.8	4	40.0
entrees				
spaghetti and meat sauce	1	224.0	5	134.0
	2	195.6	6	216.8
beef pattie	3	52.4	7	42.0
	4	63.4	8	62.6
hamburger pie	5	115.6	1	171.6
	6	145.6	2	167.4
fish	7	86.0[2]	3	142.4[3]
	8	127.2[3]	4	78.6[2]

[1]Weights recorded to the nearest gram; mean of five portions.

[2]Fish weighed without bun.

[3]Fish weighed with bun.

For observed plate waste, visual scores were based on a 6-point rating scale adapted from Comstock (49), which is used to estimate the proportion left of an original serving. Values were assigned to each point on the rating scale for percent observed plate waste (Table 5):

0 = no food left on plate
1 = 25% of food left on plate
2 = 50% of food left on plate
3 = 75% of food left on plate
4 = 90% of food left on plate
5 = 100% of food left on plate

A second scale was designed to obtain the students' estimate of the amount of food they had consumed. Values also were assigned to each response alternative (Table 5):

0 = none left on plate
1 = ¼ portion left
2 = ½ portion left
3 = 3/4 portion left
4 = one bite eaten
5 = all left

Distributions of the percent weighed, observed, and self reported waste were compiled for all vegetables and entrees by system, school, and menu item. Distributions of percent weighed waste also were compiled for total plate waste (i.e., vegetable and entree combined) by system, school, and menu item. Distributions of weighed plate waste were developed by partitioning percentage waste into five ranges (0, >0-30, >30-60, >60-90, >90-$\geq$100) and computing the proportion of students' trays which had food item waste falling into each range. Distributions of observed and self reported plate waste were developed by partitioning percent waste into five ranges: none, ¼ portion, ½ portion, 3/4 portion, and most or all of portion. The weighed plate waste classifications were established to be similar to the observed and self report categories.

Pearson correlation coefficients were computed between the various estimates of plate waste: percent weighed, percent observed, and percent self report. Correlations for both vegetables and entrees were computed for all eight schools combined and for on-site and satellite systems separately.

An acceptability score was computed as an overall index of food quality. It was the sum of the students' ratings for flavor, appearance, portion size, and temperature of the vegetable and the entree (Table 5). Correlation coefficients also were computed between percent weighed, observed, and self report plate waste and the acceptability scores for all schools combined and for each of the two systems separately.

A general linear model analysis of variance was used to study the effects of sex, system, menu, and frequency of eating school lunch on plate waste of the selected menu items. For an exploratory analysis of the data, one-way analysis of variance was used to compare percent weighed, percent observed, and percent self reported plate waste according to students' acceptability ratings, hedonic ratings, and familiarity ratings for the menu items. Data were not sufficient to consider all variables simultaneously.

RESULTS AND DISCUSSION

School Lunch Participation

Percentage participation was computed as the ratio of students eating the school lunch in relation to the number of students enrolled. Mean percentage participation in the school lunch program was 59.9 percent in on-site schools and 44.4 percent in the satellite schools during the eight data collection days (Table 7). Participation in on-site schools ranged from a low of 35.1 percent in period 2 at school 1 to 85.2 percent in period 1 at school 7; whereas the low in satellite schools was 22.6 percent (period 1) and the high 88.9 percent (period 2).

School 7 had the highest percentage participation of the four on-site schools; whereas school 8 had the highest participation among the satellites. These schools had the greatest ratio of free and reduced meals (Table 2, page 26), which has been shown to be a major influence on participation (72).

The menu was hypothesized to have a strong influence on the decision to eat school lunch. Percentage participation was lowest at all schools, both on-site and satellite, when the menu items studied were hamburger pie and broccoli.

General Information

Students' frequency of eating school lunch in on-site and satellite systems and in the various schools is presented in Table 8. Forty-three percent of the students at on-site schools responded they ate lunch every

Table 7: *Data on student participation in school lunch program at on-site and satellite schools on the eight data collection days*

	on-site schools														
	school 1			school 3			school 5			school 7			all schools		
		% served			% served			% served			% served		mean % served		
grade level	students enrolled	period 1	period 2	students enrolled	period 1	period 2	students enrolled	period 1	period 2	students enrolled	period 1	period 2	period 1	period 2	both periods
		%	%		%	%		%	%		%	%	%	%	%
4th grade	57	52.6	35.1	49	63.3	57.1	82	52.4	67.1	23	65.2	78.3	58.4	59.4	58.9
5th grade	35	54.3	54.3	51	49.0	64.7	82	59.6	64.6	19	78.9	68.4	60.5	63.0	61.8
all grades (grades 1-6)	309	50.2	40.8	298	54.4	60.4	522	49.2	63.4	142	85.2	75.4	59.8	60.0	59.9
	satellite schools														
	school 2			school 4			school 6			school 8			all schools		
4th grade	32	43.8	34.4	50	48.0	42.0	103	35.9	40.8	18	83.3	88.9	52.8	51.5	52.2
5th grade	39	38.5	38.5	68	55.9	50.0	93	22.6	23.7	31	58.1	74.2	43.8	46.6	45.2
all grades (grades 1-6)	231	37.7	36.4	323	46.4	49.8	500	28.4	30.0	215	62.3	64.2	43.7	45.1	44.4

Table 8: Frequency of eating school lunch by system[1] and school[2]

system		N	frequency of eating school lunch[3] every day	two to four times week	once a week	once a month	never
			← % →				
on-site (0)		396	43.0	22.6	9.6	9.9	14.9
satellite (S)		429	26.1	15.2	8.4	14.0	25.9
system	school						
0	1	91	31.0	28.6	15.8	15.8	8.8
0	3	99	41.4	22.2	6.1	11.1	19.2
0	5	165	44.9	21.8	9.1	7.3	15.8
0	7	41	58.5	14.6	7.3	4.9	12.2
S	2	69	18.8	8.7	4.4	4.4	37.7
S	4	117	35.9	18.8	7.7	12.0	19.7
S	6	194	15.5	16.0	9.3	20.6	29.4
S	8	49	55.1	12.2	12.2	6.1	10.2

[1]Analysis by system: $\chi^2 = 64.0$, df = 5, $P \leq .0001$.

[2]Analysis by school: $\chi^2 = 178.8$, df = 35, $P \leq .0001$.

[3]Because of nonresponses, row totals do not equal 100%.

day, compared to 26.1 percent of the students attending satellite schools. At the satellite schools, 25.9 percent of the students reported they never ate school lunch; whereas, only 14.9 percent of the on-site school students never ate at school. Schools 7 and 8 had the highest percentage of students reporting eating school lunch every day. As indicated above, these schools serve the highest ratio of free and reduced price lunches (Table 2).

In Table 9, students' responses on reasons for eating school lunch are tabulated. More than 70 percent of the students at on-site schools responded they ate school lunch because they liked the food and about 20 percent, because their parents wanted them to eat at school. In satellite schools, however, less than 60 percent ate because they liked the food; whereas almost 32 percent ate school lunch because of their parents' wishes. The influence of friends did not appear to be a major factor in whether or not students ate school lunch except in schools 1 and 6. The students in those two schools are primarily from middle and upper middle class families (Table 2). The ratios of free and reduced lunches for those schools are the lowest in the district.

Students were asked to indicate their opinions of food quality in the school lunch program (Table 10). Almost 40 percent of the students in on-site systems thought the food was almost always good compared to 16 percent in satellite systems. In fact, more than 30 percent of the students attending schools with the satellite system stated the food was usually not very good.

The students reacted to the frequency of serving the same food in the school lunch program (Table 11). The majority of students in schools with on-site systems indicated the foods were served the right

Table 9: Students' responses on reasons for eating school lunch by system[1] and by school[2]

system		N	why student eats school lunch[3]		
			like the food	because friends do	parents want them to
			← % →		
on-site (0)		338	70.7	8.6	20.7
satellite (S)		255	56.5	11.8	31.8
system	school				
0	1	77	72.7	11.7	15.6
0	3	82	68.3	4.9	26.8
0	5	143	69.9	9.8	20.3
0	7	36	75.0	5.6	19.4
S	2	24	62.5	4.2	33.3
S	4	76	54.0	7.9	38.2
S	6	124	50.8	18.6	30.7
S	8	31	80.7	0.0	19.4

[1]Analysis by system: $\chi^2 = 13.0$, df = 2, $P \leq .001$.

[2]Analysis by school: $\chi^2 = 37.1$, df = 14, $P \leq .001$.

[3]Because of nonresponses, row totals do not equal 100%.

Table 10: Students' opinions of food quality in school lunch program by system[1] and by school[2]

system		N	students' opinions of food quality[3] almost always good	good some of time	usually not very good
			← % →		
on-site (0)		381	39.9	44.4	15.8
satellite (S)		350	16.0	49.7	34.3
system	school				
0	1	89	44.9	31.5	23.6
0	3	95	34.7	52.6	12.6
0	5	157	34.4	52.9	12.7
0	7	40	62.5	20.0	17.5
S	2	40	15.0	52.5	32.5
S	4	103	7.8	53.4	38.8
S	6	161	18.0	44.1	37.9
S	8	46	28.3	58.7	13.0

[1]Analysis by system: $\chi^2 = 63.2$, df = 2, $P \leq .0001$.

[2]Analysis by school: $\chi^2 = 106.5$, df = 14, $P \leq .0001$.

[3]Because of nonresponses, row totals do not equal 100%.

Table 11: Students' assessment of frequency of serving same food in school lunch program by system[1] and by school[2]

system		N	frequency of serving same food[3]		
			too often	right amount	not often enough
			← % →		
on-site (0)		373	13.9	52.6	33.5
satellite (S)		350	27.7	44.3	28.0
system	school				
0	1	88	12.5	59.1	28.4
0	3	94	16.0	46.8	37.2
0	5	151	13.9	49.7	36.4
0	7	40	12.5	62.5	25.0
S	2	36	27.8	33.3	38.9
S	4	105	32.4	39.1	28.6
S	6	163	25.8	46.6	27.6
S	8	46	23.9	56.5	19.6

[1]Analysis by system: $\chi^2 = 20.9$, df = 2, $P \leq .0001$.

[2]Analysis by school: $\chi^2 = 33.54$, df = 14, $P \leq .01$.

[3]Because of nonresponses, row totals do not equal 100%.

amount of times. The students in the satellite schools, however, showed greater dissatisfaction with frequency of service of various foods.

Data on Temperatures, Holding Times, and Quality Assessments of Menu Items

Temperatures

Temperatures of vegetables and entrees taken at the end of food preparation, beginning of transportation, arrival at service site, beginning of service, end of service, and beginning of service to fourth and fifth grade classes in each of the eight schools are enumerated in Tables 12 and 13. According to the U.S. Public Health Service (73), potentially hazardous food shall be kept at an internal temperature of 140°F or above during service. Temperatures of the vegetables remained above 140°F from end of preparation to beginning of service except in one instance. Broccoli at satellite school 2 in period 2 was 80°F at the end of preparation and was shipped at this temperature. Malfunction of a steamer contributed to the unacceptable temperature. The temperatures at the end of the serving period were below 140°F for carrots at satellite schools 4 and 8, for broccoli at satellite schools 2 and 6, and for mixed vegetables at school 8.

At the beginning of service, internal temperatures of the spaghetti, beef pattie, hamburger pie, and fish were below 140°F in six instances at the satellite schools (Table 13), and frequently remained below 140°F. Only one on-site school had a temperature below 140°F at the beginning of service, spaghetti at school 5 during period 2 was slightly below this standard (i.e., the temperature was 135°F).

Table 12: Data on temperatures of vegetables at selected points from completion of food preparation to service in on-site and satellite school foodservice systems

point in distribution-service cycle	peas				carrots				broccoli				mixed vegetables			
	on-site		satellite		on-site		satellite		on-site		satellite		on-site		satellite	
	period 1 (school 1)	period 2 (school 5)	period 1 (school 2)	period 2 (school 6)	period 1 (school 3)	period 2 (school 7)	period 1 (school 4)	period 2 (school 8)	period 1 (school 5)	period 2 (school 1)	period 1 (school 6)	period 2 (school 2)	period 1 (school 7)	period 2 (school 3)	period 1 (school 8)	period 2 (school 4)
	← °F →															
food preparation complete	205	155	195	185	202	193	184	200	160	190	165	80	208	200	200	168
point of ship	-	-	172	160	-	-	-	180	-	-	160	80	-	-	180	-
arrive at site	-	-	162	158	-	-	-	176	-	-	160	79	-	-	170	-
beginning of service	170	145	170	156	175	190	176	150	150	150	155	125	172	152	160	150
temperature before last serving	190	144	170	145	155	160	138	138	150	145	135	125	170	130	115	140
temperature at service to class	180	150	170	146	175	180	176	140	150	150	145	128	170	125	145	150

Table 13: Data on temperatures of entrees at selected points from completion of food preparation to service in on-site and satellite school foodservice systems

point in distribution-service cycle	spaghetti				meat sauce				beef pattie				hamburger pie				fish			
	on-site		satellite		on-site		satellite		on-site		satellite		on-site		satellite		on-site		satellite	
	per. 1 (sch. 1)	per. 2 (sch. 5)	per. 1 (sch. 2)	per. 2 (sch. 6)	per. 1 (sch. 1)	per. 2 (sch. 5)	per. 1 (sch. 2)	per. 2 (sch. 6)	per. 1 (sch. 3)	per. 2 (sch. 7)	per. 1 (sch. 4)	per. 2 (sch. 8)	per. 1 (sch. 5)	per. 2 (sch. 1)	per. 1 (sch. 6)	per. 2 (sch. 2)	per. 1 (sch. 7)	per. 2 (sch. 3)	per. 1 (sch. 8)	per. 2 (sch. 4)
	← °F →																			
food preparation complete	180	170	120	140	170	182	176	160	170	193	160	200	168	140	140	146	160	175	160	155
point of ship	-	-	120	140	-	-	175	150	-	-	140	180	-	-	140	120	-	-	140	140
arrive at site	-	-	120	130	-	-	164	150	-	-	130	176	-	-	145	108	-	-	130	130
beginning of service	150	135	116	136	170	170	162	150	165	190	132	150	150	155	160	120	182	160	112	120
temperature before last serving	145	155	124	148	170	154	150	160	145	160	130	138	140	170	125	120	175	140	105	120
temperature at service to class	145	140	116	148	170	180	162	160	165	180	132	140	148	150	125	120	180	150	110	120

Holding Times

In the satellite system, menu items were prepared and transported well in advance of service. The total holding time from end of production to end of service for the four vegetables and four entrees varied between on-site and satellite systems (Tables 14 and 15). Holding time from end of production to beginning of service ranged from 1 hour to 2 hours and 45 minutes for vegetables at satellite schools. Vegetables were held at the base kitchen from 0 to 55 minutes before point of shipment. Vegetables held 2 hours or longer from end of preparation to beginning of service included peas at schools 2 and 6, carrots at school 8, broccoli at school 6 and mixed vegetables at school 8. At on-site schools, holding times for vegetables from end of production to beginning of service ranged from 25 minutes to 1 hour and 30 minutes.

