EVALUATION OF THREE SCHOOL FOODSERVICE SYSTEMS: STUDENT AND EXPERT SENSORY PANEL RATINGS, PLATE WASTE AND TIME-TEMPERATURE DATA

by

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INTRODUCTION

The purpose of the National School Lunch Program (NSLP), established by the National School Lunch Act of 1946 (1), is to safeguard the health and well-being of the nation's children and encourage the consumption of agricultural commodities. The United States Congress designed the program to provide nutritious and reasonably priced lunches to school children and contribute to a better understanding of good nutrition and improved food habits in relationship to health.

Harper et al. (2) emphasized the need for acceptable food in the school lunch programs and suggested that if such is not provided, students will not receive proper nutrition. Current regulations (3, 4) require the assessment of food acceptability to ensure the consumption of school lunches.

Several studies in school foodservice indicated that acceptability ratings are highly correlated with consumption and can be used as predictors (5-7). Also, type of delivery system is one of the factors that affects food consumption.

One of the major goals of the American School Food Service Association is to improve the quality of school food and nutrition programs and increase acceptability (8). According to Allington (8), attainment of this goal depends largely on the abilities of trained personnel responsible for the day-to-day activities of planning, preparing, and serving meals. Quality of food is very important in attaining and maintaining an optimum level of participation in the school lunch program; school foodservices could benefit from an ongoing program for evaluating meal quality.

Unklesbay (9) stated that current changes in foodservice systems have been aimed primarily at either increasing productivity or decreasing food costs, but sensory quality and microbiological quality and safety have not received adequate emphasis. Johnson (7) reported that additional research is needed on food quality, especially the effect of holding times during delivery in all types of foodservice systems. Snyder and Matthews (13) stated that foodservice practitioners can assist in accomplishing the NSLP objectives by serving menu items that are of good microbiological and nutritional quality. Several studies have indicated that only slight differences exist among delivery systems in nutritional value and microbiological content (2, 8, 10, 11).

In a recent NC-120 publication (12), the statement was made that research on the effects of time and temperature on sensory quality of food during various process steps in preparation and service is limited. Although extensive research has been done on the sensory qualities of foods prepared in small quantities, the importance of seeking such information in an actual or simulated institutional or commercial foodservice setting cannot be over emphasized.

Objectives

Few studies dealing with the effect of time and temperature on sensory quality and acceptability of food in various systems have been reported. The purpose of this research is to evaluate the effect of the type of school foodservice system on acceptability, i.e., conventional (on-site preparation), satellite, and satellite with a finishing kitchen. Objectives for this study are:

- to determine if type of system influences student acceptability of food items as measured by plate waste and student ratings;
- to determine if quality characteristics, as measured by a professional sensory panel, are affected by type of system and therefore influence acceptability; and
- to relate time-temperature data to sensory qualities and student ratings.

Definitions

The following definitions are used in this research.

Conventional system - food is prepared and served in the same facility (12).

Satellite system - food is prepared in a central kitchen and transported hot to another site for service (12).

Satellite with finishing kitchen - satellite variation with a convection oven and steamer at service site for reheating foods that are below temperature standards, or preparing foods that do not transport well, i.e. vegetables and oven fried potatoes.

Hot-holding - any heated storage treatment, such as holding entrees in steam tables or warming cabinets (14).

Acceptance - expressed degree of liking or disliking for a food item (15).

Preference - expressed degree of liking or disliking for a food based on the name (15).

Consumption - amount of a food or food item actually ingested by an individual (15).

Sensory evaluation - a scientific discipline to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing (16).

Chicken nuggets - small pieces of chicken, breaded, fried and frozen. A commercial name used generically to describe similar products. Kraft brand chicken nuggets were used in this study.

Tater tots - a shredded, extruded, fried and frozen potato product in a drum shape. A commercial name used generically to describe similar products. Gourmet brand Potato Logs were used in this study.

REVIEW OF LITERATURE

Foodservice Systems

Unklesbay et al. (9) identified four types of foodservice systems: conventional, ready-prepared, assembly-serve, and commissary. A major distinguishing characteristic of the four systems is the degree of processing foods, which may vary from little or no processing prior to purchase of the foods to completely prepared foods ready for service.

Conventional System

The objective of a conventional foodservice, according to Unklesbay et al. (9), is to produce and serve quality food within one foodservice operation while effectively utilizing all renewable and non-renewable resources. Preparation is completed as close to serving time as possible to minimize holding time.

Carroll (17) stated one advantage of the conventional system is that preparation, production, portioning, and tray assembly are accomplished in the main kitchen under close supervision of management. A disadvantage is that personnel must alternate between high activity prior to meals and unproductive lulls, which may result in poor morale.

Klein et al. (12) stated that food is kept hot for two time periods, one before serving and the other at point of service. Prolonged holding times and the accompanying fluctuations in temperature are undesirable because they reduce sensory and nutritional quality and result in questionable microbiological safety.

According to Spears and Vaden (18), the conventional foodservice system is the type most establishments have traditionally used. In this system, foods are purchased for an individual operation in various stages of preparation, but all production is completed and foods are served on the premises.

Ready-Prepared System

Unklesbay et al. (9) stated the ready-prepared foodservice system was developed in response to a critical shortage of skilled food production personnel and increased labor costs. The objective of ready-prepared foodservice systems is to use effectively all resources by preparing menu items for storage. The distinct feature of ready-prepared foodservice systems is that prepared menu items are stored and ready at any time for final assembly and heating. The first heating occurs in quantity production and the second after storage just before service.

Two variations of the ready-prepared system are cook/chill and cook/freeze foodservice systems. In cook/chill foodservice operations, cooked food is maintained in a chilled state for a limited time until service to the customer. In the cook/freeze system cooked food is stored in the frozen state from one to three months until needed for service. When foods are processed for storage, the initial heat treatment should be minimal to avoid overcooking and losses of sensory quality during the final heating before service (9).

Carroll (17) further commented that the ready-prepared system is essentially a convenience food system except that foods are prepared and chilled or frozen on the premises. Efficient cost control and reductions in skilled labor costs are primary advantages of this system. The ready-prepared system does not have high activity peaks associated with the

conventional system because of a separation between production and service functions. Another advantage is that foods are served at the proper temperature by end-heat application at point of service. Disadvantages include the fact that foods are not served immediately after preparation, and quality control must be very precise. Also in a cook/freeze system, a high initial capital investment is required.

Assembly-Serve System

The assembly-serve foodservice system, according to Unklesbay et al. (9), has evolved in response to the chronic shortage of skilled personnel, technological changes in the food processing industry, and extensive marketing and distribution systems. The primary objective of the assembly-serve system is to provide optimal quality and minimize the amount of labor. In this system, procured food products have had a considerable amount of processing; only storage, assembly, heating, and service functions are commonly done within the foodservice operation.

Commissary System

Unklesbay et al. (9) stated the evolution of commissary foodservice systems has been made possible by technological developments in sophisticated foodservice equipment. Commissary foodservice systems have centralized food procurement and production functions with distribution of prepared menu items to several remote areas for final preparation and service. Currently three methods for storage are used: frozen, chilled, or hot-hold depending on the time lag between production and service. The advantages of the commissary system include reduction in duplication of production labor and equipment, minimization of equipment space

requirements at service sites, and realization of economies of volume purchasing (9).

Carroll (17) cited that the commissary system is often identified as a satellite system. Food may be prepared centrally in a conventional, cook/chill, or cook/freeze system and transported to satellites in bulk or individually plated.

Commissary systems have long been used in school foodservice, although many systems have combined conventional and commissary approaches (18). In recent years, centralized production facilities located away from schools have been constructed, usually in urban districts with a large number of schools. Often the larger secondary schools have their own conventional systems, and the central production facility only produces meals for the smaller elementary schools in the district. A more common system, however, uses the larger secondary school kitchen as the commissary for producing meals that are transported for service in bulk or portions to the smaller elementary schools (18).

Effect of Foodservice System on Quality

Bobeng (19) defined food quality as a multi-dimensional characteristic comprised of microbiological, nutritional, and sensory attributes. She also stated that quality of food is related to consumer acceptability which is often based on sensory attributes such as flavor, appearance, and temperature. David (20) offered an alternate definition: quality food is nutritious and safe, as well as satisfying to the consumer.

In a study by Allington et al. (8), quality was assessed by evaluating ten characteristics divided into three main categories: preparation, service, and sanitation and safety. Food preparation characteristics were

appearance, taste, texture, and temperature, and service ones were meal appearance, accuracy of tray or table setting, and delivery or service times. The sanitation and safety characteristics involved an evaluation of equipment, kitchen area, and foodservice personnel.

Microbiological Quality

According to Bryan (21), the five most common factors contributing to foodborne disease outbreaks in the U.S. are inadequate cooling of foods, lapse of a day or more between preparing and serving, improper handling of foods by infected persons without subsequent heat-processing, inadequate time or temperature or both during heat processing of foods, and insufficiently high temperature during storage of hot foods. Of these, inadequate cooling was the major contributor to outbreaks of foodborne disease.

Cremer and Chipley (22-26) conducted several studies on the effect of foodservice systems on the microbiological quality of food. Microbiological quality of precooked frozen hamburger patties in a satellite system was evaluated and results indicated that quality varied as the patties passed through the satellite system (22). The quality was generally acceptable at the time of service. In another study, Cremer and Chipley (23) evaluated the microbiological quality of spaghetti and chili in a cook-chill satellite system. Results indicated that microbiological quality was generally acceptable.

Avens et al. (11) compared four school lunch preparation and delivery systems to ascertain whether one was more susceptible to potential food safety hazards than others. The four systems evaluated were: conventional on-site preparation and service, preparation in a central kitchen with hot bulk transport to satellite schools, preparation in a central kitchen with

chilled transport of preportioned food to satellite school, and purchase of frozen preportioned meals for heating to serving temperature in individual schools. Results indicated that food preparation and handling abuse was a characteristic of individual schools and was not unique to any particular food preparation and delivery system. The data also suggested that all four systems were capable of producing safe foods for school lunch programs. Food safety hazards were the fault of some of the schools and not the food preparation and delivery system.

Cremer and Chipley (24) evaluated the microbiological quality of meat loaf in a commissary system with heated transport of food. Data indicated that the numbers of surviving microorganisms were related to either the length of time that cooked loaves were stored in the refrigerator or the position of loaves in stacked trays. The researchers concluded that thorough cooking prior to assembly, prevention of recontamination during refrigerated storage, and thorough reheating for assembly and service were important factors in the safety of the meat loaves.

A hospital cook-chill system, which used microwaves for reheating scrambled eggs and roast beef, was the focus of another study by Cremer and Chipley (25, 26). They reported that despite considerable temperature abuse during preparation of the scrambled eggs, the microbial quality was relatively good. Also, the microbial quality of the roast beef was good but variable among replications. An increase in number of microorganisms at processing were attributed to the relatively long storage times at temperatures conducive to microbial growth. When comparing the scrambled eggs and roast beef, the microbial quality was better for the eggs; difference was attributed to the pasteurization of the eggs and the lack of hand contact.

Chipley and Cremer (27) reported the results of several studies concerning microbiological quality of food in various types of systems (satellite in school and elderly feeding program, hospital cook-chill, and fast food). They concluded that the microbiological data indicated that thorough cooking and cooling of entrees, prevention of recontamination during storage, and thorough reheating of products for subsequent service are the most important factors for the safety of these items. They also stated that the potential exists for public health hazards if entrees are not closely monitored within these operating systems. Satellite food-service systems can be effective in providing wholesome food to large numbers of people if extremely good quality control is exercised.

Rini et al. (28) assessed the microbiological quality of beef loaf in four commissary foodservice treatments. The first and second treatments used insulated plastic trays to hold heated prepared food for one or two hours respectively during transportation to a service unit. The third consisted of portioning food into foil containers, chilling and holding for 24 hours, and then heating in a convection oven. In the fourth treatment, the food was chilled in bulk, held 24 hours, heated, then portioned into insulated plastic trays, and held for one hour during transportation to serving unit. No significant differences were found in the microbial quality among treatments.

Brown et al. (29) evaluated conditions, procedures, and practices that affected food safety in ten school satellite foodservice systems. Nine of the ten foodservice systems transported ready-to-serve food in bulk to satellite service units, and one of the foodservice systems preportioned food into styrofoam containers at the production site before transportation. The results of this study indicated no clear relationship

between the number of microorganisms in the samples and the internal temperature of food during preparation, transportation, and service.