For entrees at satellite schools, holding times from end of production to beginning of service ranged from 1 hour and 50 minutes to 3 hours and 10 minutes. Entrees were held at the base kitchen from 10 minutes to 1 hour and 20 minutes before shipping. Entrees held 2 hours or longer from end of preparation to beginning of service included spaghetti and hamburger pie at schools 2 and 6, meat sauce at school 2, and beef pattie and fish at schools 4 and 8. At on-site schools holding times for entrees ranged from 40 minutes to 1 hour and 50 minutes.

Food Quality

Observer comments on food quality are summarized in Table 16. Comments on quality of foods at on-site schools tended to be more positive than comments on menu items at satellite schools. Poor color, overcooking, and mushiness affected the quality of vegetables at satellite schools. Observers reported that the entrees at satellite schools tended

Table 14: Data on holding times for vegetables at selected points from completion of food preparation to service in on-site and satellite school food-service systems

point in distribution-service cycle	peas				carrots				broccoli				mixed vegetables			
	on-site		satellite		on-site		satellite		on-site		satellite		on-site		satellite	
	period 1 (school 1)	period 2 (school 5)	period 1 (school 2)	period 2 (school 6)	period 1 (school 3)	period 2 (school 7)	period 1 (school 4)[1]	period 2 (school 8)	period 1 (school 5)	period 2 (school 1)	period 1 (school 6)	period 2 (school 2)	period 1 (school 7)	period 2 (school 3)	period 1 (school 8)	period 2 (school 4)[1]
	← min. →															
food preparation complete to point of ship	-	-	55	30	-	-	-	20	-	-	34	0	-	-	28	-
food preparation complete to arrive at site	-	-	120	55	-	-	-	70	-	-	55	60	-	-	68	-
food preparation complete to beginning of service	60	90	165	145	25	75	65	150	50	50	155	105	45	60	162	50
food preparation complete to service to classes	80	120	165	190	25	90	65	180	80	70	200	210	60	60	190	50
length of service period	40	70	40	50	60	35	40	40	75	40	50	35	35	60	40	40

[1]Vegetables are prepared on-site at school 4. Other menu items are transported from the high school.

Table 15: Data on holding times for entrees at selected points from completion of food preparation to service in on-site and satellite school foodservice systems

point in distribution-service cycle	spaghetti				meat sauce				beef pattie				hamburger pie				fish			
	on-site		satellite		on-site		satellite		on-site		satellite		on-site		satellite		on-site		satellite	
	per. 1 (sch. 1)	per. 2 (sch. 5)	per. 1 (sch. 2)	per. 2 (sch. 6)	per. 1 (sch. 1)	per. 2 (sch. 5)	per. 1 (sch. 2)	per. 2 (sch. 6)	per. 1 (sch. 3)	per. 2 (sch. 7)	per. 1 (sch. 4)	per. 2 (sch. 8)	per. 1 (sch. 5)	per. 2 (sch. 1)	per. 1 (sch. 6)	per. 2 (sch. 2)	per. 1 (sch. 7)	per. 2 (sch. 3)	per. 1 (sch. 8)	per. 2 (sch. 4)
	← min. →																			
food preparation complete to point of ship	-	-	30	12	-	-	30	10	-	-	80	20	-	-	45	15	-	-	60	20
food preparation complete to arrive at site	-	-	90	40	-	-	90	40	-	-	95	70	-	-	65	70	-	-	100	40
food preparation complete to beginning of service	40	70	140	130	60	110	140	110	60	80	210	150	50	50	165	125	70	85	190	150
food preparation complete to service to classes	60	110	140	180	80	170	140	175	60	95	219	180	75	70	210	130	85	60	220	150
length of service period	40	70	40	50	40	70	40	50	60	35	40	40	80	40	50	35	35	60	40	40

Table 16: Observer comments on food quality at on-site and satellite foodservice systems

	on-site				satellite			
	period 1		period 2		period 1		period 2	
food item	school no.	descriptive comments	school no.	descriptive comments	school no.	descriptive comments	school no.	descriptive comments
peas	1	a little hard, good color--bright green	5	bright green color, hard in center	2	poor color, lukewarm	6	faded, olive green color, hard texture
carrots	3	good color and flavor	7	overcooked, *mushy*, slightly salty	4	overcooked, mushy, sweet carrot flavor	8	tender, good flavor
broccoli	5	yellow-green color, a little overdone	1	good flavor, excellent color, cooked just right	6	overcooked, strong flavor, olive color	2	cold--not cooked right, brown on top
mixed vegetables	7	good buttery flavor, good color	3	overcooked	8	bland, need more carrots for color	4	too salty, good appearance, nice mixture of vegetables
spaghetti and meat sauce	1	spaghetti nicely cooked, not greasy, a little bland in flavor	5	good tomato and meat flavor, appearance--good, could use more salt	2	lukewarm, good flavor	6	good flavor
beef pattie	3	spicy, tender, moist	7	greasy, soy-flavor, breaded flavor	4	greasy	8	hard on outside, soggy coating, in the middle very spicey
hamburger pie	5	good flavor, very cheesy	1	meat fell apart, good flavor, attractive appearance	6	meat underdone, potatoes very salty	2	good flavor, moist, cold
fish	7	tender, nicely browned	3	overcooked outside, brown, crunchy, hard	8	fish had heavy breading	4	tender, lightly browned

to be lukewarm, cold, and greasy. These comments could be partially explained by the long holding times (Table 15) and temperatures below the recommended standard of 140°F.

Plate Waste

Plate waste was studied from several perspectives. Distributions were compiled by type of production-service system (on-site or satellite), by school (i.e., for each of the eight schools in the study), and also, by type of menu item for each of the three methods of assessing waste (weighed, observed, and self report). Correlation coefficients were computed to examine the relative agreement among the three assessment methods. Also, the effects of selected variables on plate waste were studied. In all instances, data reported are percentages of plate waste in relation to the portion served to individual students.

A standard portion size was used as the basis for computing the percentage of weighed plate waste, which was an average of five portions randomly selected from the serving line. Because actual serving size could have exceeded this standard portion size (Table 6) used to compute this percentage, percent weighed plate waste could exceed 100. Other researchers (5, 69) have reported this to be a problem in measuring plate waste by the weighed method.

In Table 17, the mean percentage plate waste for all of the menu items studied as assessed by the three methods are shown, aggregated by all the eight schools in the district. Using the observational and self report methods, this issue of serving size variability is avoided because a reporting scale is used which is then translated into a percentage of plate waste. In fact, Comstock and Symington (69) concluded that using

Table 17: Percentage plate waste of selected menu items by weighing, observation, and students' self reports

menu item	plate waste measure		
	weighed	observed	self report
	← mean % plate waste →		
vegetables:			
peas	68.7	69.5	71.7
carrots	62.3	54.9	57.9
broccoli	71.4	60.9	60.8
mixed vegetables	69.9	64.7	60.3
all vegetables	69.3	62.8	63.4
entrees:			
spaghetti and meat sauce	20.0	24.0	20.1
beef pattie	15.8	16.3	22.7
hamburger pie	48.6	45.7	42.9
fish	16.6	18.2	18.9
all entrees	25.8	26.6	26.6

visual estimates of plate waste by trained observers may be as accurate as weighed plate waste data because of variability in serving sizes. Several studies also have found that indirect measures of plate waste (observational and self report) require less time and space than weighing, which makes it more practical to measure plate waste for more children at a meal while retaining accuracy (41, 49, 58).

Mean percent weighed plate waste for all vegetables served was 69.3 and for entrees, 25.8. Mean percent observed plate waste was 62.8 for vegetables and 26.6 for entrees, whereas self reported plate waste was 63.4 percent for vegetables and 26.6 percent for entrees.

Broccoli was the least consumed vegetable; the overall plate waste for that vegetable was 71.4 percent. Carrots had the highest consumption

of the four vegetables studied; however the mean plate waste was relatively high (62.3 percent). Beef pattie was the entree with the highest percentage consumption and hamburger pie the lowest; plate waste was 15.8 percent and 48.6 percent, respectively.

Comstock and Symington (69) reported that school lunch plate waste tends to have a bimodal distribution. Therefore, plate waste distributions were compiled according to system, school, and menu item to examine whether or not this phenomena would be characteristic of data from this study. They found percent waste of a food item was best characterized by the proportion of individuals who consumed all or almost all of the serving (i.e., wasted 10 percent or less) and the proportion who consumed none or almost none (wasted 91 percent or more). The remaining proportion of individuals was found to be distributed remarkably evenly across the "partially consumed" ranges. These distributions indicated that the mean was not a characteristic measure of individual percent plate waste.

Vegetable Plate Waste

A comparison of the distribution of percentage waste by weighing of vegetables between on-site and satellite systems is shown in Table 18. Over 30 percent of the students in on-site systems had no vegetable plate waste compared to 24.2 percent in satellite systems. The observed report of the approximate portion of vegetables left on the plate was similar to the weighed distribution (Table 19). The students' estimates of their plate waste reflected somewhat lower percentages; 23.2 percent in on-site systems and 22.4 percent in satellite systems left no food on the plate according to those data (Table 20). Data from vegetable plate waste reflected a bimodal distribution, findings which concurred with those of

Table 18: Distribution of percentage waste by weighing of vegetables in on-site and satellite systems[1]

percent waste by weighed plate waste	system	
	on-site (N=457)	satellite (N=359)
	← % of sample →	
0	30.9	24.2
>0-30	2.8	1.1
>30-60	6.8	7.2
>60-90	19.0	25.6
>90->100	40.5	41.9

[1]Analysis by system: $\chi^2 = 13.7$, df = 12, $P \leq .32$.

Table 19: Observed vegetable plate waste in on-site and satellite systems[1]

observed report of approximate portion of food left on plate	system	
	on-site (N=455)	satellite (N=359)
	← % of sample →	
none	30.8	24.2
1/4 portion	4.2	3.9
1/2 portion	5.5	7.5
3/4 portion	4.8	7.8
most or all of portion	54.7	56.6

[1]Analysis by system: $\chi^2 = 13.7$, df = 5, $P \leq .02$.

Table 20: Self report of vegetable plate waste in on-site and satellite systems[1]

self report of approximate portion of food left on plate	system	
	on-site (N=471)	satellite (N=362)
	← % of sample →	
none	23.2	22.4
1/4 portion	5.7	3.6
1/2 portion	4.3	7.2
3/4 portion	4.7	6.9
most or all of portion	62.1	59.9

[1]Analysis by system: $\chi^2 = 10.0$, df = 5, $P \leq .07$.

Comstock and Symington (69). Students tended to eat either most or all of the vegetables served or they ate only a small portion. Examination of data indicates that about 60 percent of the students left 60 percent or more of their vegetables. According to the weighed and observed assessment methods, waste from the satellite system tended to be somewhat higher than the on-site. Self reports, however, were similar for the percentage of students who left three-fourths or more of the vegetable portion.

Distribution of percentage waste of vegetables by weighing in the eight selected schools is shown in Table 21. There was a significant relationship ($P \leq .0001$) between the distribution of weighed plate waste and schools. Schools 7 and 8 had the greatest amount of vegetables consumed with 56.9 and 41.4 percent, respectively, of the sample at these schools having no plate waste. Satellite schools 2 and 4 had the largest percentage of students wasting 90 percent or more of the vegetable served.

Table 21: Distribution of percentage waste of vegetables by weighing in schools with on-site and satellite systems[1]

percent waste by weighed plate waste	schools--on-site system				schools--satellite system			
	1 (N=93)	3 (N=105)	5 (N=201)	7 (N=58)	2 (N=50)	4 (N=118)	6 (N=121)	8 (N=70)
	← % of sample →							
0	26.9	21.9	29.9	56.9	14.0	22.0	20.7	41.4
>0-30	3.2	1.0	2.5	6.9	0.0	0.0	1.7	2.9
>30-60	9.7	2.9	6.4	10.3	4.0	3.4	9.1	12.8
>60-90	10.7	33.3	17.4	12.1	32.0	15.3	33.9	24.3
>90->100	49.5	40.9	43.8	13.8	50.0	59.3	34.6	18.6

[1]Analysis by school: $\chi^2 = 211.2$, df = 84, $P \leq .0001$.

The observed report (Table 22) and students' self reports (Table 23) of the approximate portion of vegetable left on the plate showed school distributions consistent with the weighed plate waste distribution.

Distributions of percentage weighed waste of each vegetable menu item across all schools in both systems are enumerated in Table 24. Observed and self report data are in Tables 25 and 26. Peas appeared to be the least popular of the four vegetables studied. According to weighed plate waste, less than 20 percent of the students consumed all the portion served (Table 24). Data were similar for observed and self reports (Tables 25 and 26). The largest percentage of the students (48.4 percent) left over 90 percent of the broccoli portions served compared to the other three vegetables according to weighed data, which was interesting since almost one-third ate all of the portion. These results support a trend that students either tend to eat all the vegetable or eat none.

The observed plate waste distribution (Table 25) was similar to that from weighed reports except the observers may have had difficulty in distinguishing between 3/4 portion and most or all of the portion left. This difficulty could be partially due to variability of serving sizes. The students also reported (Table 26) that they had left "most or all of a portion" instead of distinguishing between 3/4 portion and the most or all of a portion category.

Entree Plate Waste

The distribution of percentage waste of entrees by weighing was similar for on-site and satellite systems (Table 27). Sixty-three percent of the students served by on-site systems and 57.4 percent from satellite systems had no entree plate waste. Results from the observed and self-report estimates (Tables 28 and 29) of approximate portion of

Table 22: Observed vegetable plate waste in schools with on-site and satellite systems[1]

observed report of approximate portion of food left on plate	schools--on-site system				schools--satellite system			
	1 (N=92)	3 (N=105)	5 (N=200)	7 (N=58)	2 (N=50)	4 (N=118)	6 (N=121)	8 (N=70)
	← % of sample →							
none	27.2	21.9	30.0	55.2	14.0	22.1	20.7	41.4
1/4 portion	5.4	0.9	5.5	3.5	4.0	1.7	4.1	7.2
1/2 portion	7.6	3.8	4.0	10.3	16.0	5.1	4.1	11.4
3/4 portion	7.6	8.6	3.0	0.0	8.0	5.1	11.6	5.7
most or all of portion	52.2	64.8	57.5	31.0	58.0	66.0	59.5	34.3

[1]Analysis by school: $\chi^2 = 97.7$, df = 35, $P \leq .0001$.

Table 23: Self report of vegetable plate waste in schools with on-site and satellite systems[1]

self report of approximate portion of food left on plate	schools--on-site system				schools--satellite system			
	1 (N=91)	3 (N=120)	5 (N=202)	7 (N=58)	2 (N=51)	4 (N=122)	6 (N=120)	8 (N=69)
	← % of sample →							
none	20.9	21.6	27.2	56.9	13.7	20.5	20.8	34.8
1/4 portion	4.4	5.8	5.5	8.6	0.0	4.1	1.7	8.7
1/2 portion	5.5	1.7	4.9	5.2	15.7	3.3	8.3	5.8
3/4 portion	3.3	6.7	4.5	3.4	7.9	7.4	5.8	7.2
most or all of portion	65.9	64.2	57.9	25.9	62.7	64.7	63.4	43.5

[1]Analysis by school: $\chi^2 = 95.7$, df = 35, $P \leq .0001$.

Table 24: Distribution of percentage waste of four selected vegetables by weighing[1]

percent waste by weighed plate waste	menu			
	peas (N=246)	carrots (N=168)	broccoli (N=219)	mixed vegetables (N=183)
	← % of sample →			
0	19.9	35.7	31.1	27.9
>0-30	3.3	3.6	0.9	0.6
>30-60	8.5	7.2	6.4	5.5
>60-90	29.7	19.6	13.2	24.0
>90->100	38.6	33.9	48.4	42.0

[1]Analysis by menu: $\chi^2 = 100.3$, df = 36, $P \leq .0001$.

Table 25: Observed plate waste of four selected vegetables[1]

observed report of approximate portion of food left on plate	menu			
	peas (N=246)	carrots (N=168)	broccoli (N=217)	mixed vegetables (N=183)
	← % of sample →			
none	19.9	35.7	31.3	27.3
1/4 portion	5.3	3.6	4.6	2.2
1/2 portion	6.1	7.7	6.0	6.0
3/4 portion	9.3	3.6	3.7	7.1
most or all of portion	59.4	49.4	54.4	57.4

[1]Analysis by menu: $\chi^2 = 25.9$, df = 15, $P \leq .04$.

Table 26: Self report of plate waste for four selected vegetables[1]

self report of approximate portion of food left on plate	menu			
	peas (N=247)	carrots (N=189)	broccoli (N=217)	mixed vegetables (N=180)
	← % of sample →			
none	17.8	31.8	28.6	26.7
1/4 portion	4.1	5.8	3.2	6.7
1/2 portion	6.9	1.6	7.4	5.5
3/4 portion	3.2	7.4	6.9	5.5
most or all of portion	68.0	53.4	53.9	55.6

[1]Analysis by menu: $\chi^2 = 40.9$, df = 15, $P \leq .001$.

Table 27: Distribution of percentage waste of entrees by weighing in on-site and satellite systems[1]

percent waste by weighed plate waste	system	
	on-site (N=457)	satellite (N=359)
	← % of sample →	
0	63.0	57.4
>0-30	6.6	7.2
>30-60	11.4	12.6
>60-90	7.6	11.7
>90->100	11.4	11.1

[1]Analysis by system: $\chi^2 = 12.9$, df = 11, $P \leq .30$.

Table 28: Observed entree plate waste in on-site and satellite systems[1]

observed report of approximate portion of food left on plate	system	
	on-site (N=455)	satellite (N=359)
	← % of sample →	
none	62.9	57.4
1/4 portion	7.9	8.6
1/2 portion	8.6	9.5
3/4 portion	4.6	7.8
most or all of portion	16.0	16.7

[1]Analysis by system: $\chi^2 = 4.7$, df = 5, $P \leq .45$.

Table 29: Self report of entree plate waste in on-site and satellite systems[1]

self report of approximate portion of food left on plate	system	
	on-site (N=467)	satellite (N=360)
	← % of sample →	
none	62.7	51.1
1/4 portion	9.4	13.6
1/2 portion	8.8	9.4
3/4 portion	7.3	8.1
most or all of portion	11.8	17.8

[1]Analysis by system: $\chi^2 = 13.4$, df = 5, $P \leq .02$.

entree left on the students' plates in on-site and satellite systems were similar to those from weighed plate waste assessments.

Distributions of percentage waste by weighing, observation, and self report of entrees were significantly ($P \leq .0001$ level) related to school (Table 30). Distributions resulting from the three methods of measuring plate waste were similar (Tables 31 and 32). Over 93 percent of the sample from school 7 had no plate waste according to the estimate by weighing, as did 78.5 percent from school 8. School 2 had 42 percent of the students having no plate waste and 22 percent with >90 to >100 percent entree waste. As indicated earlier weighed plate waste could exceed 100 percent if the actual serving size exceeded the standard portion size used in the computations.

The distributions of percentage waste were significantly related ($P \leq .0001$) to type of entree menu for weighed, observational, and self report measurements of plate waste (Tables 33, 34, 35). The three measures of plate waste resulted in similar distributions. The percentage of students with no entree waste by weighing was 61 percent for spaghetti and meat sauce, 78.6 percent for beef pattie, 39.7 percent for hamburger pie, and 68.3 percent for fish. These data indicate the least popular entree was hamburger pie. Dependent on the method of assessment, between 67 and 79 percent of the students left >90 to >100 percent of the portion served of this menu item.

For an additional examination of the data, weighed plate waste data for vegetables and entrees were combined and analyzed. The percentage of students leaving no plate waste for both entree and vegetables was somewhat greater in on-site samples compared to the satellite system (Table 36). More than 34 percent of the on-site sample and 24.5 percent of the

Table 30: Distribution of percentage waste of entrees by weighing in schools with on-site and satellite systems[1]

percent waste by weighed plate waste	schools--on-site system				schools--satellite system			
	1 (N=93)	3 (N=105)	5 (N=201)	7 (N=58)	2 (N=50)	4 (N=118)	6 (N=121)	8 (N=70)
	← % of sample →							
0	50.5	65.7	58.7	93.1	42.0	67.0	42.2	78.5
>0-30	11.8	6.7	5.5	1.7	6.0	3.4	14.1	2.9
>30-60	15.1	20.0	8.0	1.7	20.0	9.3	14.1	10.0
>60-90	12.9	4.8	7.9	3.5	10.0	7.6	19.0	7.2
>90->100	9.7	2.8	19.9	0.0	22.0	12.7	10.6	1.4

[1]Analysis by school: $\chi^2 = 204.7$, df = 77, $P \leq .0001$.

Table 31: Observed entree plate waste in schools with on-site and satellite systems[1]

observed report of approximate portion of food left on plate	schools--on-site system				schools--satellite system			
	1 (N=92)	3 (N=105)	5 (N=200)	7 (N=58)	2 (N=50)	4 (N=118)	6 (N-121)	8 (N=70)
	← % of sample →							
none	50.0	65.7	59.0	91.4	42.0	67.0	42.2	78.6
1/4 portion	17.4	8.6	5.0	1.7	10.0	6.8	13.2	2.8
1/2 portion	6.5	17.1	6.5	3.5	14.0	4.2	13.2	8.6
3/4 portion	7.6	3.8	4.5	1.7	10.0	5.9	9.9	5.7
most or all of portion	18.5	4.8	25.0	1.7	24.0	16.1	21.5	4.3

[1]Analysis by school: $\chi^2 = 118.5$, df = 35, $P \leq .0001$.

Table 32: Self report of entree plate waste in schools with on-site and satellite systems[1]

self report of approximate portion of food left on plate	schools--on-site system				schools--satellite system			
	1 (N=90)	3 (N=118)	5 (N=202)	7 (N=57)	2 (N=52)	4 (N=119)	6 (N=120)	8 (N=69)
	← % of sample →							
none	53.3	65.3	57.9	89.5	38.5	58.8	39.2	68.1
1/4 portion	14.5	9.3	9.4	1.8	11.5	9.2	18.3	14.5
1/2 portion	11.1	5.9	11.4	1.7	13.5	5.1	14.2	5.8
3/4 portion	6.7	6.8	8.9	3.5	19.2	4.2	10.0	2.9
most or all of portion	14.4	12.7	12.4	3.5	17.3	22.7	18.3	8.7

[1]Analysis by school: $\chi^2 = 95.4$, df = 35, $P \leq .0001$.

Table 33: Distribution of percentage waste of four selected entrees by weighing[1]

percent waste by weighed plate waste	menu: spaghetti with meat sauce (N=246)	beef pattie (N=168)	hamburger pie (N=219)	fish (N=183)
	% of sample			
0	61.0	78.6	39.7	68.3
>0-30	12.1	2.4	5.5	5.5
>30-60	12.6	5.3	11.9	16.9
>60-90	9.8	5.4	14.6	6.6
>90->100	4.5	8.3	28.3	2.7

[1]Analysis by menu: $\chi^2 = 183.1$, df = 33, $P \leq .0001$.

Table 34: Observed plate waste of four selected entrees[1]

observed report of approximate portion of food left on plate	menu: spaghetti with meat sauce (N=246)	beef pattie (N=168)	hamburger pie (N=217)	fish (N=183)
	% of sample			
none	61.0	78.6	39.7	67.8
1/4 portion	13.0	3.5	6.9	7.6
1/2 portion	5.7	3.0	12.9	14.2
3/4 portion	8.5	3.0	5.5	6.0
most or all of portion	11.8	11.9	35.0	4.4

[1]Analysis by menu: $\chi^2 = 130.1$, df = 15, $P \leq .0001$.

Table 35: Self report of plate waste for four selected entrees[1]

self report of approximate portion of food left on plate	menu: spaghetti with meat sauce (N=248)	beef pattie (N=189)	hamburger pie (N=216)	fish (N=174)
	← % of sample →			
none	60.5	67.2	38.0	67.8
1/4 portion	15.3	6.4	10.1	12.1
1/2 portion	11.7	6.3	13.0	3.5
3/4 portion	6.9	3.7	13.4	5.7
most or all of portion	5.6	16.4	25.5	10.9

[1]Analysis by menu: $\chi^2 = 94.4$, df = 15, $P \leq .0001$.

Table 36: Distribution of percentage waste of combined menu items by weighing in on-site and satellite systems[1]

percent waste by weighed plate waste	system: on-site (N=457)	satellite (N=359)
	← % of sample →	
0	12.8	17.8
>0-30	34.6	24.5
>30-60	17.9	31.2
>60-90	12.3	15.3
>90->100	11.4	11.2

[1]Analysis by system: $\chi^2 = 38.1$, df = 11, $P \leq .0001$.

satellite sample wasted >0 to 30 percent. Percentage vegetable-entree plate waste distributions among the various schools are shown in Table 37. Distribution of percentage weighed waste of the four selected vegetable and entree combinations are enumerated in Table 38. The carrots and beef pattie combination resulted in the least waste, with almost one-third of the sample leaving no plate waste. The menu with broccoli and hamburger pie was consumed least frequently with 27.8 percent of the sample leaving >90 to >100 percent.

Correlation Between Methods

Correlation coefficients between percentage plate waste measured by weighing, observation, and self report are shown in Table 39. The coefficients between percent weighed and percent observed in both systems ranged from .88 to .97. The coefficients were higher for entrees than for vegetables, probably because portion sizes for meat items are more standardized than those for vegetables. The correlation coefficients between weighed and self report measurements for all schools combined were .76 and .77 for vegetables and entrees, respectively, with little variation between systems. The correlation between observed and self report plate waste also indicated close agreement; coefficients ranged from .76 to .84 with those for vegetables being somewhat higher than those for entrees.