Snyder and Matthews (30) reviewed research pertaining to the microbiological quality of menu items in the cook/chill, cook/freeze, cook/hot-hold, and heat/serve systems. Most of the research has focused on the cook/chill method and least on the heat/serve. The reviewers emphasized that all methods required strict managerial control to assure food that is microbiologically safe, and that thermal processing may have a greater effect on food quality than any other food handling procedure.

Sensory Quality

Karlstrom and Jonsson (31) evaluated the effect of temperature and time on the sensory and nutritional quality of white potatoes, fish, and meats. Results indicated that the greatest amount of total quality loss caused by warm-holding was attributable to sensory quality, especially for potatoes; whereas fish and meats were only moderately affected. Both warm-holding time and temperature are important. Flavor and texture appeared to be the most important sensory parameters.

Cremer and Chipley (22) evaluated the quality of precooked frozen hamburger patties prepared for a satellite system. An eight-member trained taste panel evaluated appearance, color, texture, flavor, and general acceptability of the patties at point of service. Based on a nine-point scale ranging from "excellent" to "extremely poor," the sensory quality of the patties was rated "fair."

In a similar study, Cremer and Chipley (23) evaluated the sensory quality of spaghetti and chili in a cook-chill school foodservice satellite system. The taste panel scores denoted a food quality for spaghetti and chili ranging from "fair" to "very good."

Bobeng and David (32) compared the sensory quality of beef loaf in conventional, cook/chill, and cook/freeze systems. Beef loaves in the conventional system were held hot for 60 minutes before serving; whereas, those produced in the cook/chill and cook/freeze systems were heated in a microwave oven immediately prior to service. A trained panel consisting of nine judges used a six-inch horizontal line to evaluate the sensory attributes and overall acceptability of the beef loaves. Color of crust, color of meat, uniformity of color, texture, juiciness, flavor, and general acceptability were evaluated.

Scores for general acceptability of the beef loaves in the conventional system were significantly greater ($p \leq 0.05$) than for those produced in the cook/chill and cook/freeze systems. The results indicated that of the quality characteristics measured (weight, microbiological, nutritional, and sensory) only sensory quality differed significantly among type of system (32).

Cremer and Chipley (24), using the same methodology as in their earlier studies, evaluated the sensory quality of meat loaf prepared in a commissary system using heat during transport of food. Sensory quality ratings of the meat loaf ranged from "below good above fair" to "good."

Cremer and Chipley in the microbiological study of scrambled eggs and roast beef also included sensory evaluation conducted by a 10-member trained panel using a nine point scale with descriptive terms (25, 26). Scrambled egg color, texture, flavor, and general acceptability were evaluated. Data indicated "good" general acceptability, "very good" color, and "below good, above fair" texture. The sensory quality of the eggs was better than expected. Appearance, color, texture, tenderness, juiciness, flavor, and general acceptability of roast beef were evaluated.

Sensory scores indicated that the quality of the roast beef was generally "good."

Rini et al. (28) in a microbiological study of beef loaf assessed the sensory quality. An eight-member trained panel evaluated appearance, color, texture, flavor, and general acceptability using a nine-point scale with descriptive terms ranging from "excellent" to "extremely poor." Results of the sensory evaluation indicated general acceptability for hot beef loaf portions held one hour after baking scored significantly higher than for those held two hours or chilled 24 hours and heated in a convection oven. No significant difference was observed between portions held one hour prior to chilling and those chilled 24 hours, heated, and then held for one hour (28).

Cremer (33) evaluated the sensory quality of spaghetti with meat sauce after varying holding treatments and heating in institutional microwave and convection ovens. The spaghetti was evaluated after heating to temperatures considered effective for microbiological safety after one hour chilled storage, 24 hour chilled storage, 24 hour frozen storage, 24 hour frozen storage followed by 24 hour chilled storage, and after no storage or reheating. An eight-member trained sensory panel evaluated appearance, flavor, mouthfeel, spaghetti texture, meat texture using a 15 cm line anchored at 1 and 14 cm. The freshly prepared product was scored higher for appearance of moistness and clumping, was less dry and greasy in mouthfeel, and was firmer and chewier than for all other samples. Data indicated that spaghetti held one hour chilled or 24 hours chilled and heated in either a convection or microwave oven was of better quality than the same product frozen 24 hours or frozen 24 hours then held chilled for 24 hours. Holding food chilled 24 hours after freezing 24 hours did not

affect quality as compared to spaghetti heated directly after 24 hours frozen storage. Sensory quality after 1 or 24 hours chilled storage was similar (33).

Al-Obaidy et al. (34) compared the sensory quality of freshly prepared spaghetti with meat sauce before and after hot holding on a cafeteria counter. The spaghetti was held for 90 minutes at approximately 66°C. Sensory evaluations were conducted by an eight to ten member experienced and trained taste panel. An unstructured category scale, 10 cm long, was used to evaluate the appearance, flavor, mouthfeel, spaghetti texture, and meat texture. General acceptability scores for sauce, spaghetti, and spaghetti with meat sauce were significantly higher ($p \leq 0.05$) for the freshly cooked product than for the hot-held product.

Time-Temperature Relationships

Klein et al. (12) reported that time and temperature relationships were involved in five of the six major factors contributing to outbreaks of foodborne disease in the United States from 1961 through 1976. The authors suggested that the data emphasized the importance of devising methods for maintaining and controlling food safety and quality at critical points throughout the food flow process. Tools for effective monitoring include standardized procedures, initial and end-heating temperature controls, microbial controls, and appropriate training procedures.

Hazard Analysis Critical Control Points (HACCP)

Bauman (35) defined hazard analysis as the identification of sensitive ingredients, critical process points, and relevant human factors affecting product safety. Critical control points are those processing

determiners whose loss of control would result in an unacceptable food safety risk. The Hazard Analysis Critical Control Point (HACCP) was developed as a preventive system of control particularly with regard to microbiological hazards.

Peterson and Gunnerson (36) defined hazard analysis as a systems approach for estimating the risk in producing a food product. It provides for the assessment of all possible hazards and probability of occurrence, prescribes for the elimination of avoidable hazards, and sets acceptable limits for those hazards not possible to eliminate in the processing of a food. Peterson and Gunnerson also stated that much in-process control consists of maintaining time-temperature standards and may involve continuous surveillance.

Unklesbay (37) stated that considerable managerial competence in areas of procurement, production, distribution, and decision-making is required to monitor time-temperature relationships of food products from procurement to consumption. She also identified nine control points requiring monitoring for microbial quality and safety within foodservice operations. Food procurement, food storage, food packaging, preprocessing, heat processing, food storage following heat processing, heat processing of precooked menu items, food product distribution, and food service are the control points.

For the critical control point of food storage following heat processing for hot food, Unklesbay (37) asserted that both high temperatures and humidity decrease food quality. Prolonged holding at 73°C adversely affects nutritional and sensory quality. They recommended that the hot-holding period should be as short as feasible in commissary and conventional foodservice systems, given the system constraints.

For the critical control point of food product distribution, Unklesbay (37) recommends when transporting food temperatures should be between 60°C and 70°C. Also, menu items should be served below 7°C and above 60°C. To minimize microbial contamination and to retard evaporation and surface cooling, protection of food by covering is recommended. If managerial monitoring is not effective at the point of service, the effectiveness of all previous controls throughout the flow of food products may be nullified.

Bobeng and David (14) applied the HACCP concept to foodservice and defined it as a preventive system for quality control designed to inform management of potential dangers justifying corrective action. HACCP models were developed for three on-premise hospital foodservice systems: conventional, cook/chill, and cook/freeze. Four critical control points were defined: ingredient control and storage, equipment sanitation, personnel sanitation, and time-temperature. The critical control point of time-temperature refers to the relationship of time and temperature at control points of entree production. Time-temperature was a critical control point throughout entree production in each model, and parameters were established for all points.

Bobeng and David (14) concluded that establishing time-temperature standards is a practical method for monitoring entree production in hospital foodservice systems. They also postulated that adherence to minimal temperature standards during heat processes will not only control microbiologic quality but also conserve nutritional and sensory qualities of the entree. Temperatures higher than necessary for microbiologic control may have a deleterious effect on nutritional and sensory qualities of entrees.

According to Bryan (38), hazard analysis consists of an examination of operations in a foodservice establishment to identify potentially hazardous food and sensitive ingredients, find sources and specific points of contamination, and determine the potential for microorganisms to survive a heat process and multiply at room temperature and during hot and cold storage. Bryan (38) also stated that hot-holding can be one of the most hazardous operations in a foodservice establishment and, therefore, is a critical control point. Unless hot-holding is an integral part of cooking, most foods should be heated to 60°C or higher before being placed in hot-holding devices. As soon as food temperature falls below 55°C, the food should be served, reheated, or chilled and subsequently thoroughly reheated.

Cichy (39) applied HACCP, as a quality assurance tool, in a commissary foodservice system. The HACCP procedure revealed time-temperature deficiencies in the system and indicated appropriate corrective action. He concluded that proper review of the time-temperature history of a food product can red-flag the process stages at which microbiological proliferation is likely to occur. Also, within each foodservice system, identification of time-temperature critical control points involved in food handling is of paramount importance for adequate control of food safety and quality. Sensory attributes of the food product can be negatively affected through inadequate time-temperature control. It was recommended that the food item should not be exposed to the temperature danger zone any longer than absolutely necessary.

Effect on Sensory Quality

Blaker et al. (40) conducted a study to determine desirable serving temperatures in various food categories. Results indicated that customers

preferred foods at the following temperatures: soup 145-150°F, potatoes and vegetables 140°F, entrees 140-145°F, and hot beverages 145-150°F.

Hill (41) affirmed that hot-holding was destructive to vegetable quality and recommended vegetables be consumed directly following cooking and not be subjected to more than 30 minutes hot-holding. Paulus (42) found that meat entrees could be held hot at least three hours without major decreases in sensory quality. Bengtsson and Dagersborg (43) found, however, that more than two hours of hot-holding greatly reduced sensory quality of beef slices and patties in a cook/freeze system.

Bengtsson and Dagersborg (43) also stated that of all the possible stresses on sensory quality during meal distribution, hot-holding has caused the greatest concern. In fact, hot-holding has been cited as a very "effective" means of destroying the sensory quality of food products that have been prepared after a careful choice of raw materials and processing and storage conditions. Sensory quality losses through hot-holding can be reduced, however, by proper control of the environment and temperature. Obviously the most effective means is a reduction in the hot-holding time.

Other studies (12) conducted on acceptable serving temperatures have found a preferred temperature of 145 to 167°F for potatoes, 140 to 169°F for meat balls and 138 to 156°F for pea soup. In research conducted at Iowa State University (12), the preferred temperatures of a ground beef and tomato sauce mixture for several groups of people were determined. Third-grade children preferred the mixture at 120°F whereas 20 to 59 year old adults preferred it at 140°F and those 65 and over preferred a temperature of 151°F.

Measures of Acceptability

Pilgrim (44) stated that food acceptability can be operationally defined simply as consumption. However, in order to include the affective reactions, acceptance should be defined as consumption with pleasure.

Ellis (45) stated that preference is sometimes used interchangeably with acceptance, but this is incorrect because the two terms are related but not the same. He also stated that preference is only one of many factors involved in acceptability, but it is an important factor, and actual utilization (consumption) may be measured by preference or liking for a specific food item.

According to LaChance (46), the purpose of acceptance testing is to determine the overall degree of like or dislike of a food. Also, it can be used to determine if preference or lack of preference varies. For example, food may have a good average rating because almost everyone likes it to a fair degree; or it may have a good average rating because a large number of students like the food very much and another large number dislikes it very much.

Acceptance testing is used (46), to determine whether a new food product will be acceptable to clients or to test quality deterioration, especially if preference has been affected. The frequency any given food can be scheduled without a loss in acceptance due to monotony also can be determined. According to Head et al. (5), methods for measuring food acceptability can be divided into two main categories: quantifying plate waste to measure behavioral responses and rating items on a hedonic scale to measure affective responses.

Hedonic Scale Measures

The hedonic scale is used to measure the level of liking for food products by a population and it may be applied in testing for preference or acceptance. This method relies on test subjects' abilities to report directly and reliably their feelings of like and dislike. The traditional hedonic scale consists of nine categories with a continuum from "like extremely" through "neither like nor dislike" to "dislike extremely." Two variations of this scale are a seven- and a five-point scale (16).

Another type of hedonic scale is the Food Action Rating Scale (FACT), a nine-point scale for measuring food acceptance, developed by Schutz (16, 45). The FACT scale requires the individual to be very specific about what actions he would take in terms of the number of times he would be interested in eating a food product in a given period.