Chmielinski and White (58) found a .80 correlation between visual ratings of plate waste by trained observers and physical weights; whereas Comstock et al. (49) found correlations of .90 to .95. The correlation between child ratings and weighed waste was lower and more variable, however, ranging from .39 to .84. Stallings et al. (59) also correlated

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Table 37: Distribution of percentage waste of combined menu items by weighing in schools with on-site and satellite systems[1]

percent waste by weighed plate waste	schools--on-site system				schools--satellite system			
	1 (N=93)	3 (N=105)	5 (N=201)	7 (N=58)	2 (N=50)	4 (N=118)	6 (N=121)	8 (N=70)
	← % of sample →							
0	17.2	15.2	21.9	56.9	8.0	16.9	14.9	31.0
>0-30	35.5	32.4	38.3	24.1	36.0	11.0	32.2	26.2
>30-60	17.2	36.2	10.0	13.8	18.0	44.1	20.7	37.1
>60-90	18.3	12.4	11.4	5.2	20.0	14.4	19.8	5.7
>90->100	11.8	3.8	18.4	0.0	18.0	13.6	12.4	0.0

[1]Analysis by school: $\chi^2 = 244.0$, df = 77, $P \leq .0001$.

Table 38: Distribution of percentage waste of four selected vegetable and entree combinations by weighing[1]

percent waste by weighed plate waste	menu			
	peas/ spaghetti with meat sauce (N=246)	carrots/ beef pattie (N=168)	broccoli/ hamburger pie (N=219)	mixed vegetables/ fish (N=183)
	← % of sample →			
0	17.1	31.6	18.3	20.8
>0-30	50.4	15.5	19.6	29.0
>30-60	15.0	32.1	15.1	38.2
>60-90	13.0	11.3	19.2	9.8
>90->100	4.5	9.5	27.8	2.2

[1]Analysis by menu: $\chi^2 = 228.6$, df = 33, $P \leq .0001$.

Table 39: Correlation of percentage plate waste measured by weighing, observation, and students' self reports

system	vegetables	% observed	% self report
		r	r
both	% weighed	.90	.76
	% observed		.83
on-site	% weighed	.88	.76
	% observed		.84
satellite	% weighed	.92	.75
	% observed		.81
system	entrees	% observed	% self report
		r	r
both	% weighed	.97	.77
	% observed		.77
on-site	% weighed	.97	.77
	% observed		.76
satellite	% weighed	.96	.78
	% observed		.79

visual assessments by observers and weighed plate waste and reported coefficients ranging from .58 to .99.

Comstock et al. (49) contended that variability in serving sizes acts to reduce the percent waste/child rating correlation but not the correlation between visual estimates and percent waste. They hypothesized that the child rates waste based on a mental image of the actual amount served, while the trained observer makes visual estimates based on a mental image of an "average" full tray.

The major findings about the relationships among measures of food consumption from the Nebraska study (49) were that trained data collectors

could make visual estimates of plate waste that correlate highly (about .93) with percent weighed waste. These estimates are quite accurate when compared to expected values. Second, child ratings of food consumption correlate highly with percent weighed waste (about .74), though not as high as visual estimates. Stallings et al. (59) also concluded that visual assessment seemed a reliable and simple method for plate waste assessment.

Effects of Selected Variables on Plate Waste

The simultaneous effects of several variables on the plate waste measures were examined using the general linear model analysis of variance. F ratios are shown in Table 40. An effect for frequency of eating school lunch was shown on weighed and observed vegetable plate waste. Students reporting they ate once a month (Table 41) had the lowest mean percent vegetable plate waste (60.5 percent, weighed; 53.4 percent, observed), whereas those reporting 2 to 4 times a week had the highest mean percent waste. Mean percent plate waste for vegetables was 62.1 percent for those students who ate school every day.

Menu significantly affected all three entree plate waste measures. The beef pattie entree had the lowest percentage plate waste (Table 42) and spaghetti with meat sauce and hamburger pie the highest, dependent on measure utilized. Male and female self report responses differed significantly for the menu item, beef pattie. Males mean percent plate waste was 21.1 percent whereas for females the waste was 7.6 percent.

Relationship of Students' Acceptability, Hedonic, and Familiarity Ratings and Plate Waste Measures

To study the relationship between plate waste and various student assessments of food acceptability, hedonic ratings, and familiarity

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Table 40: F ratios for analysis of effects of selected variables on plate waste of selected menu items

dependent variable	mean square error	F ratios for effects of:[1] sex	system[2]	menu[3]	freq. of eating[4]	sex/ system	sex/ menu	sex/ eat	system/ menu	freq. of eat/ system	freq. of eating/ menu	school (system/ menu)
% weighed plate waste of vegetables	3137.3	0.2	0.4	2.0	2.9*	1.9	1.7	0.6	0.5	0.9	1.4	7.5***
% weighed plate waste of entrees	1236.2	1.8	1.7	9.0***	1.0	0.4	1.0	1.2	1.1	0.4	1.1	2.5*
% observed plate waste of vegetables	1708.7	0.1	0.4	0.5	2.6*	0.2	1.2	1.3	0.2	1.6	1.2	5.4***
% observed plate waste of entrees	1212.0	1.7	1.5	10.4***	1.1	0.4	1.2	0.9	2.0	0.6	1.0	3.2**
% self reported plate waste of vegetables	1600.3	1.6	0.3	2.0	2.0	0.0	0.1	0.5	2.2	1.8	0.7	5.4***
% self reported plate waste of entrees	1160.7	1.1	1.4	5.3*	1.5	0.8	2.9*	0.7	0.8	0.3	0.9	2.9**

[1] N varies from 814 to 833.

[2] Systems: on-site or satellite.

[3] Menus: peas/spaghetti and meat sauce
carrots/beef pattie
broccoli/hamburger pie
mixed vegetables/fish

[4] Frequency of eating school lunch: every day, 2 to 4 times a week, once a month, never.

* $P \leq 0.05$ ** $P \leq .01$ *** $P \leq .001$

Table 41: Mean percentage plate waste of vegetables

variable[1]	mean % plate waste	
	weighed	observed
	← least square means and std. errors →	
frequency of eating school lunch		
every day	62.1 ± 2.9	56.7 ± 2.1
2 to 4 times a week	80.2 ± 4.3	68.9 ± 3.2
once a week	66.0 ± 7.8	58.2 ± 5.8
once a month	60.5 ± 11.9	53.4 ± 8.8
never[2]	76.6 ± 20.4	57.8 ± 15.1

[1]Frequency of eating school lunch was the only independent variable affecting vegetable plate waste.

[2]Several students reported they never ate school lunch; however, on the two data collection days in each school, some of these students were school lunch participants.

Table 42: Mean percentage plate waste of entrees

variable[1]	mean % plate waste		
	weighed	observed	self reported
	← least square mean and std. error →		
menu item			
spaghetti and meat sauce	49.8 ± 5.5	37.0 ± 6.3	30.5 ± 6.2
beef pattie	5.2 ± 7.0	4.4 ± 6.9	14.3 ± 6.5
hamburger pie	33.6 ± 6.3	51.6 ± 5.5	46.5 ± 5.2
fish	26.5 ± 7.0	26.9 ± 6.9	28.5 ± 6.7
sex menu[2]			
male 1			27.8 ± 7.0
female 1			33.3 ± 6.8
male 2			21.1 ± 7.8
female 2			7.6 ± 6.9
male 3			47.9 ± 5.6
female 3			45.1 ± 6.6
male 4			33.5 ± 7.8
female 4			23.6 ± 7.3

[1]Data shown for significant findings only.

[2]Menu 1 - spaghetti and meat sauce
2 - beef pattie
3 - hamburger pie
4 - fish

indexes, a series of analyses were computed. One way analysis of variance was used to compare percent weighed, observed, and self reported plate waste according to students' ratings for the menu items.

Acceptability Ratings. Plate waste of vegetables according to students' acceptability ratings is shown in Table 43. For all vegetables, plate waste decreased as the acceptability ratings for flavor and appearance were more positive. Mean percent observed and self reported plate waste were similar to weighed plate waste values and followed the same trend.

The effect of temperature on the amount of vegetables left on the plate also is summarized in Table 43. Less plate waste occurred when students reported the temperature was "just right." Students who responded that the temperature was "O.K." or "too cool" had significantly higher mean percent waste.

Reactions to portion size also affected plate waste. Students who responded their portion size was "too much" had mean percent plate waste of 70 percent or greater for all vegetables, whereas those reporting portions were "not enough" had plate waste ranging from 19 to 40 percent.

Plate waste of entrees according to students' acceptability ratings is listed in Table 44. Students rating flavor as "great" had significantly less plate waste (1.0 to 13.3 percent). For all entrees except hamburger pie, students who rated the flavor as "bad" had higher plate waste than those who rated flavor as "awful." Mean percent weighed plate waste was 1.7 percent for students who thought the appearance of beef pattie was "great." For all entrees, plate waste decreased as the appearance score was more positive with two exceptions. Those rating

Table 43: Plate waste of vegetables according to students' acceptability ratings

menu item	plate waste measure	flavor					F ratio[1]	appearance					F ratio[1]
		awful	bad	so-so	good	great		awful	bad	so-so	good	great	
		← mean % plate waste →						← mean % plate waste →					
peas	weighed[2]	85.4	78.8	65.8	26.6	22.8	20.5	86.7	67.2	64.2	44.7	27.4	9.6
	observed	85.5	82.5	66.6	30.2	22.4	27.7	86.5	69.8	65.4	45.5	28.7	11.7
	self reported	90.1	89.2	65.0	27.0	20.6	50.8	87.9	76.3	63.5	49.7	24.2	14.6
carrots	weighed	86.8	87.5	45.9	33.9	19.6	9.7	91.0	75.3	59.5	42.4	6.7	6.9
	observed	78.8	80.1	40.8	28.2	11.7	17.6	84.4	67.4	53.3	36.4	5.9	10.3
	self reported	86.6	76.8	35.8	29.8	11.6	33.7	88.2	68.9	61.1	27.1	10.4	18.5
broccoli	weighed	106.6	89.3	63.8	28.2	10.7	40.5	106.6	68.9	61.2	28.3	27.5	22.1
	observed	90.3	78.3	52.6	25.5	7.9	50.6	88.6	65.4	49.0	23.9	26.3	22.9
	self reported	91.8	73.1	54.1	28.3	6.8	66.1	87.7	63.7	56.5	24.4	19.6	25.9
mixed vegetables	weighed	97.1	89.3	68.2	33.6	14.9	27.2	90.3	98.1	79.6	37.7	2.6	19.6
	observed	86.6	87.8	64.1	27.8	15.6	35.5	82.8	84.2	73.8	38.5	1.9	20.7
	self reported	85.5	83.7	53.8	25.6	7.3	51.3	80.7	82.8	69.1	29.4	1.8	26.1

menu item	plate waste measure	temperature			F ratio[1]	portion size			F ratio[1]
		just right	O.K.	too cool		too much	right amount	not enough	
		← mean % plate waste →				← mean % plate waste →			
peas	weighed	42.4	74.5	74.0	9.5	83.4	58.8	38.6	18.3
	observed	44.0	76.2	74.2	11.8	84.8	59.0	40.5	24.7
	self reported	42.8	74.8	79.1	16.0	88.5	57.6	39.1	38.3
carrots	weighed	36.6	64.6	69.6	4.1*	76.0	50.7	34.4	7.1
	observed	29.0	56.6	69.2	9.1	70.1	43.4	33.6	10.1
	self reported	26.1	60.7	74.2	17.2	74.2	49.3	31.0	14.5
broccoli	weighed	24.7	78.2	87.8	21.8	101.8	62.5	27.2	40.6
	observed	19.9	65.2	75.1	25.2	86.8	52.2	21.6	51.1
	self reported	19.9	66.2	75.3	30.4	86.0	55.4	19.3	58.4
mixed vegetables	weighed	30.0	83.4	90.0	26.9	94.7	56.0	37.0	21.7
	observed	28.2	76.4	83.2	32.3	87.2	50.8	34.5	27.1
	self reported	22.1	69.3	83.4	40.1	84.6	46.5	26.4	36.5

[1]All F ratios significant at or beyond $P \leq .001$ with one exception noted by * where $P \leq .05$.

[2]Plate waste in excess of 100% indicates the served portion exceeded the standard portion used for assessment.

Table 44: Plate waste of entrees according to students' acceptability ratings

menu item	plate waste measure	flavor					F ratio[1]	appearance					F ratio[1]
		awful	bad	so-so	good	great		awful	bad	so-so	good	great	
		← mean % plate waste →						← mean % plate waste →					
spaghetti	weighed	49.4	83.8	30.3	21.4	9.7	13.8	65.3	38.3	23.4	16.7	14.2	9.6
and	observed	53.9	88.8	38.1	25.4	13.3	11.9	70.5	50.6	28.2	20.7	18.2	8.7
meat sauce	self reported	58.6	90.2	34.1	19.2	8.8	27.1	75.2	45.6	22.9	18.8	10.9	20.4
beef pattie	weighed	58.9	61.1	18.8	11.9	1.0	24.8	51.3	54.8	17.2	6.4	1.7	14.9
	observed	62.3	57.8	22.1	11.5	1.0	25.3	56.3	52.7	17.1	6.9	1.7	16.1
	self reported	76.7	77.4	25.8	18.8	3.1	42.6	65.4	61.6	22.5	16.9	1.4	20.5
hamburger	weighed	92.7	82.7	52.9	26.8	10.6	44.1	75.0	57.1	44.2	33.2	10.6	12.7
pie	observed	81.3	77.7	52.0	26.1	10.8	40.7	69.1	51.6	42.4	31.5	11.6	12.5
	self reported	81.5	77.5	49.5	23.1	11.6	48.9	67.1	43.2	42.1	31.4	9.9	13.4
fish	weighed	33.9	64.6	25.9	12.4	9.1	9.0	26.1	65.7	23.3	8.8	10.7	7.4
	observed	37.7	60.7	27.8	12.7	11.1	7.3	30.9	67.4	23.6	9.9	13.0	6.7
	self reported	88.3	71.3	43.9	7.6	4.3	55.6	63.1	58.4	32.1	8.5	2.1	22.1

menu item	plate waste measure	temperature			F ratio[1]	portion size			F ratio[1]
		just right	O.K.	too cool		too much	right amount	not enough	
		← mean % plate waste →				← mean % plate waste →			
spaghetti	weighed	14.6	22.1	39.6	9.1	62.0	18.5	9.8	47.2
and	observed	18.4	26.1	47.3	9.9	68.9	22.9	13.7	41.0
meat sauce	self reported	12.8	23.8	43.6	18.1	57.4	19.1	11.6	43.4
beef pattie	weighed	4.8	27.2	33.9	13.1	55.9	14.6	2.3	31.4
	observed	4.8	28.4	35.5	13.9	57.3	15.5	2.5	30.2
	self reported	7.7	35.8	55.7	27.2	55.6	25.2	8.3	18.8
hamburger	weighed	22.0	56.0	74.5	23.6	85.5	41.3	14.1	61.7
pie	observed	22.2	52.0	67.1	21.6	78.1	38.4	14.4	62.0
	self reported	20.2	50.0	67.7	27.1	74.8	34.1	19.1	53.2
fish	weighed	10.5	21.6	17.0	3.1*	56.4	15.9	9.6	22.1
	observed	12.3	22.4	19.2	2.3NS	61.1	17.6	10.6	22.9
	self reported	7.9	28.7	29.5	9.2	83.2	23.7	4.8	58.1

[1]All F ratios significant at or beyond $P \leq .001$ with two exceptions noted by: NS = not significant and * where $P \leq .05$.

beef pattie and fish "bad" had higher mean percent plate waste than those rating these items as "awful."

Reactions to food temperature also affected mean percent plate waste of entrees. Temperatures which students reported were "too cool" resulted in an increased amount of plate waste. For example, hamburger pie rated as "too cool" had a mean percent weighed plate waste of 74.5 percent. Students who rated the portion sizes of entrees as "too much" left greater amounts of plate waste (55.6 to 85.5 percent) than those indicating portions were the "right amount" or "not enough."

Hedonic Ratings. Following the lunch period, students gave hedonic ratings on the selected menu items used in the study. Positive student ratings corresponded with a lower amount of plate waste for both vegetables and entrees (Tables 45 and 46).

For example, those students rating broccoli and mixed vegetables as "awful" on the hedonic scale wasted all or almost all of the portion served (Table 45). Students who rated these vegetables as "great" left very little; weighed plate waste was 6.5 and 5.2 percent, respectively.

Plate waste data on entrees according to students' hedonic ratings are shown in Table 46. Plate waste on entrees rated as "great" varied from 1.7 to 10.9 percent, whereas those rated as "awful" ranged from 62.7 to 91.9 percent.

Familiarity Ratings. Tables 47 and 48 detail plate waste of vegetables and entrees according to students' reports of where food is eaten and whether food is included in family meals. Vegetables and entrees eaten both at home and school resulted in the lowest mean percent plate waste for all menu items.

Table 45: Plate waste of vegetables according to students' hedonic ratings[1]

menu item	plate waste measure	students' hedonic rating of food					F ratio[2]
		awful	bad	so-so	good	great	
		← mean % plate waste →					
peas	weighed[3]	83.9	75.2	59.3	32.4	21.5	16.0
	observed	84.9	78.6	58.3	37.0	21.7	22.3
	self reported	92.0	79.3	57.4	32.0	14.8	52.5
carrots	weighed	90.6	106.4	34.6	38.4	7.7	21.0
	observed	82.2	77.9	35.6	26.7	7.3	29.7
	self reported	85.7	84.3	38.6	22.5	5.0	53.7
broccoli	weighed	108.3	89.0	78.5	29.8	6.5	54.1
	observed	92.1	80.2	60.4	28.8	3.6	71.9
	self reported	93.1	76.9	59.3	32.4	8.6	81.1
mixed vegetables	weighed	101.4	89.3	67.4	35.7	5.2	40.4
	observed	90.0	85.4	62.4	36.5	4.6	48.4
	self reported	89.9	82.3	56.4	23.6	-0.1	87.1

[1]Facial hedonic scale used for ratings. System (on-site vs. satellite) was considered in the analyses but was nonsignificant in all cases.

[2]All F ratios significant at $P \leq .001$.

[3]Plate waste in excess of 100% indicates the served portion exceeded the standard portion used for assessment.

Table 46: Plate waste of entrees according to students' hedonic ratings[1]

menu item	plate waste measure	students' hedonic rating of food					F ratio[2]
		awful	bad	so-so	good	great	
		← mean % plate waste →					
spaghetti and meat sauce	weighed	68.5	62.8	28.6	26.4	6.6	20.3
	observed	76.4	66.1	35.7	30.0	10.9	16.3
	self reported	85.7	74.2	32.8	20.8	7.2	47.8
beef pattie	weighed	67.2	65.7	27.5	11.1	1.8	31.6
	observed	69.3	63.1	31.5	10.9	1.7	32.6
	self reported	82.1	72.2	38.3	18.8	3.5	48.0
hamburger pie	weighed	91.9	81.8	60.1	28.1	7.7	46.0
	observed	82.1	74.6	56.0	30.5	7.4	42.1
	self reported	82.5	78.3	52.9	25.7	8.9	54.3
fish	weighed	62.7	67.4	24.0	19.4	6.4	20.9
	observed	67.4	67.5	24.8	22.6	7.5	18.8
	self reported	87.8	74.2	45.4	13.2	3.9	45.7

[1]Facial hedonic scale used for ratings. System (on-site vs. satellite) was considered in the analyses but was nonsignificant in all cases.

[2]All F ratios significant at $P \leq .001$.

Table 47: Plate waste of vegetables according to students' reports of where food is eaten and whether food is included in family meals[1]

menu item	plate waste measure	place where food is eaten: only at home	only at school	both at home and school	never eat	F ratio[2]	included in family meals: yes	no	F ratio[3]
		← mean % plate waste →					mean % plate waste		
peas	weighed	83.7	64.9	57.7	87.2	7.4	65.9	84.6	4.2*
	observed	85.6	68.3	58.7	87.5	9.7	66.6	86.7	6.4*
	self reported	91.4	86.8	57.6	91.8	18.8	69.1	87.2	5.7*
carrots	weighed	83.1	40.8	46.3	96.3	9.0	55.2	91.9	9.7*
	observed	72.7	41.7	40.7	83.0	10.8	49.7	76.0	8.2*
	self reported	81.5	48.6	43.5	82.7	12.9	54.8	72.5	4.5*
broccoli	weighed	106.5	63.2	50.9	110.86	22.1	67.1	99.0	11.4**
	observed	88.0	57.4	41.5	96.4	28.8	55.6	86.0	16.1**
	self reported	91.0	65.6	40.0	91.0	30.3	55.3	85.2	17.7**
mixed vegetables	weighed	91.8	71.5	58.4	92.8	5.4*	64.0	80.3	1.78NS
	observed	85.3	64.5	53.5	86.6	7.0	59.9	72.1	1.64NS
	self reported	86.0	62.4	46.3	88.4	13.2	54.8	71.9	3.28*

[1]System (on-site vs. satellite) was considered in all analyses but was nonsignificant in all cases.

[2]All F ratios significant at or beyond $P \leq .001$ with one exception noted by * where $P \leq .05$.

[3]Significance levels are indicated: * = $P \leq .05$, ** = $P \leq .001$, NS = nonsignificant.

Table 48: Plate waste of entrees according to students' reports of where food is eaten and whether food is included in family meals[1]

menu item	plate waste measure	place where food is eaten: only at home	only at school	both at home and school	never eat	F ratio[2]	included in family meals: yes	no	F ratio[3]
		← mean % plate waste →					mean % plate waste		
spaghetti and meat sauce	weighed	65.2	26.3	17.7	86.8	13.5	21.4	23.4	0.0NS
	observed	67.2	28.4	22.2	95.0	10.1	26.5	27.0	0.0NS
	self reported	68.7	21.9	18.2	75.0	16.7	21.5	28.1	0.5NS
beef pattie	weighed	34.6	10.7	3.1	76.7	44.2	5.2	24.0	12.2**
	observed	37.3	11.0	3.9	75.3	37.4	5.3	25.0	12.9**
	self reported	57.6	18.0	10.9	79.2	29.1	16.4	28.9	4.6*
hamburger pie	weighed	67.6	31.3	37.1	80.6	18.1	43.0	50.0	0.6NS
	observed	43.2	31.4	34.6	72.2	15.1	36.2	47.1	1.9NS
	self reported	50.0	31.0	33.7	69.3	15.0	36.5	45.0	1.2NS
fish	weighed	33.2	10.9	15.3	67.1	6.6	15.6	27.6	4.1*
	observed	33.2	11.0	16.8	72.5	6.7	17.3	28.6	3.2NS
	self reported	58.7	10.8	15.2	95.0	16.5	17.2	39.2	9.5*

[1]System (on-site vs. satellite) was considered in all analyses but was nonsignificant in all cases.

[2]All F ratios significant at or beyond $P \leq .001$.

[3]Significance levels are indicated.

For vegetables, mean percent plate waste was similar for categories "eat only at home" and "never eat," with plate waste of 83 percent or higher. Higher percentage plate waste resulted among students who reported that peas, carrots, and broccoli were not included in family meals. Mixed vegetables also followed this trend but two of the three F ratios were not significant.

Students who responded that they "never eat" one of the four entrees studied had eaten at least part of the portion served on the data collection day because mean percent weighed plate waste ranged from 67 to 95 percent. Those students who reported they only ate the entree in question "at school" or "both at home and at school" had lower plate waste than did those who said they ate the entree "at home." Less plate waste tended to occur when the students reported the entree was included in family meals but the F ratios were not significant in several instances.

Correlation Between Acceptability and Plate Waste. As an overall measure of acceptability, an index was constructed from students' ratings of flavor, appearance, temperature, and portion size. Correlation coefficients were computed between this index and the various plate waste assessments.

Correlations of acceptability score with plate waste measurements were negative (Table 49). An increase in plate waste correlated with a decrease in the acceptability score for both vegetables and entrees. The highest correlation existed between percent self report plate waste and the acceptability score.

Table 49: Correlation of acceptability score with plate waste measurements

plate waste measure	acceptability score[1]		
	all schools	on-site schools	satellite schools
	γ	γ	γ
vegetables			
% weighed	-0.53	-0.54	-0.50
% observed	-0.59	-0.60	-0.56
% self report	-0.66	-0.67	-0.64
entrees			
% weighed	-0.56	-0.57	-0.56
% observed	-0.54	-0.54	-0.55
% self report	-0.65	-0.65	-0.64

[1]Variable constructed from ratings of flavor, appearance, temperature, and portion size to measure food acceptability (higher scores = greater acceptability).

SUMMARY AND CONCLUSIONS

Acceptance and consumption of foods affect the nutritional contribution of the school lunch to the student. The objectives of this research were to compare consumption and acceptability of entree and vegetable menu items in on-site and satellite foodservice systems and investigate the relationship among different methods for measuring food consumption and acceptability.

The study was conducted in eight elementary schools; four had on-site preparation and service, and four were satellite service centers with food transported in bulk form from secondary school base kitchens. All students in grades four and five were test subjects. Data collection occurred at one on-site and one satellite school per test day. Menu items studied were four frozen vegetables and four entrees. An on-site data collection team consisting of a Research Coordinator and a Research Assistant gathered data on food acceptability and consumption. Five sample trays were selected at random to determine average serving size of the test menu items. Data collectors visually estimated plate waste on the students' trays, then weighed plate waste was measured. Teachers distributed acceptability tray cards before the lunch period and classroom cards to the students after lunch for them to provide data on acceptability of the menu items, a self report of plate waste, hedonic ratings, familiarity measurements, and general information. Holding times and temperatures for the vegetable and entree menu items were recorded by the Research Coordinator at various points in the production/service cycle.

Distributions of percent weighed, observed, and self reported plate waste were compiled for all vegetables and entrees by system, school, and menu item. Correlation coefficients were computed between percent weighed, observed, and self reported waste. An acceptability score was computed as an overall index of food quality which was derived from students' ratings of flavor, appearance, portion size, and serving temperature of the menu items.

A larger percentage of students in on-site schools ate lunch every day than in satellite schools. Forty percent of the students in on-site systems thought the food was almost always good compared to only 16 percent in satellite schools. Longer holding times in satellite systems resulted in many temperatures below 140°F and decreased food quality, indicated by students' acceptability ratings of flavor, color, and temperature. For entrees, at satellite schools, holding times from end of production to service ranged from 1 hour and 50 minutes to 3 hours and 10 minutes.

Mean percent plate waste by weighing was 69.3 percent for all vegetables and 25.8 percent for all entrees. Percent waste of a given menu item was better represented by the proportion of individuals who consumed all or almost all of a serving and the proportion who consumed none or almost none. Distributions of plate waste measured by weighing, observation, and self report were similar for all vegetables and entrees in both systems. Based on data collectors' observations, using the observational plate waste method may be as accurate as the weighed method because of the variability of serving sizes of menu items.

Correlations of percentage plate waste measured by weighing, observation, and self report were positive, ranging from .76 to .90 for vegetables

and .77 to .97 for entrees. These data suggest that trained data collectors can make visual estimates of plate waste that correlate highly with percent weighed waste. Students' self reports correlate highly with percent weighed waste, though not as high as visual estimates by trained observers.