Because descriptive phrases can be ambiguous to some people including children, the hedonic scale has been converted into what is known as a facial hedonic scale (45, 46). In this scale, faces depict the degree of pleasure, or displeasure, experienced by the subject. A neutral face is the median interval. Investigators at Rutgers University (46) found that a scale based on five simple faces could be used to evaluate how a person feels about a food.

Plate Waste Measures

Plate waste can be used to measure preference, monotony, adequacy of serving size and nutrient intake (47). Types of plate waste measurement are weighed plate waste, aggregate plate waste, observational plate waste, and self-reported consumption.

Weighed Plate Waste. The traditional method used to measure plate waste, according to Comstock et al. (48), has been to collect a sample of

trays at the end of the meal and weigh the leftovers from each food item on each tray. This method provides accurate and detailed information on each food item and on each child.

Disadvantages of this method are (48):

- A great deal of space is required for holding trays and for scraping and weighing waste.
- The procedure is time-consuming and costly.
- Measuring plate waste for more than 100 individuals at one meal is impractical.

Aggregate Plate Waste. Comstock (48) also stated that aggregate measures simplify the data collection process because waste is weighed only after scraping is completed. Waste from all trays is scraped into separate containers for each food item. A mean or percent waste per child for each food item at each meal is calculated. The advantages of aggregate plate waste is that it can be weighed much faster than individual waste, and it still provides accurate measures of total or mean waste.

However, Graves and Shannon (49) asserted that aggregate plate waste does not provide enough information in some cases. When plate waste is aggregated across children, many interesting questions at the individual level cannot be addressed. Another disadvantage is that if the number of children within a class is very small, one child could heavily influence the mean waste weight.

Observational Plate Waste. LaChance (47) recommended that school foodservice workers visually estimate plate waste and outlined a simple procedure to be used. He stated that the visual method, if it is performed in a systematic manner, can provide very reliable data.

The visual method of measuring plate waste requires observers to rate each food item on each tray returned at the end of a meal. The

observers are trained to recognize average serving sizes of each food item and make judgments regarding the proportion remaining on the tray. If samples of initial servings are weighed, visual estimations of the proportion remaining may be translated into estimated weights (47).

Several studies have been conducted to validate this method of measuring plate waste (7, 47-50). Comstock (48) found that trained data collectors can make visual estimations of plate waste that correlate highly with the actual percent waste, and these estimations are quite accurate when compared with expected values.

Stallings and McKibben (50) conducted a study to validate the visual method of measuring plate waste and concluded that visual assessment seems to be a reliable and simple method of measuring plate waste. They also observed, even though the person performing the assessment must have experience evaluating plate waste, time spent gaining experience is much less than time involved in laborious scrape and weigh procedures.

Johnson (7) found that observed plate waste distribution 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 portion left." This difficulty may be partially due to variability of serving sizes. Correlation between weighed plate waste and with observed waste was .88 to .97. Johnson concluded that the observational plate waste method may be as accurate as the weighed method because of variability of serving sizes.

Self-Reported Consumption. Self-reported consumption is another indirect measure of actual plate waste (48). This method is similar to visual estimation except that children are asked to rate their own consumption from memory shortly after leaving the cafeteria. A study by Head et al. (5) indicated a positive relationship between self-reported

and actual consumption; and when an accurate measure of consumption is not necessary, self-reporting may be used.

Comstock (48) compared self-reported consumption to actual plate waste and to the visual estimation method. Self-reported ratings correlated highly with percent waste but not as high as the visual estimation technique.

Johnson (7) also compared self-reported and visual observation techniques with weighed plate waste. She corroborated the findings of Comstock that self-reported ratings correlated highly with percent weighed waste, but not as high as the visual estimates.

Acceptability Studies in School Foodservice

In the last several years, many studies have been done in the National School Lunch Program to assess consumption and acceptability of food served. Carver and Patton (51) evaluated plate waste in an Ohio public elementary school for twenty-eight days. Results indicated that children in the first three grades ate proportionately less than did the older children who varied in their eating habits from grade to grade. At all ages, food acceptance varied widely from day to day, related in some cases, but not all, to a particular food served.

Harper et al. (2) evaluated the menu item acceptability in various food delivery systems. Food acceptability was measured as the percentage consumed by approximately 50 fifth and sixth grade students. Results indicated that acceptability of ground beef and spaghetti, peas, chocolate pudding, and baked beans varied significantly depending on type of delivery system. On-site preparation and service produced meals with higher acceptability than did chilled or frozen preportioned meals. Within each delivery system, some schools had higher acceptability than did others.

These differences indicate potential improvements could be made in all delivery systems.

Head et al. (5) compared the following three types of information for assessing student acceptability of school-served food items: hedonic rating scale, self-reported consumption, and plate waste. Results indicated that acceptability ratings were very good indicators of consumption.

Jansen and Harper (6), in evaluating the Nutrient Standard Menu as a method of planning school lunches, reviewed consumption by menu item category and by specific menu item. No difference was found between menus planned using the Type A lunch pattern and those using the Nutrient Standard Menu.

The influence of student selected menus on plate waste and student attitudes was evaluated by Garret and Vaden (52). Sixth grade students in three elementary schools participated in this study. Plate waste was decreased significantly in two of the three schools when student selected menus were used. Also, a positive change in attitude toward school foodservice was noted in the school which permitted students to observe and participate in the kitchen as part of the project. Attitude scores were significantly higher for children who frequently ate lunch in the school foodservice than for those who did so infrequently.

Zacharias (53) reported results of a survey taken among students. Results showed that acceptance of meals depends to a decisive degree upon the sensory value, particularly upon taste, texture, and appearance. Eighty-five percent of the students rated taste as most important criterion.

Lilly et al. (1) evaluated consumption in the National School Lunch Program to provide an estimate of the magnitude of plate waste in school

foodservice, and to identify foods most acceptable and those least acceptable. Type of foodservice system had an effect on plate waste and percentage consumption of cooked and raw vegetables, potatoes/pasta, fruit, and bread. On-site foodservice systems had less plate waste and greater percentage consumption than did schools with preportioned lunches.

Jansen et al. (54) evaluated the effect of alternate lunch patterns on food acceptability in high schools. The researchers concluded that a free choice lunch may be effective in reducing plate waste, particularly for poorly consumed menu items. Excessive plate waste is not a general problem for all students and food categories; but rather plate waste is dependent upon subgroups of students and particular food categories.

Head et al. (55-57) evaluated the acceptability of school-served foods by examining students' rating of acceptability, the consumption of food, and nutrition education. Entrees (55) received the third highest rating, being outranked by milk and desserts. The data for entrees indicated that ratings from males were higher than from females, black students rated entrees higher than white students, and students who received free lunches rated items higher than those who paid full price.

Of the six food groups, the fruit group received the next to lowest acceptability rating followed by the vegetable group which had the lowest rating (56). Of the six food groups, elementary students ranked desserts second and breads fourth, whereas secondary students ranked breads and desserts approximately midway (57). As with the other food groups, sex, age, race, and paying status affected the acceptability ratings.

Graves and Shannon (49) used visual and physical plate waste measurement to assess consumption. Data were compared by plate waste measurement and by sex across grades. The two plate waste methods used were weighed

and visual assessment. Results indicated a significant difference in plate waste between boys and girls for 10 of the 18 food items. In all cases, girls wasted more food than boys. The fifth grade appeared to be the most accepting, and grade four consistently had high plate waste in comparison to the other grades for all food items.

Johnson (7) evaluated food acceptability between on-site and satellite foodservice systems. Eight elementary schools in the same district participated in the study. Four had on-site preparation, and four were satellites. Students in the fourth and fifth grades served as test subjects. Plate waste tended to be higher in satellite schools than in those with on-premise production of food. Vegetables and entrees, reportedly eaten both at home and at school, resulted in the lowest mean percent plate waste for all menu items studied. Also, items with lower food acceptability had higher amounts of plate waste.

Sensory Evaluation

The Sensory Evaluation Division of the Institute of Food Technologists defines sensory evaluation as a scientific discipline used to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials as perceived by the senses of sight, smell, taste, touch and hearing (16). Klein et al. (12) stated sensory quality of food is measured by response of consumers to certain attributes such as appearance, flavor, texture, and temperature. The condition of food when it enters a foodservice system and to the degree of control of the procedures for food processing and holding within a system are related to eating quality (12).

According to Dahl (58), all processing steps in a foodservice system have a cumulative effect on the quality of food at the point of service. Sensory quality begins with menu planning and systems design and is closely related to detailed purchase specifications, standardized food formulations, and close monitored storage techniques.

Types of Sensory Evaluation

Sensory evaluation techniques can be divided into two main types: analytical and affective. The type of test to use is determined by the information desired (16, 59, 60). The analytical test uses trained or experienced panelists and evaluates products in terms of differences or similarities and for identification and quantification of sensory characteristics (16). Two types of analytical tests are discriminative (i.e., triangle, ranking, rating) and descriptive (i.e., attribute rating, profiling). The effective test uses an untrained consumer panel and evaluates preference, acceptance and opinions about a product. Affective tests are used when information regarding acceptability and preference is needed. The hedonic scale is an example of a technique used in affective testing (16, 59). Skelton (59) stated that in the sensory evaluation process, trained taste panels distinguish and describe the characteristics and quality of prepared food items, and untrained consumer panels determine preferences among food items.

Uses of Sensory Evaluation in Foodservice Systems

Cichy (60) used sensory analysis as a quality assurance tool in a commissary foodservice system. He stated that sensory principles can be applied in all stages of product flow, from incoming inspection, through in-process controls, to final product inspection and product

surveillance. Also, fundamental to the success of sensory evaluations of food products is the establishment of standards and training programs for personnel.

Skelton (59) stated that continuing quality assurance programs should include sensory evaluation to ensure consistency. Adjustments can be made before the effects of change become disastrous. Sensory evaluation techniques can be used to measure customer acceptance in a foodservice.

Sensory analysis has been used in research to compare the effects of various foodservice systems on the sensory quality of food (22-26, 28-34). Product development personnel utilize a trained sensory panel to obtain a complete description of quality characteristics of a product (59-61).

METHODOLOGY

Research Site

The study was conducted in the school lunch program of five schools in the Manhattan, Kansas, school district (USD 383). Three types of foodservice delivery systems were evaluated: conventional, satellite, and satellite with a finishing kitchen. The district uses three systems under one management with uniform policies and procedures. Collaboration with the district school foodservice supervisor, who writes the menus for all the schools, assured the same menu for the days research was conducted. Data were collected at five elementary schools: one with a conventional system and four satellites, two receiving food from the middle school and two from the high school. The separate schools, the type of foodservice system, enrollment, and the percentage participation in the school lunch program follows:

School	Foodservice System	Student Enrollment	School Lunch % Participation
A	satellite	221	72
B	satellite	201	70
C	satellite	326	73
D	satellite	282	57
E	conventional	513	78

Four of the schools had serving lines and a foodservice employee served the students. These schools also had a self-serve salad bar where a few items such as fruit, bread, and sometimes vegetables were placed.

School D had family style service, in which a foodservice employee dished up the food into serving bowls with the correct number of servings for each table. Two students from each table then went through the serving line and picked up the bowls for their table. Also, at this school, students from all grades ate together. The absence of accurate measures of portion size and plate waste precluded use of data from this school in that part of the study.

Research Design

Chicken nuggets,[1] broccoli, and tater tots,[2] all purchased frozen, were chosen for the study because of popularity and the effect of high holding temperatures on quality. Data were collected at satellite schools A, B, C, and D, four times each. For two data collections, food items were heated in the central kitchens and delivered ready for service. For the other two data collections, the frozen food was sent to the satellites for heating; chicken nuggets and tater tots were heated in the convection oven and the broccoli was cooked in the steamer. Additional data were collected twice at school E, which had the conventional system.

To avoid any possible bias, the school and system type were randomly assigned to each data collection day. Data were collected on five non-consecutive days with either three or four schools being sampled per day. The data collection schedule is given in Appendix A.

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[1] Small pieces of chicken, breaded, fried and frozen. A commercial name used generically to describe similar products. Kraft brand chicken nuggets were used in this study.

[2] A shredded, extruded, fried and frozen potato product in a drum shape. A commercial name used generically to describe similar products. Gourmet brand Potato Logs were used in this study.

The same food items were evaluated each day of the study using four types of data: student evaluations, aggregate plate waste, time-temperature data and sensory panel ratings. Sixth grade students were selected to participate because this age group would be able to complete the evaluation forms independently.