For all vegetables, plate waste decreased as the acceptability ratings for flavor and appearance increased. Temperature and portion size also affected mean percent plate waste. Temperatures of menu items that students marked as "too cool" corresponded with increased amounts of plate waste and those for which students rated portion size as "too much" also had a high amount of plate waste. Positive student hedonic ratings corresponded with lower amounts of plate waste. Vegetables and entrees eaten both at home and school resulted in the lowest mean percent plate waste for all menu items studied. A significantly higher percentage plate waste resulted when students answered that the vegetable was not included in family meals; data on entrees also tended to follow this trend. Correlations of acceptability scores with plate waste measurements were negative; i.e., larger amounts of plate waste correlated with lower acceptability scores.

Validity of using food consumption and acceptability ratings from one school to predict food consumption in another school should be questioned. Large standard deviations were found within a school as well as between schools. Additional research is needed regarding holding times and the effect on food quality in all types of foodservice systems.

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APPENDIXES

APPENDIX A

Correspondence and Forms for Principals and Teachers

(KSU Letterhead)

October 28, 1981

TO: (School Principals)

FROM: Cheryl S. Johnson
Mary Frances Nettles, R.D.
Allene G. Vaden, Ph.D., R.D.

Acceptance and consumption of foods affects the nutritional contribution of the school lunch to the student. In cooperation with Mrs. Sue Greig, District Director of Food Service, we plan to collect data in the elementary schools in USD 383 during November and early December to determine acceptability (consumption) of foods in the school lunch program. This project will provide information for the school foodservice to evaluate the students' acceptance of menu items in schools where food is prepared on-site and in those schools with food transported from the Middle or High School.

The fourth and fifth grade classes have been selected to participate in the study. According to our plans, we will measure several aspects of food acceptance. Limited data collection at the Middle and High Schools will involve recording times of food delivery to elementary schools.

Plate waste will be measured after the students have finished eating. This will involve weighing the leftover foods on students' trays in the foodservice area. Prior to students coming to the lunchroom, we will need the classroom teachers to distribute a form to students in the participating classes.

Following the lunch period, we will request students to complete a few questions related to how much they believed they ate and how much they liked the food. We will need to collect data on only two different days in each school. This should take only about 10 minutes each day.

Also, we will be collecting data related to the foodservice area and from the foodservice employees. This information will be collected in all schools in the district. This aspect of the study will not affect the school operations or interfere in any way with the instructional program. We did however, want you to be thoroughly aware of the total scope of the project.

We wish to express our appreciation in advance for your cooperation.

We will contact you within the next week to schedule an appointment to explain details of the project and answer any questions you may have. Thank you again for your assistance and help.

cc: Mrs. Sue Greig

(KSU Letterhead)

November 5, 1981

To: (Fourth and Fifth Grade Teachers)

From: Cheryl Johnson
Allene G. Vaden, Ph.D., R.D.

Acceptance and consumption of foods affects the nutritional contribution of the school lunch to the student. In cooperation with Mrs. Sue Greig, District Director of Food Service, we plan to collect data in the elementary schools in USD 383 during November and early December to determine acceptability (consumption) of foods. This project will provide information for the school foodservice to evaluate the students' acceptance of menu items in schools where food is prepared on-site and in those schools with food transported from the Middle or High School.

The fourth and fifth grade classes have been selected to participate in the study. We have reviewed the study with all the elementary principals.

According to our plans, we will measure several aspects of food acceptance and will collect data on two different days at each elementary school. The specific tasks for which we need your assistance are outlined on the attached page.

On each of the two data collection days, just before lunch the study procedure calls for distribution of tray cards which the students will fill out during the lunch period. Then, as soon as possible after the lunch period, we ask that you administer classroom cards which measure self-reported food consumption and like/dislike of foods. This should take only about 10 minutes. Narrative scripts and posters will be provided to assist with both of these data collection tasks.

Before the first data collection day, we will meet with you to explain the narratives and posters and answer any questions you may have. Also, to assist us in preparing for the study, we need a roster of the students in your class. Would you please fill in the names of the students in your class on the attached form and we will pick it up from you at the time we bring the materials indicated?

We wish to express our appreciation in advance for your cooperation. Thank you for your assistance. If you have questions, please contact one of us or Mrs. Greig.

cc: Mrs. Sue Greig

(KSU Letterhead)

To: Teachers of participating 4th and 5th grade classes[1]

From: Cheryl Johnson

The first two sheets with the PINK narrative are for you to use BEFORE lunch when passing out and giving instructions for the tray cards. The tray cards are in the small brown envelope.

The last four sheets with the BLUE narrative are for you to use AFTER lunch when the students complete the four classroom cards. The packets of classroom cards are in the larger brown envelope.

Please use the appropriate posters for giving all these instructions.

Thank you for your help and cooperation.

[1]Distributed to appropriate teachers on afternoon prior to each data collection date.

(KSU Letterhead)

SCHOOL FOODSERVICE STUDY

TEACHER'S ROLE

We ask that teachers whose classrooms are participating in this study be responsible for the tasks listed below. Detailed instructions will be provided.

1. Provide the research team with a list of the full name of each child in the class (names can then be prerecorded on forms by the research team).

2. On each of the two data collection days:

   a. Hand out tray cards which the students will fill out during the lunch period and explain how to fill the card out using narrative script and poster provided.

   b. Administer classroom cards which measure self-reported consumption and like/dislike of foods after the lunch period using the narrative script and posters provided.

School: Date:

Teacher: Class:

ID no.	name of student	Day 1					Day 2				
		present/ absent	ate school lunch	data check			present/ absent	ate school lunch	data check		
				tray card	plate waste record	card packet			tray card	plate waste record	card packet

APPENDIX B

Acceptability Tray Card

TRAY CARD

STUDENT NAME _____ DATE _____

SCHOOL NAME _____ I.D.# _____

Circle the words that best describe how you feel about the food today

FOOD		
1.	TASTES	Circle one: Great Good So-So Bad Awful
	LOOKS	Circle one: Great Good So-So Bad Awful
	TEMPERATURE	Circle one: Just right O.K. Too cool
	AMOUNT	Circle one: Too much Right amount Not enough
2.	TASTES	Circle one: Great Good So-So Bad Awful
	LOOKS	Circle one: Great Good So-So Bad Awful
	TEMPERATURE	Circle one: Just right O.K. Too cool
	AMOUNT	Circle one: Too much Right amount Not enough

Color - Yellow

APPENDIX C

Classroom Cards

CARD NO. 1

STUDENT NAME _____ DATE _____

SCHOOL NAME _____ I.D.# _____

Directions: Mark an "X" by your answer(s) to each question.

1. Sex
   ___ (1) Female
   ___ (2) Male

2. How often do you usually eat the lunch served in the school lunchroom?
   ___ (1) Every day
   ___ (2) Two to four times a week
   ___ (3) Once a week
   ___ (4) Once a month
   ___ (5) Never

3. The food in the school lunch program is
   ___ (1) almost always good
   ___ (2) good only some of the time
   ___ (3) usually not very good

4. In the school lunch program, the same food is served
   ___ (1) too often
   ___ (2) about the right amount of times
   ___ (3) not often enough

5. Check as many of the following as you feel are correct for you.
   ___ (1) I usually like the food that is served
   ___ (2) I eat the school lunch because my friends do
   ___ (3) My parents want me to eat the school lunch.

6. Did you eat school lunch today?
   ___ (1) Yes
   ___ (2) No, if no you do not need to complete the other three cards.

Color - Orange

CARD NO. 1

STUDENT NAME _____ DATE _____

SCHOOL NAME _____ I.D. # _____

Directions: Mark an "X" by your answer to the question.

1. Did you eat school lunch today?

___ (1) Yes
___ (2) No, if no you do not need to complete the other three cards.

Color - Orange

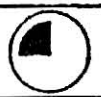
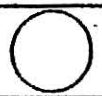
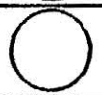
CARD NO. 2

STUDENT NAME _____ DATE _____

SCHOOL NAME _____ I.D.# _____

How much did you eat?

For each food, please put an "X" on the amount you ate.

FOOD	I ate none of it	I just tasted it	I ate a little	I ate half of it	I ate a lot	I ate all of it
1.						
2.						

Color - Blue

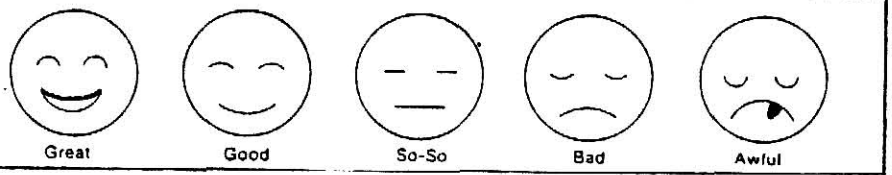
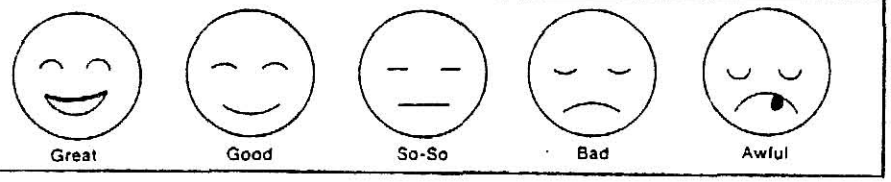
CARD NO. 3

STUDENT NAME _____ DATE _____

SCHOOL NAME _____ I.D.# _____

Did you like what you ate?

Check (✓) the face that shows how you felt about the food served today in the lunchroom.

FOOD	
1.	
2.	

Color - Tan

CARD NO. 4

STUDENT NAME _____ DATE _____

SCHOOL NAME _____ I.D.# _____

Do you eat these foods at home, at school, both places or not at all? For each food put an "X" under the statement that best describes where you eat the food.

FOOD	Eat ONLY at home	Eat ONLY at school	Eat BOTH at school and home	NEVER eat
1.				
2.				

Circle yes or no to each question.

1. Do your family meals ever include: _____? yes no

2. Do your family meals ever include: _____? yes no

Color - Green

APPENDIX D

General Information Form

Department of Dietetics, Restaurant
and Institutional Management
Kansas State University

SCHOOL FOODSERVICE STUDY

GENERAL INFORMATION

SCHOOL: _____ DATE: _____

OBSERVERS: _____ _____

I. MENU DESCRIPTION

Food Item	Description	Observer Comments on Food Quality
1.		
2.		

II. SERVING WEIGHTS

	Food Items	
Tray No.	Vegetable	Main Dish
1		
2		
3		
4		
5		

III. MENU

_____

_____

_____

_____

_____

_____

_____

IV. GENERAL OBSERVATIONS

A. Did anything unusual occur today (e.g., early dismissal from lunch, high sickness rate, food fights, food trading)?

B. Any problems collecting data today?

C. Other Comments:

V. PARTICIPATION DATA

Class	No. Served	No. Enrolled	%
Total School			

APPENDIX E

Plate Waste Record

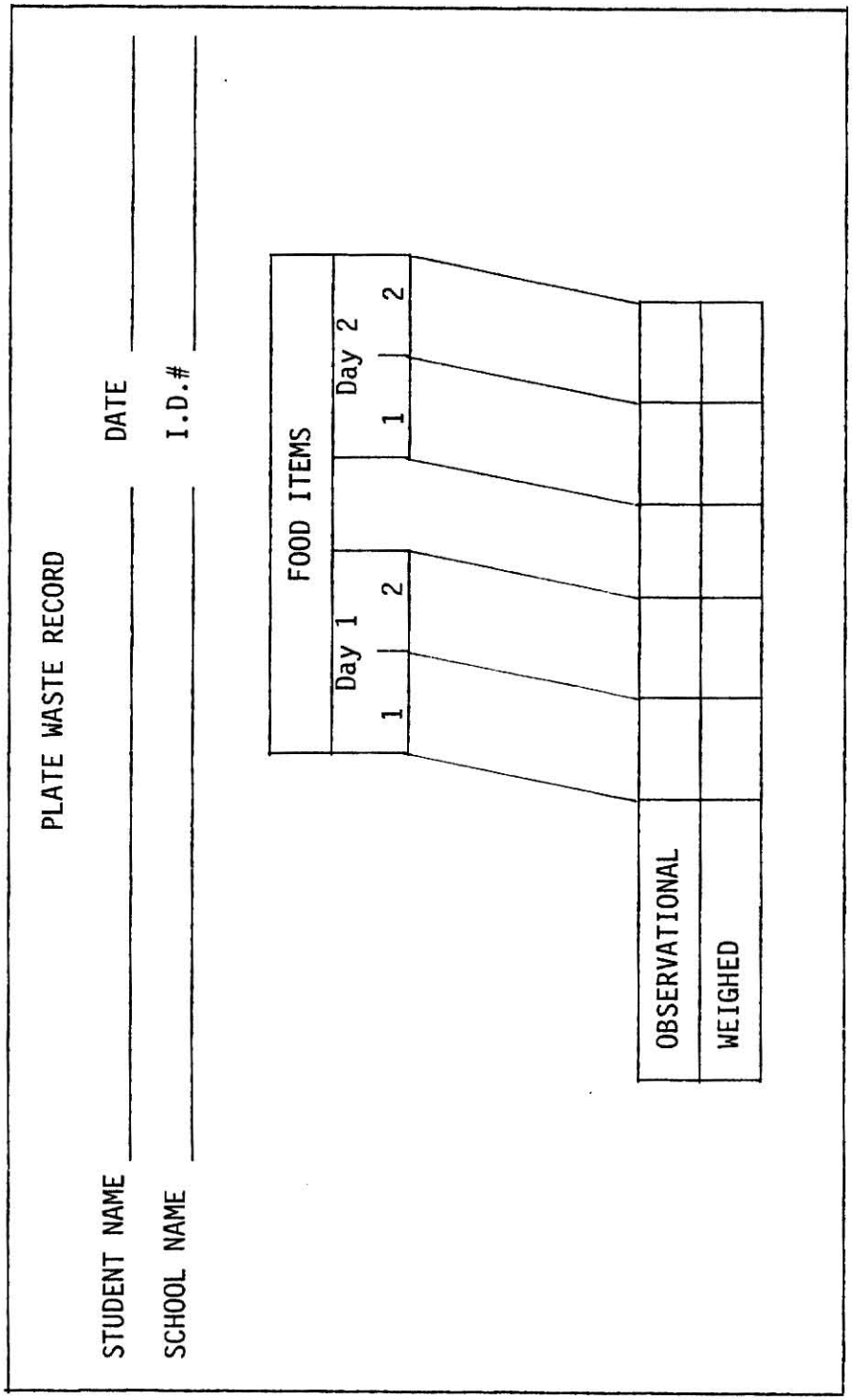


PLATE WASTE RECORD
STUDENT NAME
SCHOOL NAME
DATE
I.D.#
FOOD ITEMS
Day 1
1
2
Day 2
1
2
OBSERVATIONAL
WEIGHED

Color - White

APPENDIX F

Temperature and Holding Time

SCHOOL FOODSERVICE STUDY

HOLDING AND SERVING TIMES AND TEMPERATURES

Food item: _____

	TIME	TEMP.
* Food preparation is complete (when food is placed in hot cart for satellite systems)	_____	_____
Shipped to satellite	_____	_____
Arrives at satellite	_____	_____
* Beginning of serving period	_____	_____
* Length of serving time	_____	_____
* Temperature of food before serving last plate		_____
* Time and temperature when first plate is served to each class (4th and 5th graders only)	_____	_____
	_____	_____
	_____	_____
	_____	_____

* Record for on-premise

Foodservice Manager _____
School _____
Date _____
Base Kitchen Manager _____

Color - White

APPENDIX G

Research Procedures

Department of Dietetics, Restaurant
and Institutional Management
Kansas State University

SCHOOL FOODSERVICE STUDY

PRELIMINARY WORK

1. Set up a meeting with the Foodservice Director and Managers.

   * Explain the procedures to be followed; explain that five lunches will be purchased before the meal and selected at various times during serving to determine how much parts of the meal weigh. Explain that the research team will try not to change any normal lunchroom procedures, but that after lunch, trays will be intercepted from participating students. These trays will have a yellow tray card on them. Enlist the help of the dishroom people to give the research team any trays they have missed. Explain that you will try to work as rapidly as possible, but they should expect some delay in the return of some trays.

   * Explain holding time and temperature form and ask Foodservice Director to make arrangements for Managers to fill it out. Also make arrangements with the Foodservice Director about the menus.

2. Obtain a list of students in the 4th and 5th grades.

3. Set up a briefing for the 4th and 5th grade teachers and the principal.

   * Explain instructions for tray cards and for administering classroom cards after the lunch period.

   * Explain use of posters.

Department of Dietetics, Restaurant
and Institutional Management
Kansas State University

SCHOOL FOODSERVICE STUDY

DATA COLLECTION PROCEDURE

1. In the morning before lunch, set up all equipment--tables, scales. Help with recording time and temperature data.

2. Check the exact menu with the foodservice manager. If there are any changes as to the vegetable and entree, record these changes on all recording forms.

3. Collection of sample trays for average portion weight. (See procedure.)

4. During the meal, notice the general characteristics of the food as served and record them on the Food Consumption Information Form. Also record any things which may have influenced how much the children consumed. Monitor the lunchroom and discourage trading of food. Answer questions about filling out the tray card.

5. Stand ready to collect the trays from participating students. They should have a yellow tray card on their trays. Place these trays in the tray rack or collection area.

6. Do all the visual measures before you do any weighing of student trays. (See procedure for observational plate waste.)

7. After visual measurement is completed on all trays of participating students, begin weighing. (See procedure for weighed plate waste.)

8. As soon as weighing is completed on a tray, return it to the dishroom. After all trays are weighed, collect all cards and clean up.

9. After lunch, the teachers of the participating classes will administer the classroom cards using posters and scripts. The teachers also pass out the tray cards before lunch and explain how to fill them out using a poster and script.

*Menu items and Student Name and I.D.# will be recorded on all cards prior to data collection.

**Card Colors--Yellow: Tray card
Orange: Information card
Blue: Self-reported consumption
Tan: Hedonic scale
Green: Where the food is consumed

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Kansas State University

SCHOOL FOODSERVICE STUDY

OBSERVATIONAL PLATE WASTE PROCEDURE

1. Before the meal begins, view a sample of five trays randomly selected from those to be served.

2. Weigh each of the vegetable and entree portions on the five sample trays and record on the Food Consumption Information form.

3. Both members of the research team will have a clipboard, pencil and a Plate Waste Index Scale. (See below.)

4. After the students complete their meal, look carefully at the portions of the vegetable and entree remaining.

5. Write down a number that corresponds to your judgment of how much food is left on the student's Food Consumption Record (white card). Numbers correspond to:

   5 if a full portion remains
   4 if nearly a full portion remains, but you can tell that at least one bite was tasted
   3 if 3/4 of a portion remains
   2 if ½ of a portion remains
   1 if ¼ of a portion remains
   0 if none remains, but you can tell it has been served
   (-) if there is no evidence that the food item was served

*If you cannot decide between two ratings, give the lower numbered rating.

**When both items have been visually measured, make a check on the yellow tray card to indicate that the food items are now ready to be weighed.

Department of Dietetics, Restaurant
and Institutional Management
Kansas State University

SCHOOL FOODSERVICE STUDY

WEIGHED PLATE WASTE PROCEDURE

A. Collection of Sample Trays for Average Portion Weight

1. Determine serving schedule for classes being studied.

2. Fill in description of preparation for the vegetable and entree on the Food Consumption Information form.

3. The person collecting sample trays should get in line at a random point with the sample grade and receive a tray of food. Do not let the server fix a special portion of food, but take a tray that already has the food portioned. Go through the line 5 times.

4. Take selected sample trays to a table for weighing. Together both observers should weigh both food items and record the serving weight to the nearest gram on the Food Consumption Information form.

B. Collection of Returned Trays for Food Acceptability Record

1. Have a table set up near tray return area for the purpose of collecting trays. Calibrate scales.

2. Collect all trays with a yellow tray card.

3. After students have left the lunchroom, do visual measure and then weigh the edible portion of the remaining vegetable and entree.

4. Weighing specifics: Try to separate one item from another as accurately as you can. Use a clean paper plate for each weighing and use a rubber scrapper to transfer as much food as possible from the tray to the plate. Weigh any bits that remain!

5. As with the visual measure, a code should be recorded in every column of the weighed measure line on the Food Consumption Record (white card):
   * The weight to the nearest gram if any of the food remains.
   * (0) is no measurable amount remains, but you can tell it has been served.
   * (-) if there is no evidence that the food item was served.

6. Record the weight of the remaining portion of the vegetable and entree on the Food Consumption Record (white card). Each student has an individual Food Consumption Record and it is used to record both observational and weighed plate waste.

HOLDING AND SERVING TIMES AND TEMPERATURES

INSTRUCTIONS

* Please use thermometer provided

* Record information for entree and vegetable only

* To make a temperature reading --

    1. Insert thermometer into the center of a full pan (after serving begins take succeeding readings from the center of the remaining mass).

    2. Make sure the thermometer does not touch the sides or the bottom of the pan.

    3. For entree items (fish, hamburger pattie and pizza) insert thermometer in the center of a portion. Make sure the bulb of the thermometer is inside the food mass.

    4. The thermometer should be inserted in the food for 2 min before a reading is made.

* A research assistant will be available at the elementary school to help with recording times and taking temperatures.

A. On-Premise Kitchens

    1. Record time and temperature for all starred items on the form provided.

        a. Food Preparation is complete (when main dish and vegetable have been prepared and are ready to be put in holding unit until serving time).

        b. Beginning of serving period (the time and temperature of the food when the first class is served).

        c. Length of serving time (the number of minutes from the start to the finish of serving). Record the temperature of the food when the last plate is served.

        d. Time and temperature when each 4th and 5th grade class is served (record temperature when first plate for the class is served).

B. Satellite Kitchens

    1. Record information on form starting when food arrives at satellite kitchen.

a. Record the time the food arrives and its temperature.

b. Continue filling out the rest of the form following instructions for On-Premise Kitchens b, c, d.

C. Base Kitchen

1. Record time and temperature of food when it is first placed in the hot carts for the satellite system.

2. Record time and temperature just as the hot carts are loaded on the truck to be shipped to the satellite.

3. Send the form and this instruction sheet with the hot cart to the satellite school listed below.

Date _____

Base Kitchen _____ On-Premise Kitchen _____

Satellite School _____

APPENDIX H

Data from Preliminary Work on Observational Plate Waste

Summary of Data from Preliminary Work on
Observational Plate Waste

food item	number of observations	number of times observers: agreed	disagreed
mixed vegetables	23	22	1
broccoli	46	45	1
peas	48	41	7
spaghetti and meat sauce	46	45	1
totals	163	153	10

Data from Preliminary Work on Observational Plate Waste[1]

observation	spaghetti and meat sauce		broccoli	
	observer 1	observer 2	observer 1	observer 2
1	3	3	4	4
2	1	1	5	5
3	1	1	0	0
4	1	1	0	0
5	1	1	4	4
6	2	2	2	2
7	1	1	1	1
8	1	1	0	0
9	1	1	0	0
10	1	1	1	1
11	2	2	0	0
12	3	3	1	1
13	1	1	1	1
14	2	2	1	1
15	1	1	2	2
16	4	4	1	1
17	2	3	2	2
18	1	1	2	2
19	0	0	1	1
20	1	1	1	1
21	1	1	0	0
22	0	0	0	0
23	2	2	1	1
24	3	3	1	1
25	1	1	1	0
26	1	1	5	5
27	0	0	2	2
28	0	0	0	0
29	0	0	0	0
30	1	1	0	0
31	2	2	1	1
32	0	0	1	1
33	3	3	2	2
34	2	2	0	0
35	1	1	0	0
36	1	1	0	0

[1]Scale:
- 5 if a full portion remains
- 4 if nearly a full portion remains, but you can tell that at least one bite was tasted
- 3 if 3/4 of a portion remains
- 2 if ½ of a portion remains
- 1 if ¼ of a portion remains
- 0 if none remains, but you can tell it has been served
- (-) if there is no evidence that the food item was served

Data from Preliminary Work on Observational Plate Waste (cont.)

	spaghetti and meat sauce		broccoli	
observation	observer 1	observer 2	observer 1	observer 2
37	1	1	0	0
38	0	0	3	3
39	0	0	4	4
40	0	0	1	1
41	0	0	2	2
42	1	1	0	0
43	2	2	1	1
44	4	4	1	1
45	5	5	0	0
46	0	0	0	0
	mixed vegetables		peas	
1	3	3	4	4
2	1	1	1	1
3	2	2	2	1
4	1	1	1	2
5	1	1	3	3
6	3	3	1	2
7	1	1	2	1
8	0	0	1	1
9	0	0	3	4
10	1	1	2	2
11	1	1	1	1
12	1	1	3	2
13	1	1	2	2
14	2	2	0	0
15	3	3	0	0
16	2	2	1	1
17	2	2	1	1
18	2	2	1	1
19	1	1	3	3
20	0	0	2	2
21	1	1	1	1
22	1	1	1	1
23	1	1	3	2
24			1	1
25			0	0
26			0	0
27			3	3
28			2	2
29			2	2
30			1	1
31			1	1
32			1	1
33			0	0

Data from Preliminary Work on Observational Plate Waste (cont.)

	mixed vegetables		peas	
observation	observer 1	observer 2	observer 1	observer 2
34			2	2
35			1	1
36			1	1
37			2	2
38			3	3
39			2	2
40			0	0
41			4	4
42			5	5
43			0	0
44			1	1
45			1	1
46			1	1
47			2	2
48			2	2

APPENDIX I

Instructions for Teachers

Department of Dietetics, Restaurant
and Institutional Management
Kansas State University

SCHOOL FOODSERVICE STUDY

INSTRUCTIONS FOR TRAY CARDS

THE FOLLOWING INSTRUCTIONS ARE WRITTEN IN BOTH UPPER AND LOWER CASE. UPPER CASE INDICATES AN INSTRUCTION TO YOU. LOWER CASE (ON PINK PAPER) INDICATES A "SCRIPT" THAT WE WOULD LIKE YOU TO READ TO THE STUDENTS. IT IS IMPORTANT THAT YOU SPEND SOME EXTRA TIME FOLLOWING EACH STEP THE FIRST DAY TO MAKE SURE THE STUDENTS UNDERSTAND WHAT TO DO. IT WILL BE EASIER THE SECOND DAY.

TRAY CARDS (YELLOW CARDS) ARE TO BE HANDED OUT BEFORE THE STUDENTS GO TO THE LUNCHROOM. THEY SHOULD TAKE THE CARD AND A PENCIL WITH THEM.

TEACHER SAY:

Today you all are going to be a part of a survey about the school lunch. Take this yellow card and a pencil with you to lunch. After you have eaten your food, fill out the card and then leave it on your tray. It is very important that you do not trade food today.

To fill out the yellow card--circle the word that best describes how the meat and vegetables tasted and looked, the temperature of the food, and the amounts you were served.

SHOW POSTER 1

For example if you had carrots and meatloaf--
First you would circle the word that best describes how the carrots tasted. Did they taste (POINT ON POSTER 1) great, good, so-so, bad, or awful? Then you would circle the word that best describes how the carrots looked. Did they look (POINT ON POSTER 1) great, good, so-so, bad, or awful? Then you circle the word that best describes how you felt about the temperature of the carrots. Were they (POINT ON POSTER 1) just right, ok, or too cool? Next circle the word that best describes how you felt about the amount of carrots you received. Was the serving size (POINT ON POSTER 1) too much, the right amount, or not enough? Then you answer the same questions about the meatloaf. Be sure and leave the card on your tray when you are finished.