A five member trained and experienced sensory panel from Kansas State University was used for sensory evaluations. The panel was divided into two groups, each consisting of two panelists and one alternate. To avoid bias, each panelist was randomly assigned to a group. Also, the schools and the order of evaluation were randomly assigned. Each group was assigned to two schools on each data collection day as shown in Appendix B. In a recent study, Chambers (62) stated that a small, well-trained panel can produce the same results as a large, semi-trained panel.

Project Approval

Prior to data collection, the project was approved by the College of Home Economics Human Subjects Committee. An application for approval to use human subjects (Appendix C) and a copy of the project proposal were submitted to the committee. Following this approval, the project was approved by the Dean of the College of Education in accordance with an agreement between the school board and the college (Appendix D). The final approval was then obtained from the Superintendent of Education of USD 383 and the elementary school principals. Following all approvals, the project was explained by the researcher to school foodservice staff at a cooks' meeting.

A cover letter describing the research project and a student participation consent form (Appendix E) were sent home with each sixth grade

student. The consent form, which was to be returned to the school principal, requested signatures from the parent or guardian and the student.

Research Team

The research team consisted of nine Institutional Management graduate students; one was project director and three were research coordinators. These four were responsible for taking time-temperature data, transporting supplies to schools, setting up plate waste tables, setting up tables for the sensory panel, and returning supplies and plate waste in special containers to the research laboratory. The five additional research assistants were responsible for collecting plate waste, counting the number of trays scraped, and collecting evaluation cards from the students. The project director weighed containers, plate waste, and five sample servings for calculation of average serving size.

Development of Instruments

Information required for the research was a demographic profile for each student, student acceptability ratings of food items, analytical sensory ratings of food items, time-temperature relationships for the food items, and food waste. Forms for this information in single sheet format were either adapted from previous research or especially developed for this study.

Student Demographic Information Card

The demographic information card (Appendix F) for completion by students was adapted from the one developed for the Johnson study (7). Questions and statements concerning biographical data, frequency of

eating school lunch, attitudes about school lunch, and reasons for eating school lunch were included.

Student Evaluation Card

Separate score cards for chicken nuggets, broccoli, and tater tots (Appendix G) to be completed by students were also adapted from the Johnson study (7). Each contained a five point hedonic scale for the evaluation of flavor and appearance, a three point hedonic scale for temperature and serving size, and two questions on the student's familiarity with the food item. An additional question was included on the chicken nugget card to determine if the student felt like eating that day.

Sensory Score Card

A meeting with the cooks was held to obtain their input on the quality characteristics of the three food items they believed were most affected by transport to the satellite. Based on these characteristics, a sensory evaluation score card was developed with the assistance of a sensory specialist at Kansas State University. Following a training session with the sensory panel, the final score card was devised (Appendix H). The score card, to be completed by the sensory panel, consisted of six 15 cm unstructured line scales, one for each quality characteristic: moistness, tenderness, and coating crispness of chicken nuggets; color and firmness of broccoli; crispness of tater tots. A space was also provided for the panelist to record the temperature of food items at the time of evaluation.

Time-Temperature Record

Two time-temperature record forms were developed: one for satellite schools, and one for the conventional system and satellites with finishing kitchen (Appendix I). For the satellite kitchens, time-temperature data were recorded at end of production, when leaving the preparation kitchen, arriving at the satellite, and at the beginning, during, and end of service. At the conventional kitchen and satellite with finishing kitchen, time-temperature data were recorded at end of production and beginning, during, and end of service.

Plate Waste Record

The plate waste record (Appendix J) was designed for completion by the research team. Spaces were provided for average serving weight and plate waste weight for each of the three food items and number of students as indicated by trays.

Sensory Panel Training

Since the panel was well trained in sensory analysis, only familiarization with the project was necessary. The panel was trained to recognize the end points of the scale for each quality characteristic evaluated.

To acquaint the sensory panel with the scale end points, samples of the three food items were prepared exemplifying the highest and lowest qualities. Each panel member was given a sample of these end points and after evaluating had a discussion with the project director. The panel members were also asked for their input concerning the adequacy of the score card, which was revised according to their suggestions and tested during the pilot study (Appendix H).

Pilot Study

A pilot study was conducted at two schools to test data collection procedures, evaluate sensory score card, and determine if the sensory panel needed additional training. Students did not evaluate food items at this time, but trays were collected and waste weighed.

After the pilot study, data collection procedures were refined. The project director held a meeting with the three research coordinators and the five research assistants to explain procedures. Each research coordinator and assistant was given a copy of the procedures and project schedule (Appendix K).

Before the data collection began, the project director and research coordinators visited all participating schools and met with principals and cook managers. At this time, cooks were given a copy of the data collection schedule and the procedure was reviewed with them (Appendix L). The principals also were given a copy of the data collection schedule and a list of items required in the lunch room for data collection (Appendix M). The consent forms from the students were collected at this time.

Data Collection

Student Evaluation Data

A packet was assembled for each student containing instructions for completing and returning the evaluation cards (Appendix N), a pencil, and the food item evaluation cards. On the first day of data collection at each school, students were asked to complete the demographic information card, which was also in the packet. Research coordinators were responsible for delivering packets to the principals. Packets were distributed to

students either by principals or teachers just before lunch. Students completed the cards in the lunchroom after eating. Cards were collected when the trays were brought to the table for scraping.

Sensory Data

On the day of data collection, each member of the sensory panel was given the name of the assigned schools, score cards, and a thermometer for recording the temperature of the food item at the time of evaluation. Each group of panelists visited two schools on each data collection day. The panelists were not informed of the type of system at the assigned school in order to preclude any bias toward a system.

Time-Temperature Measurement

Temperatures were recorded on the time-temperature form using pocket thermometer with a range of -20 to 105° Celsius. For the satellite schools, temperatures were taken at the central preparation kitchen at the end of production and prior to transport to the satellite school. Temperatures were also taken upon arrival at the satellite, beginning of service, at the break between lunch periods, when sixth graders came through the line, and at the end of service. At the conventional kitchen and the satellites with finishing kitchens, temperatures were taken at the end of production, beginning of service, at the break between lunch periods, when the sixth graders came through, and at the end of service. The time each temperature was taken was also recorded on the form.

Average Serving Size Data

Prior to data collection, empty containers for collecting five servings of each menu item were weighed and weights were recorded. The servings were collected when food temperatures were taken and then weighed

at the research laboratory on an electronic scale and the average serving size calculated and recorded on the plate waste record form (Appendix J).

Plate Waste Data

Plate waste containers were weighed, and weights were recorded prior to data collection. When the sixth grade students had finished eating, they were instructed to bring their trays to the plate waste collection table. The research assistants scraped the trays and collected the waste into separate containers for each of the three food items. Also, the research assistant counted the number of scraped trays in order to determine the average waste per student. Total plate waste was taken to the research laboratory for weighing on a calibrated electronic scale and recorded on the plate waste record form (Appendix J).

Data Analysis

Programs and routines in the Statistical Analysis System (SAS) were used for analysis of the data (63). The relationship between type of foodservice system and student responses to demographic questions was analyzed using chi-square. The relationship of both school and foodservice system to student acceptability of food items also was analyzed using chi-square.

Because the data were unbalanced, the general linear model analysis of variance was used to determine the relationship of foodservice system to student evaluations, plate waste, and time-temperature data. The model for analysis of plate waste was weighted by number of student trays scraped. Plate waste data from school D were not used in analysis because accurate information was not available in a family style service. The relationship of foodservice system to sensory evaluation of quality was

analyzed using a technique described by Milliken and Johnson (64) for analysis of split-plot experiments with unbalanced data. Information provided from SAS general linear model analysis was used in the equations to estimate mean and standard error.

RESULTS AND DISCUSSION

The study sample consisted of students from five elementary schools in the Manhattan, Kansas, school district. A total of 87 sixth grade students, 57% male and 43% female participated in the study.

Student responses on the frequency of eating school lunch is presented in Table 1. Students in school D reported eating school lunch much less often than students in the other schools. The greatest participation was indicated for school A.

Table 1. Student reported frequency of eating school lunch for each school*

school	N†	frequency				
		every day	two to four times week	once a week	once a month	never
		←		%		→
A	8	87.5	12.5	-	-	-
B	11	54.55	27.27	18.18	-	-
C	18	72.22	27.78	-	-	-
D	12	25.0	33.33	8.33	8.33	25.0
E	38	76.2	21.05	-	2.63	-
mean	87	66.67	24.14	3.45	2.30	3.45

*Analysis by school: $\chi^2 = 37.147$ df = 16 p = .002.

†N = number of students responding.

No significant differences were noted on student ratings of the food quality in the various schools (Table 2). Students in school E rated food quality the highest with 32% indicating the food was "almost always good." In all schools at least 50% of the students rated the food good some of the time.

Table 2. Student ratings of food quality in school lunch program for each school*

school	N†	food quality ratings		
		almost always good	good some of time	usually not very good
		← % →		
A	8	25.0	50.0	25.0
B	11	18.18	72.73	9.09
C	18	22.22	50.0	27.78
D	12	16.67	66.67	16.67
E	38	31.58	63.16	5.26
mean	87	25.29	60.92	13.79

*Analysis by school: $\chi^2 = 7.63$ df = 8 p = .47.

†N = number of students responding.

Students were asked to react to the repetition of foods served in the school lunch program (Table 3). Over 50% of the students in each school stated that foods were served the right number of times.

Student reasons for eating school lunch are presented in Table 4. In all schools, the majority of students responded that they ate school lunch because they liked the food served. Many of the students ate school lunch

Table 3. Students' assessment by school* of the frequency same foods are served in school lunch

school	N†	frequency		
		too often	right amount	not often enough
		← % →		
A	8	12.50	62.50	25.0
B	11	9.09	72.73	18.18
C	18	22.22	55.56	22.22
D	12	8.33	50.0	41.67
E	38	28.95	57.89	13.16
mean	87	20.69	58.62	20.69

*Analysis by school: $\chi^2 = 7.43$ df = 8 p = .49.

†N = number of students responding.

Table 4. Reasons given by students for eating school lunch for each school

school	N*	reasons for eating school lunch†		
		like the food‡	because friends do#	parents want them to¶
		← % →		
A	6	100	0	0
B	11	81.82	0	54.55
C	16	68.75	18.75	62.50
D	9	55.56	0	44.44
E	38	60.53	15.79	47.37
mean	80	67.50	11.25	47.50

*N = number of students responding.

†Students could respond yes to each, totals do not equal 100%.

‡Analysis by school: $\chi^2 = 5.36$ df = 4 p = .25.

#Analysis by school: $\chi^2 = 4.98$ df = 4 p = .29.

¶Analysis by school: $\chi^2 = 7.13$ df = 4 p = .13.

because their parents wanted them to; whereas, the influence of friends did not appear to be a major factor in their decision.

Student Evaluations

Acceptability Ratings

Student ratings of flavor, appearance, temperature, and serving size for chicken nuggets, broccoli, and tater tots are given in Table 5. Ratings were compared according to type of foodservice system i.e., conventional, satellite, and satellite with finishing kitchen.

Chicken Nuggets. In all systems, chicken nugget flavor was rated as "good," appearance as "so-so," temperature as "too cool," and serving size as "too little." The temperature rating of chicken nuggets was significantly higher for the conventional system than for the satellite system. No other differences as a result of system were indicated. Chi-square analysis of the frequency of student response by school and system is presented in Tables 16-19 in Appendix O.

Broccoli. For the conventional and satellite systems, broccoli flavor was given a rating of "bad" and in the satellite with finishing kitchen was rated as "awful." Broccoli appearance was rated as being "awful" for all three systems. The temperature was "too cool," and the serving size was "just right" for all three systems. The conventional system tended to receive higher ratings for broccoli flavor, appearance, and temperature; whereas, satellite with finishing kitchen received lower ratings with significant differences between the two systems for flavor and temperature. The conventional system wlso was rated significantly higher than satellite with finishing kitchen for temperature. Chi-square analysis of frequency

Table 5. Student ratings of flavor, appearance, temperature, and serving size for each food item according to type of system

food item	system†	flavor	appearance	temperature	serving size
		mean‡ standard error			
chicken nuggets	conventional	4.32 ±.11	3.79 ±.13	1.78 ±.07	1.12 ±.05
	satellite	4.23 ±.11	3.78 ±.13	1.53 ±.07	1.20 ±.05
	satellite with finishing kitchen	4.06 ±.12	3.41 ±.13	1.62 ±.07	1.19 ±.05
broccoli	conventional	2.42 ±.12	1.96 ±.09	1.55 ±.05	2.16 ±.09
	satellite	2.06 ±.12	1.95 ±.08	1.28 ±.04	2.43 ±.08
	satellite with finishing kitchen	1.87 ±.12	1.70 ±.09	1.33 ±.05	2.41 ±.09
tater tots	conventional	4.12 ±.17	3.95 ±.14	1.58 ±.06	1.19 ±.08
	satellite	3.35 ±.17	3.37 ±.14	1.34 ±.06	1.79 ±.07
	satellite with finishing kitchen	3.45 ±.17	3.29 ±.14	1.43 ±.06	1.64 ±.08

†N for conventional varies 61-69, for satellite varies 72-79, for satellite with finishing kitchen varies 69-73.