Poster 1

TRAY CARD

FOOD

1. Green Beans	TASTES	Great Good So-So Bad Awful
	LOOKS	Great Good So-So Bad Awful
	TEMPERATURE	Just right O.K. Too cool
	AMOUNT	Too much Right amount Not enough

Color - Yellow

Department of Dietetics, Restaurant
and Institutional Management
Kansas State University

TEACHERS INSTRUCTIONS FOR ADMINISTERING THE CLASSROOM CARDS (IMMEDIATELY AFTER LUNCH)

THE FOLLOWING INSTRUCTIONS ARE WRITTEN IN BOTH UPPER AND LOWER CASE. UPPER CASE INDICATES AN INSTRUCTION TO YOU. LOWER CASE (ON BLUE PAPER) INDICATES A "SCRIPT" THAT WE WOULD LIKE YOU TO READ TO THE STUDENTS.

STEP 1--DISTRIBUTING THE CARDS TO THE STUDENTS

WHEN YOU RETURN FROM LUNCH, IT IS TIME TO ADMINISTER THE CLASSROOM CARDS. IF THE STUDENT DID NOT EAT THE SCHOOL LUNCH TODAY, THE STUDENT SHOULD ONLY COMPLETE THE FIRST CARD--THE ORANGE ONE.

WHEN ALL STUDENTS HAVE THEIR CARDS AND A PENCIL YOU ARE READY TO BEGIN. SAY:

> Take the card number 1, the orange one, and answer the questions by placing an "X" by your answer. (SHOW POSTER 2). For example, if you ate the school lunch today put an "X" by yes for question 6; if you did not eat the school lunch, put an "X" by no. ON DAY 2 OF STUDY - ALSO SAY: If you completed this card before, you only need to answer one question today.

WHEN STUDENTS ARE FINISHED WITH THE ORANGE CARD--SAY:

> If you did not eat the school lunch today, you do not need to fill out the rest of the cards. Please clip the cards together and hand them in to me. Now everyone who ate the school lunch take the second card--the blue one.

EACH RESPONSE CATEGORY SHOWS A PICTURE WHICH SYMBOLIZES THE PROPORTION OF FOOD LEFT AFTER THE CHILD HAS EATEN THE AMOUNT MENTIONED IN THAT RESPONSE CATEGORY. FOR INSTANCE,  SYMBOLIZES HOW MUCH SPAGHETTI IS LEFT AFTER A CHILD HAS EATEN A LOT OF HIS SPAGHETTI. WE ANTICIPATE THAT THIS WILL BE CONFUSING, SO TO REMEDY THIS SITUATION WE HAVE PROVIDED A POSTER (NO. 3) TO ASSIST IN EXPLAINING THE WAY FOR STUDENTS TO RESPOND.

SAY TO STUDENTS:

> I'm going to ask about the meat and vegetable in today's school lunch. The blue card asks how much you ate. For each food there are pictures on this poster (POINT TO POSTER #3) that show how much of the food you ate.

* If you ate <u>none</u> of the food and left it all on your tray, you would put a big X over this picture. (POINT TO  ON POSTER #3)

* If you just <u>tasted</u> the food, and left nearly all of it on your tray, put an X over this picture. (POINT TO  ON POSTER #3)

* If you ate a <u>little</u> and left most of it on your tray, put an X over this picture. (POINT TO  ON POSTER #3)

* If you think you ate <u>about half</u> of the food, and left about half on your tray, put an X over this picture. (POINT TO  ON POSTER #3)

* If you ate <u>a lot</u> or <u>almost all</u> of the food and just left a little on your tray, put an X over this picture. (POINT TO  ON POSTER #3)

* If you ate all of the food, and left none on your tray, put an X over this picture. (POINT TO  ON POSTER #3)

<u>NOW SAY</u>:

How much of the vegetable did you eat? Think about how much of it you ate and then put an X over the picture that shows how much you ate. Now, how much of the meat did you eat? Put an X over the picture that shows how much you ate.

SAY:

Now take the third card, the tan card. I want you to mark the face that shows how much you <u>liked</u> the meat and vegetable.

* If you thought the food was GREAT, mark an X over this very happy face. (POINT TO  ON POSTER #4)

* If you thought the food was GOOD, mark an X over this face. (POINT TO  ON POSTER #4)

* If you thought the food was So-So, neither good nor bad, mark an X over this face. (POINT TO  ON POSTER #4)

* If you didn't like the food very much and thought it was Bad, mark an X over this face. (POINT TO  ON POSTER #4)

* If you thought the food was AWFUL, put an X over the face with its tongue out! (POINT TO  ON POSTER #4)

How much did you like the vegetable? Mark an "X" on the picture that shows how much you liked it. Now--how much did you like the meat? Mark an "X" on the picture that shows how much you liked it.

Finally, take the last card, the green one. Put an "X" under the statement that best describes where you eat these two foods.

USE POSTER #5

For example, if you only eat green beans at home, put an X under the first column (POINT ON POSTER TO FIRST COLUMN). If you eat them ONLY at school, place an X under the second column (POINT ON POSTER TO SECOND COLUMN). If you eat green beans both at school and at home, place an X under the third column (POINT ON POSTER TO THIRD COLUMN). If you never eat green beans anywhere, place an X under the last column (POINT ON POSTER TO LAST COLUMN).

Next respond to whether or not your family's meals ever include the vegetable and meat served today. For example, do your family meals ever include (say name of vegetable served today). If not, circle No. If they do, circle Yes.

WAIT UNTIL THEY ARE FINISHED THEN SAY:

We're finished. Please hand in all four cards.

Poster 1

Tray Card

Food

1. Green Beans	TASTES	Great	Good	So-So	Bad	Awful
	LOOKS	Great	Good	So-So	Bad	Awful
	TEMPERATURE	Just right		O.K.		Too cool
	AMOUNT	Too much		Right amount		Not enough

Color - Yellow

Poster 2

CARD NO. 1

Did you eat school lunch today?

_X_ 1. Yes

___ 2. No

Color - Orange

Poster 3

CARD NO. 2

How much did you eat?

none

a little

a lot

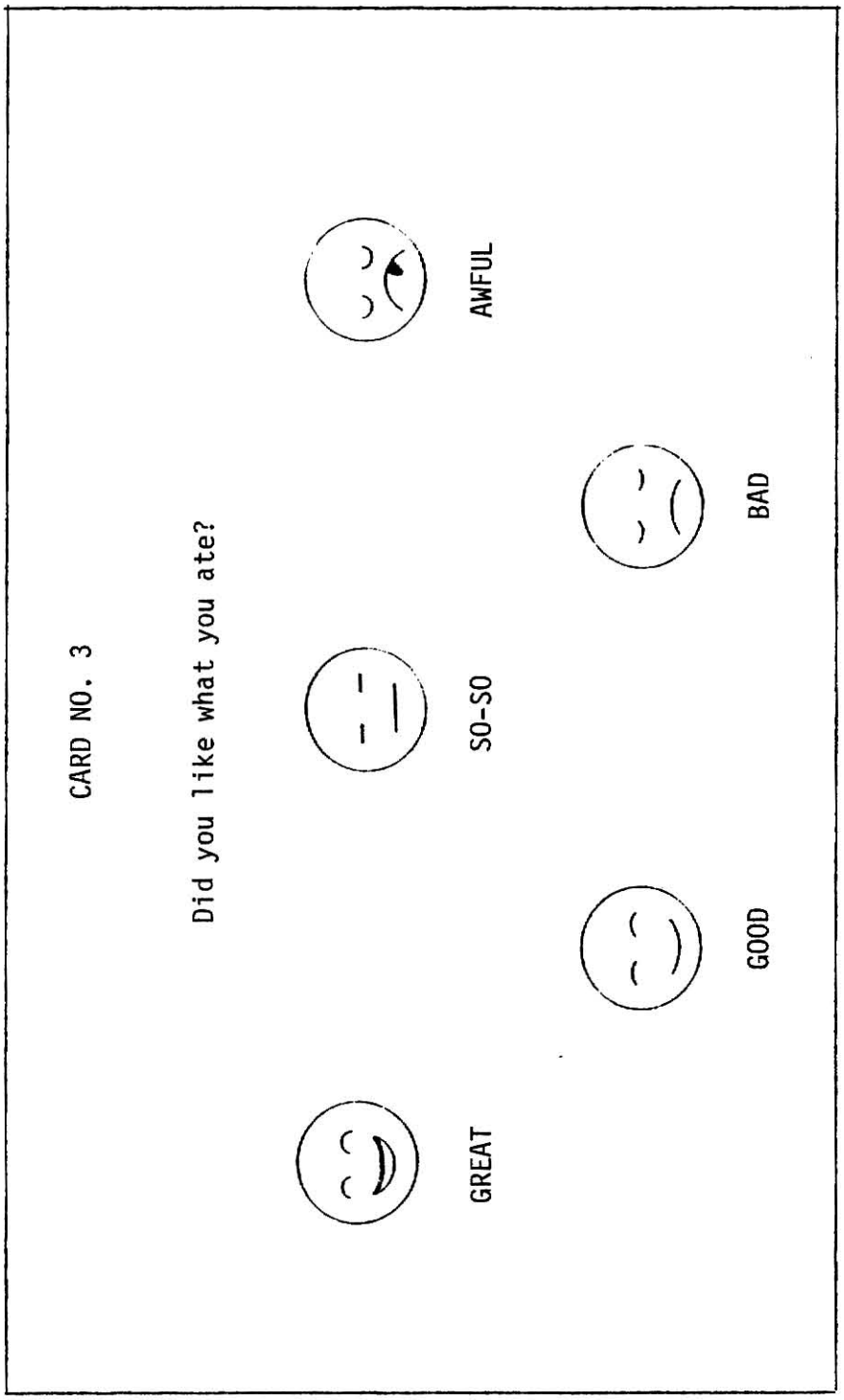
just tasted

half of it

all

Color - Blue

Poster 4



Color - Tan

Poster 5

CARD NO. 4

FOOD	Eat ONLY at home	Eat ONLY at school	Eat BOTH at school and home	NEVER eat
1. green beans				
2. pizza				

1. Do your family meals ever include: green beans ? yes no

Color - Green

FOOD ACCEPTABILITY IN SCHOOL FOODSERVICE SYSTEMS

by

CHERYL S. JOHNSON

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Dietetics, Restaurant
and Institutional Management

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1983

ABSTRACT

Acceptability of entrees and vegetables in on-site and satellite school foodservice systems was assessed and compared using four methods: weighed plate waste, observed plate waste, students' self report of plate waste, and students' ratings of food acceptability. The relationship between different methods for measuring food consumption and acceptability also was investigated.

The study was conducted in eight elementary schools of a school district in a midwestern city; four schools had on-site preparation and service, and four schools were satellite service centers with food prepared and transported from base kitchens at the district's secondary schools. Data were collected in each school on two different days approximately three weeks apart. Data collection occurred at one on-site and one satellite school per test day. Menu items studied were four frozen vegetables and four entrees. Each vegetable-entree combination was served on two days in two different pairs of schools. Students in grades four and five comprised the study sample.

A pilot study was conducted in one elementary school in the school system not used in the actual study to standardize procedures. An on-site data collection team consisting of a Research Coordinator and Research Assistant gathered data on food acceptability and food consumption.

Five sample trays were selected at random to determine average serving sizes of the test menu items. Trays were collected from the fourth and fifth grade students and data collectors visually estimated plate waste for each tray, then the weighed plate waste procedure was completed.

Teachers distributed acceptability tray cards before lunch and classroom cards to the students immediately following the lunch period. These cards provided data on acceptability of the menu items, hedonic ratings, familiarity measurements, general information, and self-reported plate waste. Holding times and temperatures for the vegetable and entree menu items were recorded by the Research Coordinator on each of the two data collection days.

Distributions of percent weighed, observed, and self-reported plate waste were compiled for all vegetables and entrees by system, school, and menu item. Correlation coefficients were computed between percent weighed, observed, and self reported waste. An acceptability score was computed as an overall index of food quality: the sum of students' ratings for flavor, appearance, portion size, and serving temperature.

A larger percentage of students in on-site schools ate lunch every day than in satellite schools. Forty percent of the students in on-site systems thought the food was almost always good compared to only 16 percent in satellite systems.

Longer holding times in satellite systems resulted in many temperatures below the recommended 140°F and decreased food quality. Length of time from completion of food preparation to end of service varied from 130 to 220 minutes in the satellite schools and from 50 to 170 minutes in the schools with on-site systems.

Mean percent weighed waste for vegetables was 69.3 percent and for entrees 25.8 percent. Plate waste data resulted in bi-modal distributions; i.e., percent waste of a given menu item was better represented by the proportion of individuals who consumed all or almost all (i.e., 90 to 100 percent) and the proportion who consumed none or almost none.

Distributions of plate waste measured by weighing, observation, and self report were similar for all vegetables and entrees. Plate waste tended to be higher in satellite schools compared to those with on-premise production of food.

Correlations of percentage plate waste measured by weighing, observation, and self report were positive ranging from .76 to .90 for vegetables and from .77 to .97 for entrees. For all vegetables, plate waste decreased as the acceptability ratings for flavor and appearance increased. Students' reactions to temperature and portion size of foods also affected plate waste. Temperatures which students believed were "too cool" corresponded with increased amounts of plate waste and portion sizes rated as "too much" also had corresponding high amounts of plate waste.

Vegetables and entrees reportedly eaten both at home and at school resulted in the lowest mean percent plate waste for all menu items studied. A significantly higher percentage plate waste resulted where students answered that the vegetable was not included in family meals; entrees also followed this trend but the differences were not significant. Correlations of acceptability score with plate waste measurements were negative indicating that greater amounts of plate waste correlated with lower food acceptability.