‡Scale = 1, awful to 5, great for flavor and appearance; 1, too cool to 3, too hot for temperature; 1, too little to 3, too much for serving size.

*$p \leq .05$; **$p \leq .01$; *** $p \leq .001$

of student responses by school and system are presented in Tables 20-23 in Appendix P.

The low ratings for satellite with finishing kitchen may be attributed to a misuse of the system. On some data collection days, food items, especially broccoli, were prepared well in advance of service and held for almost the same length of time as if prepared in the central kitchen.

Head et al. (55) compared student acceptability ratings for entrees, fruits, vegetables, breads and desserts; ratings were lowest for the vegetable group. Also, Harper et al. (2) and Johnson (7) each reported the highest acceptability ratings for food items that had been prepared on-site.

Tater Tots. Tater tot flavor was rated as "good" for the conventional system and as "so-so" for the satellite and satellite with finishing kitchen. For all systems, appearance was rated as "so-so" and temperature as "too cool." The conventional system was rated significantly higher than the satellite and satellite with finishing kitchen for flavor and appearance and significantly higher than the satellite for temperature. Serving size was rated as "too little" for all systems; however, the serving size for the conventional system was rated significantly lower than for the others. Chi-square analysis of the frequency of student response by school and system is presented in Tables 24-27 in Appendix Q.

One possible explanation for the student acceptability scores being highest in the conventional system may be the preparation techniques. In the conventional system, batch cooking techniques were used in the preparation of tater tots and if holding was necessary they were held in the ovens. In the satellite system, tater tots were prepared in the central kitchen and held for approximately two hours in hot carts before

service. In the satellites with finishing kitchens, tater tots were often held for almost an hour in hot carts after preparation. This was not intended since the purpose of finishing kitchens is to reduce holding time.

Familiarity Ratings

Table 6 presents student response to whether or not the food item was included in their family meals. Thirty-seven percent of all students stated that chicken nuggets were included. For both broccoli and tater tots a significant difference was indicated between schools. Students

Table 6. Student response indicating food item is included in family meals for each school

school	food items					
	chicken nuggets*		broccoli†		tater tots‡	
	N#	%	N#	%	N#	%
A	31	64.59	30	62.95	32	53.13
B	28	50.0	28	60.42	29	81.62
C	53	26.43	46	69.34	47	44.73
D	22	24.79	24	70.0	23	25.39
E	61	29.51	54	74.07	56	76.79
overall	195	36.92	182	68.68	187	59.36

*Analysis by school: $\chi^2 = 18.79$ df = 8 p = .02.

†Analysis by school: $\chi^2 = 2.81$ df = 8 p = .95.

‡Analysis by school: $\chi^2 = 34.34$ df = 16 p = .005.

#N = number of students responding.

from school D reported having broccoli and tater tots less often at home than students in the other schools.

Student response to where food items are eaten is presented in Table 7. A significant difference in the response between schools was noted particularly for chicken nuggets and tater tots. School A had the largest number of students indicate chicken nuggets were eaten at home, school, and restaurants while school D had the smallest number responding in this category. Forty percent of the students at school C stated that chicken nuggets were eaten only at school and at school A, 18% gave the same response.

In all schools except B, over one-third of the students indicated they never ate broccoli. School D had the largest number of students indicate they never ate broccoli (51%) and only 19% of the students at school B never ate broccoli.

At school C, 31% of students reported never eating tater tots; whereas in other schools, very few students responded this way. School D had the highest number (67%) state they ate tater tots at school only, and 20% ate them at home, school, and restaurants. School B had the highest number (65%) of students state they ate tater tots at home, school and restaurants.

Presented in Table 8 are the student responses on whether or not they felt like eating school lunch the day of the study. A positive response was given by over 80% of the students in all schools.

Table 7. Student response by school indicating where food item is eaten

food item	school	N*	place where food is eaten							
			home only	school only	restaurants only	home, school and restaurants	home and school	school and restaurants	home and restaurants	never
			%							
chicken nuggets-	A	32	3.13	18.75	-	59.38	6.25	12.5	-	-
	B	30	-	26.25	5.88	49.55	-	18.33	-	-
	C	54	1.85	40.74	12.96	27.78	-	5.56	-	11.11
	D	22	-	30.34	24.04	23.41	-	14.96	3.85	-
	E	61	-	37.7	14.75	24.59	1.64	18.03	1.64	1.64
	mean	199	1.01	33.17	11.56	35.18	1.51	13.07	1.01	3.52
broccoli‡	A	29	-	14.29	-	17.38	34.29	-	-	34.05
	B	30	9.72	10.63	-	36.88	13.63	-	-	19.5
	C	51	19.22	9.96	1.85	19.91	2.04	-	-	46.99
	D	25	8.34	-	-	28.34	8.34	-	3.34	51.67
	E	55	10.91	10.91	-	27.27	16.36	-	-	34.55
	mean	190	11.05	9.47	.53	25.26	15.26	-	.53	37.89
tater tots≠	A	31	-	28.96	-	54.79	6.46	3.34	-	6.46
	B	30	2.94	13.57	-	65.16	14.48	3.85	-	-
	C	48	-	29.22	-	37.39	2.18	-	-	31.22
	D	23	-	66.93	12.69	20.39	3.85	-	-	-
	E	56	1.79	21.43	-	55.36	10.71	1.79	1.79	7.14
	mean	188	1.06	28.72	1.06	48.40	7.45	1.60	.53	11.17

*N = number of student responses.

-Analysis by school: $\chi^2 = 68.41$ df = 56 p = .12.

‡Analysis by school: $\chi^2 = 63.53$ df = 48 p = .07.

≠Analysis by school: $\chi^2 = 86.54$ df = 56 p = .006

Table 8. Distribution of student responses by school* to question "Did you feel like eating today"

school	N†	yes	no
		← % →	
A	31	80.63	19.38
B	29	81.62	18.38
C	54	87.04	12.97
D	22	92.31	7.69
E	62	91.94	8.06
overall	198	87.37	12.63

*Analysis by school: $\chi^2 = 7.04$ df = 8 p = .53.

†N = number of students responding.

Sensory Evaluation

Sensory evaluation scores for each food item were analyzed by type of foodservice system and are shown in Table 9. The sensory panel used an unstructured line scale for rating the intensity of each sensory characteristic. Temperatures of the food items were also taken at the time of the evaluation. For tater tots, a significant difference was noted in temperature between the conventional system and the satellite system. No other significant differences in sensory ratings related to type of foodservice system were indicated for any of the food products. High variability of scores in each school and system on the days of data collection was evident. Tables 28-30 in Appendix R show the sensory ratings for each day of the study. This variability in scores may be attributed to a variation in products within each school and between schools. Holding times varied

Table 9. Mean sensory rating and temperature for food items by type of system

food items	system	number visits	number observations	sensory characteristics			
				coating crispness	tenderness	moistness	temperature+ °C
				mean‡ standard error			
chicken nuggets	conventional	2	5	5.06 ±2.74	12.08 ±1.55	11.03 ±1.71	58.28 ±11.0
	satellite	8	20	7.95 ±1.37	10.27 ± .77	10.05 ± .86	43.67 ±5.48
	satellite with finishing kitchen	8	18	8.90 ±1.38	9.95 ± .79	9.71 ± .87	53.10 ±5.49
				purity of green	firmness		
				mean‡ standard error			
broccoli	conventional	2	5	6.15 ±3.57	7.70 ±3.21		51.99 ±5.54
	satellite	8	20	5.32 ±1.78	6.41 ±1.61		47.51 ±2.76
	satellite with finishing kitchen	8	18	8.39 ±1.79	7.50 ±1.61		42.82 ±2.79
				crispness			
				mean‡ standard error			
tater tots	conventional	2	5	9.81 ±2.25			48.36 ± 4.40
	satellite	8	20	5.40 ±1.12			* 34.60 ± 2.20
	satellite with finishing kitchen	8	18	6.90 ±1.13			39.21 ±2.21

+Temperature taken at time of sensory evaluation.

‡Scale = 0, lowest to 15, highest intensity.

*$p \leq .05$

widely, the product produced was not uniform and the sensory panel was able to detect differences. Tables 31-33 in Appendix T shows holding times for each day of the study.

These results differ somewhat from the findings of Al-Obaidy (34), Bobeng and David (32), Cremer (33), and Klein et al. (12) in which sensory quality of freshly prepared food items was rated higher than that of those held hot or reheated after cold holding.

Chicken nugget sensory ratings varied from one data collection day to another (Table 28 in Appendix R). On one day of sensory evaluation in the conventional system, the chicken nuggets were prepared in advance, covered with a damp towel, and held in a hot cart until serving time. This resulted in a low rating for coating crispness on that day. On some days, chicken nuggets in the satellites with finishing kitchens received low ratings which may be attributed to a misuse of the system. On these days, food items were prepared early, instead of being prepared immediately before service, and held for almost the same amount of time as if cooked in the central kitchen. Time-temperature data for chicken nuggets by day of study is shown in Table 31, Appendix T.

Purity of green color and firmness of broccoli ratings tended to be lower for the satellite system although no significant difference was indicated between systems. These low broccoli quality scores in the satellite system support the findings of Hill (41) that hot-holding is destructive to vegetable quality. Table 29 (Appendix R) shows sensory ratings for broccoli according to day of study.

Crispness of tater tots tended to be rated higher in the conventional system than in the other systems although no significant difference between systems was indicated. Temperatures at the time of the sensory

evaluation were significantly higher for the conventional system than the satellite system. Karlstrom and Jonsson (31) reported that the sensory attributes of potatoes can be greatly affected by hot-holding. Table 30 (Appendix R) shows sensory ratings for tater tots according to day of study.

Time-Temperature Relationships

Time-temperature relationships from end of production to end of service by food items and by system are shown in Table 10. Figures 1-3 in Appendix S are graphical representations of the same data.

For all food items, temperatures were highest for the conventional system and holding times were longest for the satellite system. Temperature of chicken nuggets and tater tots were lowest in the satellite system. Temperatures of food items at the beginning of service in the satellite system were consistently at or below the standard of 60°C and by end of service in all systems were at or below the standard. Jansen and Harper (6) stated that food at proper temperatures would be better consumed, and of higher nutritional quality and safer from a microbiological standpoint. Also, Bryan (38) reported that most foods should be heated to 60°C or higher before being put into hot holding devices, and as soon as temperatures fall below 55°C should be served, chilled, or reheated.

Tables 31-33 in Appendix T show time-temperature data by day of study. The primary concern was the variability in holding time within a given type of system. For each food product, the holding times often varied by as much as one hour. For chicken nuggets (Table 31) in the satellite system, the variation in holding time was 95 minutes and in the

Table 10. Time-temperature relationship from end of production to end of service for each food item according to type of system†

food item	system	N‡	temperature °C end production	temperature °C begin service	holding time (min)# begin service	temperature °C end service	holding time (min)# end service
			mean standard error				
chicken nuggets	conventional	2	80.5 ±4.50	64.5 ±4.23	45.0 ±14.17	53.0 ±6.24	117.5 ±24.26
	satellite	8	70.0 ±2.25	52.6 ±2.11	138.13 ±7.08	47.6 ±3.12	174.5 ±12.13
	satellite with finishing kitchen	8	80.6 ±2.25	64.5 ±2.11	52.5 ±7.08	55.8 ±3.12	100.13 ±12.13
broccoli	conventional	2	70.5 ±6.61	71.5 ±5.18	45.0 ±8.61	58.5 ±7.27	117.5 ±22.10
	satellite	8	64.8 ±3.30	59.8 ±2.59	134.0 ±4.31	53.38 ±3.64	169.13 ±11.05
	satellite with finishing kitchen	8	63.6 ±3.30	59.0 ±2.59	45.75 ±4.31	52.38 ±3.64	93.38 ±11.05
tater tots	conventional	2	66.0 ±7.20	74.5 ±5.44	42.5 ±11.08	60.5 ±5.20	116.0 ±24.35
	satellite	8	60.5 ±3.60	50.0 ±2.72	136.9 ±5.54	44.0 ±2.60	171.63 ±12.18
	satellite with finishing kitchen	8	75.9 ±3.60	60.75 ±2.72	31.63 ±5.54	44.75 ±2.60	79.25 ±12.18

†Information graphically shown in Figure 1 in Appendix S.

‡N = number of observations.

#Holding time is minutes from end of production.

*p ≤ .05; **p ≤ .01; ***p ≤ .001

satellite with finishing kitchen, the variation was 79 minutes. Results were similar for both broccoli (Table 32) and tater tots (Table 33). In some instances, holding times for the satellite with finishing kitchen were as long as those in the satellite system. In satellites with finishing kitchens, holding time should be reduced because food items are prepared on-site. A possible reason for misuse of the system may be that the finishing kitchens were available only for a short period of time (approximately 6 months) and employees were not thoroughly familiar with the correct usage of equipment.

The wide range in temperatures and holding time between schools and systems suggests the need for stricter controls to ensure the shortest possible holding times and appropriate temperatures. Cichy (39) reported that quality of food products can be negatively affected through inadequate time-temperature control. Bobeng and David (14) reported that long exposure to high temperatures lead to a decrease in quality of food items. Bengtsson and Dagersbog (43) reported that quality losses can be lessened by reducing hot-holding time.

Plate Waste Data

The mean serving size for each school is shown in Table 11. No significant differences were found between serving sizes at the various schools for any of the food items. School B had the largest serving size for chicken nuggets and school A had the largest serving sizes for both broccoli and tater tots. Data from school D, could not be used because of family style service.

Mean plate waste for each food item by type of system is shown in Table 12. Plate waste was negligible for chicken nuggets and tater tots

Table 11. Mean serving size in pounds for each food item by school*

school	food item		
	chicken nuggets	broccoli	tater tots
	mean pounds† standard error		
A	.115 ±.007	.103 ±.012	.094 ±.010
B	.120 ±.007	.073 ±.012	.084 ±.010
C	.110 ±.007	.088 ±.012	.086 ±.010
E	.114 ±.007	.078 ±.012	.083 ±.010
average	.115 ±.007	.086 ±.012	.087 ±.010

*Serving size could not be accurately obtained for school D because of family style service.

†Based on 10 servings at school E, conventional system, and 20 servings at all others.

Table 12. Mean plate waste for each food item by type of system†

system	N‡	food item		
		chicken nuggets	broccoli	tater tots
		mean pounds/student standard error		
conventional	68	.000 ±.0004	.028 ±.008	.002 ±.002
satellite	61	.002 ±.0004	.060 ±.008	.010 ±.002
satellite with finishing kitchen	61	.001 ±.0004	.053 ±.008	.004 ±.002

*

†School D not included in analysis because plate waste could not be accurately measured.

‡N = number of student trays scraped.

*$p \leq .05$

in all three systems. For chicken nuggets and tater tots, plate waste was significantly lower in the conventional system than in the satellite system. Broccoli waste per student was greater than 50% of the average serving size for the satellite system and the satellite with finishing kitchen. Broccoli waste in the conventional system was significantly lower than in either the satellite system or the satellite with finishing kitchen.

Lilly et al. (1) and Johnson (7) separately reported that type of foodservice system had an effect on plate waste, and waste is less in on-site preparation systems. Head et al. (5), Jansen and Harper (6) and Johnson (7) have all indicated that consumption and acceptability ratings are related. Also, they reported that type of foodservice system affects

acceptability. High broccoli waste may support the findings of Head et al. (55) in which students gave vegetables the lowest acceptability ratings of all food groups evaluated including entrees, bread, desserts, fruit, vegetables, and milk.

Correlations of Data

Correlations were computed for plate waste data, time-temperature relationships, sensory ratings, and student ratings for each of the food items as shown in Tables 13 to 15. According to Falkner (65), correlation coefficients of 0.00 to 0.39 are classified as low, 0.40 to 0.79 as moderate, and 0.80 and above as high.

Chicken Nuggets

Results of the correlation analysis for chicken nuggets are shown in Table 13. A high correlation ($r = .85$) was found between the holding time to end of service and the holding time to beginning of service. Such a relationship is not surprising since both holding times were measured from the end of production. Moderate correlations were denoted for temperature at sensory evaluation and temperatures at beginning ($r = .64$) and end of service ($r = .59$). Sensory ratings on the tenderness and moistness of chicken nuggets, were also positively correlated ($r = .67$), suggesting that the perceived tenderness of the product improved as moistness increased. Also, a moderate correlation ($r = .69$) was indicated between student ratings on appearance and flavor of the chicken nuggets.

Broccoli

Correlation coefficients for broccoli are shown in Table 14. As with the chicken nuggets, a high correlation ($r = .84$) was found between

Table 13. Correlations of plate waste, time-temperature relationships, sensory ratings, and student ratings for chicken nuggets

	plate waste	temperature °C			holding time to†		sensory ratings				student ratings			
		end production	begin service	end service	begin service	end service	temperature	moistness	tenderness	coating crispness	flavor	appearance	temperature	serving size
plate waste														
temperature end of production	-.55*													
temperature begin service	.24	.13												
temperature end service	-.05	.13	.62*											
time begin service	.31	-.62*	-.54	-.47*										
time end service	.46*	-.63*	-.29	-.44	.85*									
temperature at sensory evaluation	-.04	.22	.62*	.64*	-.59*	-.43								
moistness	-.06	-.13	.20	-.18	.02	.08	.14							
tenderness	-.30	-.10	.23	.21	-.10	.04	.46*	.67*						
coating crispness	-.02	.10	.14	.25	.05	.06	-.07	.05	-.03					
flavor	-.40	.41	.33	.26	.01	.09	.06	.25	.06	.05				
appearance	-.20	.10	-.31	-.25	.14	.13	.09	.32	.32	.09	.68*			
temperature	.004	.21	.09	.31	-.42	-.23	.56*	-.12	.30	-.17	.11	.20		
serving size	.41	-.49*	.21	.25	.008	.09	.37	.34	.39	.33	-.22	.15	.27	

†Holding time is from end of production.

*Correlations significant at p = .05

Table 14. Correlations of plate waste, time-temperature relationships, sensory ratings, and student ratings for broccoli

	plate waste	temperature °C			holding time to†		sensory ratings			student ratings			
		end production	begin service	end service	begin service	end service	temperature	purity of green color	firmness	flavor	appearance	temperature	serving size
plate waste													
temperature end production	-.07												
temperature begin service	-.22	.35											
temperature end service	-.50*	.15	.09										
time begin service	.02	-.10	.03	.02									
time end service	.04	.06	.31	-.18	.84*								
temperature at sensory evaluation	-.47*	.23	.57*	.23	.37	.32							
purity of green color	.15	-.29	-.40	-.52	-.40	-.25	-.30						
firmness	.30	-.36	-.43	-.51*	-.30	-.24	-.43	.78*					
flavor	.13	.16	-.11	.02	-.02	-.13	.23	-.20	.09				
appearance	-.03	-.21	-.26	.06	.28	.16	.31	-.07	-.05	.68*			
temperature	.19	.28	.27	-.02	.22	-.17	.26	.16	.21	.41	-.05		
serving size	.43	-.18	-.10	-.38	.11	.21	-.37	.33	.25	-.55*	-.31	-.37	

†Holding time is from end of production.

*Correlations significant at $p \leq .05$.

the holding time to end of service and the holding time to beginning of service for broccoli. Moderate correlations ($r = .78$) were indicated between the sensory ratings for purity of green color and firmness of broccoli. Such a finding is not surprising given the loss of color and softening of texture which occurs in broccoli when it is cooked for too long a time. Student ratings of flavor and appearance were also moderately correlated ($r = .68$).

Tater Tots

Correlation coefficients for tater tots are shown in Table 15. A moderate correlation ($r = .76$) was found between the crispness of tater tots and the temperature at the beginning of service. Moderate correlations ($r = .65$) were indicated for temperature at beginning and end of service. Student temperature ratings were moderately correlated with ratings of flavor ($r = .72$) and appearance ($r = .63$). A high ($r = .84$) correlation was noted between student ratings of appearance and flavor for the tater tots which emphasizes the importance of visual presentation.

Correlations between student acceptability ratings of flavor and appearance for all three food items may suggest a possible relationship between these factors. Since a low correlation was evident between some student acceptability ratings and sensory ratings, a relationship may exist between the sensory quality of food and student acceptability. Jansen and Harper (6) reported that food served at proper temperature with good color, texture, and flavor would be better consumed. Also, Zacharias (53) reported that student acceptance of meals depends to a decisive degree on sensory value, particularly upon taste, texture, and appearance. A possible relationship may exist between temperature and sensory quality. Bengtsson and Dagersbog (43), Bobeng and David (14, 32)

Table 15. Correlations of plate waste, time-temperature relationships, sensory ratings, and student ratings for tater tots

	plate waste	temperature °C			holding time to†		sensory rating		student rating			
		end production	begin service	end service	begin service	end service	temperature	crispness	flavor	appearance	temperature	serving size
plate waste												
temperature end production	-.28											
temperature begin service	-.62*	.05										
temperature end service	-.32	-.35	.65*									
time begin service	.50*	-.62*	-.58*	-.27								
time end service	.18	-.48	-.33*	-.13	.86*							
temperature at sensory evaluation	-.64*	.32	.72*	.30	-.53*	-.30						
crispness	-.15	.01	.76*	.44	-.37	-.24	.62*					
flavor	-.56*	.006	.55*	.42	-.24	-.13	.46	.31				
appearance	-.37	-.10	.43	.46	-.14	-.23	.30	.33	.84*			
temperature	-.52*	.11	.55*	.41	-.34	-.19	.50*	.51*	.72*	.63*		
serving size	.48*	.02	-.63*	-.57*	.27	.12	-.58*	-.56*	-.48*	-.58*	-.53*	

†Holding time is from end of production.

*Correlations significant at $p \leq .05$.

as well as Klein et al. (12) stated that temperature at which foods are held and length of holding time will affect sensory quality of food items.

SUMMARY AND CONCLUSIONS

Acceptability of foods served in the school lunch program affect the nutritional contribution of the school lunch to the student. The purpose of this research was to evaluate the effect of the type of school food-service system on acceptability. Objectives were to determine if type of system influences student acceptability of food items as measured by plate waste and student ratings; to determine if quality characteristics, as measured by a professional sensory panel, are affected by type of system and therefore influence acceptability, and to relate time-temperature data to sensory qualities and student ratings.

The study was conducted in five elementary schools, one with conventional foodservice and four satellites equipped with finishing kitchens. Chicken nuggets, broccoli, and tater tots were the food items evaluated twice at the conventional foodservice and on four separate occasions in the satellite kitchens. All food items were purchased frozen and twice were delivered to the satellites from the central kitchen heated to serving temperature and twice frozen for heating in the satellite finishing kitchens.

The same food items were evaluated each day of the study using four types of data: student evaluations, sensory panel evaluations, time-temperature analysis, and aggregate plate waste. Students in the sixth grade participated in the study. Student evaluation forms for completion after eating were distributed to students. A trained and experienced sensory panel evaluated quality characteristics for each of the food items at two schools on each data collection day. Time-temperature data for

analysis were recorded at various points from end of production to end of service for each food item. Aggregate plate waste determination involved finding the average weight of five servings followed by collecting waste from trays by separate food items for weighing.

In all systems, students rated acceptability of chicken nugget flavor as "good," appearance as "so-so," temperature as "too cool," and serving size as "too little." The temperature rating of chicken nuggets was significantly higher for the conventional system than for the satellite system. No other differences as a result of system were indicated.

Student acceptability ratings of broccoli were "bad" for flavor in the conventional and satellite systems and "awful" in the satellite with finishing kitchen, and "awful" for appearance, "too cool" for temperature, and "just right" for serving size for all three systems. The conventional system tended to receive the highest ratings for flavor, appearance, and temperature; whereas, satellite with finishing kitchen received the lowest ratings with significant differences between the two systems for flavor and temperature. Also, the temperature was rated significantly higher in the conventional system than in the satellite system.

Tater tot flavor was rated as "good" for the conventional system and as "so-so" for the satellite and satellite with finishing kitchen. For all systems appearance was rated as "so-so" and temperature as "too cool." The conventional system was rated significantly higher than the satellite and satellite with finishing kitchen for flavor and appearance, and significantly higher than the satellite system for temperature.

Sensory panel ratings for coating crispness, tenderness and moistness of chicken nuggets, purity of green color and firmness of broccoli, and crispness of tater tots showed no significant difference between the three

systems. For temperatures taken at sensory evaluation, a significant difference was found for tater tots between the conventional and satellite systems. A high degree of variability of scores from one data collection to another was noted in all schools. No one school or system consistently had higher ratings than the others. This variability may be attributed to a variation in product within each school and between schools. Holding times varied widely, thus product produced was not uniform.

Temperatures were highest for the conventional system for all food items; whereas, the satellite system had the longest holding times. For chicken nuggets and tater tots, the satellite system had the lowest temperatures. In most cases, the mean temperatures at the beginning of service were at or below 60°C for the satellite and satellite with finishing kitchen. At the end of service, the mean temperatures in all three systems were at or below 60°C.

Plate waste was negligible for chicken nuggets and tater tots in all three systems, but was significantly lower in the conventional system than in the satellite. Broccoli waste per student was greater than 50% of the average serving size for the satellite system and the satellite with finishing kitchen. Broccoli waste in the conventional system was significantly lower than waste in the satellite or satellite with finishing kitchen.

Correlation coefficients for student ratings of flavor and appearance were positive and ranged from .68 for broccoli, .69 for chicken nuggets, and .84 for tater tots. For tater tots, correlations between student ratings for temperature and flavor were .72 and for appearance .63.

Correlations for all three food items suggest a possible relationship between student acceptability ratings of flavor and appearance, and also,

between temperature of food items and acceptability. Also, a possible relationship may exist between temperature and sensory quality of the food items. Since a low correlation was found between student acceptability ratings of flavor and appearance and some of the sensory ratings, a relationship may exist between sensory quality and student acceptability. A higher correlation between sensory and student acceptability ratings could be obtained by developing the sensory score card based on a series of student acceptability ratings indicating high and low quality of food items.

The purpose of the finishing kitchen is to reduce holding time since equipment is available to prepare food items, such as frozen chicken nuggets, tater tots, and vegetables, just before serving. Time-temperature data and observations indicate that the finishing kitchens were not used properly. Food items often were prepared long before serving time instead of just prior to service. The satellite with finishing kitchen, when used properly, can produce food items of good quality and high acceptability. This is shown by high sensory scores on days when holding time was relatively short in the satellite with finishing kitchen.

Sensory evaluation by an expert panel is an objective means of measuring the quality of food items served in school foodservice. Large deviations of time-temperature data and sensory ratings were found within each school and between schools, thereby potentially masking difference between systems. Because the variability may have resulted from the use of improper preparation techniques, training of employees in preparation techniques may be indicated. Additional research is needed to assess whether proper preparation techniques would improve the quality of food served in three types of foodservice systems.

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APPENDIXES

APPENDIX A

Data Collection Schedule

KANSAS STATE UNIVERSITY

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA COLLECTION SCHEDULE

Date	Schools	Treatment
April 1	Northview	conventional
	Bluemont	satellite with finishing kitchen
	Theodore Roosevelt	satellite with finishing kitchen
April 11	Bluemont	satellite
	Eugene Field	satellite with finishing kitchen
	Woodrow Wilson	satellite with finishing kitchen
	Theodore Roosevelt	satellite
May 6	Woodrow Wilson	satellite
	Eugene Field	satellite
	Theodore Roosevelt	satellite with finishing kitchen
	Bluemont	satellite with finishing kitchen
May 15	Northview	conventional
	Theodore Roosevelt	satellite
	Eugene Field	satellite with finishing kitchen
	Woodrow Wilson	satellite
May 23	Bluemont	satellite
	Woodrow Wilson	satellite with finishing kitchen
	Eugene Field	satellite

APPENDIX B

Sensory Panel Schedule

SCHOOL FOODSERVICE QUALITY STUDY

SENSORY PANEL SCHEDULE

Date	Panel	School 1	School 2
April 1	Sanner Colley	Theodore Roosevelt (11:3S - 12:20)	Bluemont (11:35 - 12:15)*
	Smith Vacin	Northview (11:35 - 12:3S)	
April 11	Sanner Colley	Woodrow Wilson (11:30 - 12:20)	Theodore Roosevelt (11:35 - 12:20)
	Smith Vacin	Bluemont (11:40 - 12:20)	Eugene Field (11:30 - 12:15)
May 6	Smith Sanner	Theodore Roosevelt (11:3S - 12:20)	Bluemont (11:3S - 12:15)
	Colley Vacin	Woodrow Wilson (11:30 - 12:20)	Eugene Field (11:30 - 12:15)
May 1S	Sanner Vacin	Eugene Field (11:30 - 12:15)	Woodrow Wilson (11:30 - 12:20)
	Smith Colley	Theodore Roosevelt (11:35 - 12:20)	Northiview (11:35 - 12:3S)
May 23	Smith Vacin	Bluemont (11:3S - 12:1S)	Woodrow Wilson (11:30 - 12:20)
	Sanner Colley		Eugene Field** (11:30 - 12:1S)

*End of service times will vary from what is stated so try to be to the second school 10 minutes before they are through serving.

** Taste at this school at the same time as if you had gone to another school first.

APPENDIX C

Human Subjects Committee Application

APPLICATION FOR APPROVAL TO USE HUMAN SUBJECTS

1. ACTIVITY OR PROJECT TITLE: Evaluation of Alternative School Foodservice Systems as Measured by Student and Expert Sensory Panel Ratings, Plate Waste, and Time-Temperature Data

2. PROPOSED SPONSOR (IF ANY):

Agricultural Experiment Station

3. Dr. Marian Spears (NAME (applicant must be faculty member)) | Dietetics, Restaurant and Institutional Management (DEPARTMENT) | 532-5521 (PHONE)

4. RISK

A. Are there risks to human subjects? _____yes ___X___no

If yes, briefly describe. (See definition of risk, page 2 of the Handbook.)

B. Describe the benefits of the research

a) to the subjects: Improved quality and acceptability of food served in the School Lunch Program.

b) to the discipline/profession: The evaluation of the effects of various types of foodservice delivery systems on the quality of food served in School Lunch Programs. The results will help in decision making in the selection of the type of system to be used in schools.

5. INFORMED CONSENT: General informed consent requirements are described on pages 3 and 4 of the Handbook. The written informed consent document must include the following: (1) a fair explanation of procedures to be followed, (2) description of discomforts and risks, (3) description of benefits, (4) disclosure of appropriate alternatives available, (5) an offer to answer inquiries, and (6) instructions that the subject is free to withdraw consent and participation at any time. Special informed consent policies relative to questionnaire/survey studies are described in the "Handbook Supplement" dated July, 1977.

On what page(s) of the proposal are your informed consent procedure and/or forms described? (If not a part of your proposal, the procedures and informed consent document must accompany this application.)

pages 4,10, and 11.

(OVER)

6. EMERGENCIES

A. Are any possible emergencies anticipated? _____yes ___X___no

If yes, describe briefly or give the page of the proposal where these are described.

B. Describe procedures for dealing with emergencies, or give the page of the proposal on which these descriptions may be found.

7. PRIVACY: On what page of the proposal do you discuss procedures for keeping research data private? 10 This should include procedures for maintaining anonymity of subjects. Supplemental information concerning privacy of data may be discussed below. (See page 3 of the Handbook on "Safeguarding Information.")

The names of students will not be used only identification numbers.

8. STATEMENT OF AGREEMENT: The below named individual certifies that he/she has read and is willing to conduct these activities in accordance with the Handbook for Research, Development, Demonstration, or Other Activities Involving Human Subjects. Further, the below named individual certifies that any changes in procedures from those outlined above or in the attached proposal will be cleared through Committee 8290, The Committee on Research Involving Human Subjects via the College of Home Economics Subcommittee.

Signed Marian C. Spears (Applicant) Date February 20, 1985

Send applications to:

APPENDIX D

Letter to Dean of College of Education

(KSU Letterhead)

February 18, 1985

Dr. David R. Byrne
Dean, College of Education
Bluemont Hall, Room 006
Kansas State University
Manhattan, KS 66506

Dear Dr. Byrne:

We are seeking your approval of a research project funded by the Agricultural Experiment Station concerning the acceptability of food served in the School Lunch Program in USD 383. Acceptance and consumption of foods affect the nutritional contribution of the school lunch to the student. In cooperation with Mrs. Sue Greig, District Director of Foodservice, we would like to collect data in the elementary schools to determine the acceptability and quality of foods served in the School Lunch Program. This study will provide information regarding food prepared on-site in Lee and Northview schools and in Bluemont, Eugene Field, Theodore Roosevelt, and Woodrow Wilson schools with food transported from the Middle or High School.

The fourth grade classes have been selected to participate in the study. Acceptance will be measured by plate waste and a student evaluation of the menu items. Several quality characteristics that may affect acceptability will be assessed by a trained sensory panel. Time-temperature data will also be recorded. Food temperatures will also be taken at the Middle and High Schools prior to the transportation of the food.

Plate waste will be measured by the research team after the students have finished eating. This will involve weighing of the leftover foods from the students' trays in the foodservice area. Following the lunch period the students will be asked to complete a short evaluation form (copy enclosed). This should take no more than five minutes of classroom time.

We would like to conduct a pilot study in two of the schools during the first week of March (March 4-8) to train the research assistants on plate waste and temperature assessment techniques. The students will not be asked to evaluate the food at this time.

We plan to conduct the study during the first two weeks of Aoril (April 1-12) and the first three weeks in May (May 6-24). Data will be collected four times over a five week period at all schools except Lee and Northview where it will be collected twice.

We need your approval of the enclosed project proposal as soon as possible to allow for a reply from Dr. Hal Rowe, Superintendent of USD 383. The project if approved will be presented to the principals at their meeting February 27, 1985. If you have any questions, you may reach us at 532-5521. Thank you for taking the time to review this project.

Sincerely,

Della M. Rieley

Della M. Rieley, R.D.
Graduate Research Assistant

Marian C. Spears

Marian C. Spears, Ph.D., R.D.
Professor and Department Head

enclosure

cc Dr. Hal Rowe
Mrs. Sue Greig

APPENDIX E

Letter to Parent or Guardian and Parental and Student Consent Forms

(KSU Letterhead)

Dear Parent or Guardian and Student:

Your school has been selected to participate in a research study comparing the acceptance and quality of menu items in schools where food is prepared on-site and in those with food transported from the Middle or High School. The department of Dietetics, Restaurant and Institutional Management in cooperation with the USD 383 foodservice will collect data using student evaluations, plate waste, and sensory panel evaluations. This project has been approved by the superintendent of your school district, the school principal, and the District Foodservice Director.

Students in the sixth grade in each selected school will be asked to complete an evaluation form on how they feel about the taste, appearance, temperature, and the amount served of the selected menu items. The students will complete the form in the lunchroom after they have eaten. This will take no more than five minutes. Data will be collected four nonconsecutive days at each school, except Lee and Northview where data will be collected only on two nonconsecutive days.

All information will be kept confidential with responses identified by number only. We hope that all students will take part in the study; however participation is voluntary. The student may refuse to participate or discontinue participation at any time with no penalty.

Information gained from this study will be useful to the District Director of Foodservice, USD 383, and eventually to the students in the district. Results from this study also will be helpful to other school districts in Kansas and in other states.

Please indicate your willingness to take part in the study by completing the attached form and returning it to the classroom teacher by March 22. Parent and student must both give consent before the student can participate in the study. If you have any questions regarding the research please contact Della Rieley (532-5521). Thank you for your cooperation.

Sincerely,

Della M. Rieley

Della M. Rieley, R.D.
Graduate Research Assistant

Marian C. Spears

Marian C. Spears, Ph.D., R.D.
Professor and Department Head

Parental Consent

I have read the description of the research study and:

(Please check one)

_____ I give permission for _____ to participate
(child's name)
in the school lunch study.

_____ I do not give permission for _____ to participate
(child's name)
in the school lunch study.

_____
(signature of parent or guardian)

_____
(date)

Student Consent

I have read or have had read to me the description of the research study and:

(Please sign your name after one sentence)

I will take part in this study. _____ _____
(signature of student) (date)

I will not take part in this study. _____ _____
(signature of student) (date)

Please return to your teacher by March 22.

APPENDIX F

Student Demographic Information Card

GENERAL INFORMATION

School_____ Date_____ ID#_____

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 cards.

APPENDIX G

Student Evaluation Cards

(Student Score Card for Chicken Nuggets)

STUDENT EVALUATION

School_____ Date_____ ID#_____

Place an "X" under the word that best describes how you feel about the CHICKEN NUGGETS today.

	GREAT	GOOD	SO-SO	BAD	AWFUL
TASTE					
LOOKS					

	TOO HOT	JUST RIGHT	TOO COOL
TEMPERATURE			

	TOO MUCH	RIGHT AMOUNT	TOO LITTLE
AMOUNT			

Please CIRCLE the correct response below:

1. Do your family meals include CHICKEN NUGGETS YES NO
2. Do you eat CHICKEN NUGGETS ONLY at HOME ONLY at SCHOOL ONLY at RESTAURANTS AT all THREE NEVER
3. Did you feel like eating today YES NO

(Student Score Card for Broccoli)

STUOENT EVALUATION

School_____ Date_____ IO#_____

Place an "X" under the word that best describes how you feel about the BROCCOLI today.

	GREAT	GOOD	SO-SO	BAO	AWFUL
TASTE					
LOOKS					

	TOO HOT	JUST RIGHT	TOO COOL
TEMPERATURE			

	TOO MUCH	RIGHT AMOUNT	TOO LITTLE
AMOUNT			

Please CIRCLE the correct response below:

1. Oo your family meals include BROCCOLI YES NO
2. Do you eat BROCCOLI ONLY at HOME ONLY at SCHOOL ONLY at RESTAURANTS AT all THREE NEVER

(Student Score Card for Tater Tots)

STUDENT EVALUATION

School_____ Date_____ ID#_____

Place an "X" under the word that best describes how you feel about the TATER TOTS today.

	GREAT	GOOD	SO-SO	BAD	AWFUL
TASTE					
LOOKS					

	TOO HOT	JUST RIGHT	TOO COOL
TEMPERATURE			

	TOO MUCH	RIGHT AMOUNT	TOO LITTLE
AMOUNT			

Please CIRCLE the correct response below:

1. Do your family meals include TATER TOTS YES NO
2. Do you eat TATER TOTS ONLY at HOME ONLY at SCHOOL ONLY at RESTAURANTS AT all THREE NEVER

APPENDIX H

Sensory Score Card

(score card reduced 88%)

SCHOOL FOODSERVICE QUALITY STUDY

Sensory Evaluation
Score Card

Date_____

Name_____ School_____.

Please indicate the intensity of each characteristic of the three samples. Mark with a perpendicular line.

CHICKEN NUGGETS ____°C

Moistness:

Very dry ——— Very moist

Tenderness:

Very tough ——— Very tender

Outer Coating:

Not very crisp ——— Very crisp

Comments:

BROCCOLI ____°C

Purity of Green:

Extremely dull ——— Extremely bright

Firmness:

Very mushy ——— Very firm

Comments:

TATER TOTS ____°C

Crispness:

Very soggy, limp ——— Very crisp

Comments:

APPENDIX I

Time-Temperature Record Forms

TIME AND TEMPERATURE RECORD (for On-Site preparation or satellite with finishing kitchen)

Date_____ School_____ Type of Service_____

TEMPERATURE °C

	TIME	CHICKEN NUGGETS	BROCCOLI	TATER TOTS
End of production				
Beginning of Service				
Between Lunch Periods#				
When first 6th grader is served*				
When last 6th grader is served**				
End of Service				

#At Northview there are three lunch periods so the temperatures need to be taken at both breaks.

*Depending on the school the 6th graders may be served before or after the break between lunch periods.

**If the 6th graders are the last class to be served then this time will be the same as end of service.

TIME AND TEMPERATURE RECORD (for satellite kitchen)

Date_____ School_____ Type of Service_____

		TEMPERATURE °C		
	TIME	CHICKEN NUGGETS	BROCCOLI	TATER TOTS
End of production (when food is placed in hot cart for satellite system)#				
Shipped to satellite				
Arrival at satellite				
Beginning of service				
Between lunch periods				
When first 6th grader is served*				
When last 6th grader is served**				
End of service				

#End of production and when item is shipped to satellite may be the same.

*Depending on the school the 6th graders may be served before or after the break between lunch periods.

**If the 6th graders are the last class to be served then this time will be the same as end of service.

APPENDIX J

Plate Waste Record Form

PLATE WASTE RECORD

Date_____ School_____ Type of service_____

WEIGHTS OF 5 SERVINGS (minus container weight):

Chicken Nuggets: _____

weight/5 = _____ = average weight of 1 serving

Tater Tots:_____

weight/5 = _____ = average weight of 1 serving

Broccoli:_____

weight/5 = _____ = average weight of 1 serving

WEIGHTS OF PLATE WASTE

FOOD ITEM	WEIGHT OF CONTAINER	WEIGHT OF CONTAINER AND WASTE	TOTAL WASTE
Chicken Nuggets	_____	_____	_____
Broccoli	_____	_____	_____
Tater Tots	_____	_____	_____

NUMBER OF STUDENTS' TRAYS _____

APPENDIX K

Data Collection Procedures and Schedule

(KSU Letterhead)

MEMO TO: (Research Coordinators)

FROM: Della Rieley

RE: School Foodservice Quality Study

Attached you will find instructions for collecting data, a schedule of data collection days and where you will be, addresses of the schools, and samples of the forms to be used.

On the days data is collected you will be required to wear a hair net. Please provide your own. Also, on these days wear washable clothes.

On data collection days you will be responsible for the following:

1. Taking the containers for the plaste waste and for the 5 servings to the school.
2. Taking the sign to the school.
3. Taking the plate waste and time-temperature forms, and the thermometer to the school.
4. Taking gloves, scrapers, containers for taking temoeratures, cups for the sensory panel, and paper towels to the school.
5. Taking the evaluation forms for the students, and the box to collect the forms in.
6. Helping the plate waste collectors set up table
7. Making sure the table and chairs for the taste panel are set up, and there are cups of water on the table.
8. Making sure the containers and forms are brought back to Justin 111, and that the forms are placed with the containers.
9. Bringing back the sign
10. Bringing back the student evaluation forms

If you have any questions regarding the procedures, please feel free to ask any time.

Thank you for your help with this study.

(KSU Letterhead)

MEMO TO: (Research Assistants)

FROM: Della Rieley

RE: School Foodservice Quality Study

Attached you will find instructions for collecting plate waste, a schedule of the times, schools, and days you are scheduled to help with the study, and addresses of the schools.

On the days you will be helping to collect data, you will be required to wear a hair net. Also wear clothes that are washable. It is important that you arrive at the school on time. When you get to the school, ask at the office how to get to the kitchen. Everything that you will need for collecting data will be at the school when you arrive. Either Patti, Linda, Janet or myself will already be at each school, we will instruct you in how to help set up and we will also help with the collection of the plate waste.

If you have any questions regarding the procedures, please feel free to ask any time.

Thank you for your help with this study.

Instructions for Collecting Time-Temoerature data

The research assistant who will be taking the temperatures (Patti, Linda, Janet and Della) of the menu items will also help with the plate waste. Five of the servings used to take the temperatures will also be weighed to obtain an average serving size weight.

When taking temperatures, first, ask the server for a serving of chicken nuggets. Have her put the serving in the small container you have. Do not go through the line, have the server give you the serving from behind the counter. Take and record the temperature IMMEDIATELY. After the temperature has been recorded on the green time-temperature data form, place the serving in the labeled container so htat the average serving size weight can be obtained. Repeat this process for the tater tots and the broccoli. The five servings of each food item will be placed in separate containers (chicken nuggets in one, tater tots in one, and broccoli in one). The containers will be weighed in Justin 111 on the Toledo digital scale by Della.

The procedure for taking the temperatures is as follows:

1. For chicken nuggets insert thermometer into 2 of the nuggets making sure bulb is covered.
2. For tater tots insert thermometer into a couple of tater tots making sure bulb is covered.
3. For broccoli insert thermometer into 1 or 2 pieces if possible. If broccoli is too tough pierce it with a fork and then insert the thermometer. If the pieces are too small to insert the thermometer into them, cover the bulb of the thermometer as best as you can.

When recording the temperatures of the menu items be sure to also record the time when the temperature was taken. Two forms will be used to record the time-temperature data: one for satellite when food is shipped; one for on-site preparation and satellites when food is prepared on-site.

When temperatures are taken at the high school and the middle school, remove only the amount needed to take the temperatures.

Instructions for Collecting Plate Waste Data

The containers at the data collection table will be pre-weighed and labled at Justin before going to the schools. There will be six containers:

a) 3 for the 5 servings after their temperatures have been taken and recorded and will be weighed for "average" serving size weight.(1 for 5 servings of Tater Tots, 1 for 5 servings of chicken nuggets, and 1 for 5 servings of broccoli)

b) 3 for collecting plate waste. (1 for chicken nuggets, 1 for Tater Tots, and 1 for broccoli)

Plate waste will be collected from the sixth graders who are participating in this study. At the time they bring their trays to be scraped, they will also put their completed evaluation forms in the box provided. Count the number of students who have their trays scraped whether or not they had leftovers. Record the number of trays counted on the yellow plate waste form.

After the plate waste has been collected, put lids on the 6 containers. The research assistants (Della, Patti, Linda and Janet) will be responsible for seeing that the containers and evaluation forms are brought back to Justin.

The plate waste will be weighed by Della at Justin. It will be important that the yellow plate waste forms stay with the containers from the respective school.

SCHOOL FOODSERVICE QUALITY STUDY
DATA COLLECTION SCHEDULE

Date	Name	School(s)	Time
April 1	Patti Simonis	Northview	10:30
	Linda Yarrow	Bluemont	10:15
	Oella Rieley	Theodore Roosevelt	10:00
	Mary Gregoire	Northview	12:15
	Mary Ecklund	Bluemont	11:15
	Janet Beary	Theodore Roosevelt	11:15
April 11	Patti Simonis	Woodrow Wilson	10:00
	Linda Yarrow	High School Theodore Roosevelt	9:00 (after leave high school)
	Janet Beary	Eugene Field	10:30
	Della Rieley	Middle School Bluemont	9:00 (after leave middle school)
	Robin Zingheim	Bluemont	11:15
	Mary Ecklund	Eugene Field	11:45
	Karen Greathouse	Woodrow Wilson	11:45
	Stephanie Wilson	Theodore Roosevelt	11:15
May 6	Patti Simonis	High School Woodrow Wilson	9:00 (after leave High school)
	Oella Rieley	Middle School Eugene Field	9:00 (after leave Middle school)
	Janet Beary	Theodore Roosevelt	10:00
	Linda Yarrow	Bluemont	10:15
	Mary Gregoire	Woodrow Wilson	11:45
	Mary Ecklund	Theodore Ronsevelt	11:15
	Stephanie Wilson	Bluemont	11:15
	_____	Eugene Field	11:45

Date	Name	School(s)	Time
May 15	Della Rieley	Northview	10:30
	Linda Yarrow	High School Theodore Roosevelt	9:00 (after leave High School)
	Janet Beary	Eugene Field	10:30
	Patti Simonis	High School Theodore Roosevelt	9:00 (after leave High School)
	Mary Gregoire	Northview	12:15
	Karen Greathouse	Theodore Roosevelt	11:15
	Stephanie Wilson	Eugene Field	11:45
		Woodrow Wilson	11:45
May 23	Linda Yarrow	Middle School Bluemont	9:00 (after leave Middle school)
	Della Rieley	Woodrow Wilson	10:00
	Janet Beary	Middle School Eugene Field	9:00 (after leave Middle school)
	Stephanie Wilson	Bluemont	11:15
	Karen Greathouse	Woodrow Wilson	11:45
	Mary Ecklund	Eugene Field	11:45

APPENDIX L

Data Collection Schedules for Cooks and Principals

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA COLLECTION SCHEDULE

BLUEMONT

April 1	with finishing
April 11	without finishing
May 6	with finishing
May 23	without finishing

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA COLLECTION SCHEDULE

EUGENE FIELD

April 11	with finishing
May 6	without finishing
May 15	with finishing
May 23	without finishing

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA CDLLECTIDN SCHEDULE

THEODDRE RODSEVELT

April 1	with finishing
April 11	without finishing
May 6	with finishing
May 15	without finishing

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHDDL FODDSERVICE QUALITY STUDY

DATA COLLECTIDN SCHEDULE

WODDROW WILSDN

April 11	with finishing
May 6	without finishing
May 15	without finishing
May 23	with finishing

KANSAS STATE UNIVERSITY

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA COLLECTION SCHEDULE

MIDDLE SCHOOL

April 1	Bluemont	with finishing
April 11	Bluemont	without finishing
	Eugene Field	with finishing
May 6	Eugene Field	without finishing
	Bluemont	with finishing
May 15	Eugene Field	with finishing
May 23	Bluemont	without finishing
	Eugene Field	without finishing

KANSAS STATE UNIVERSITY

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA COLLECTION SCHEDULE

NORTHVIEW

April 1
May 23

KANSAS STATE UNIVERSITY

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

SCHOOL FOODSERVICE QUALITY STUDY

DATA COLLECTION SCHEDULE

HIGH SCHOOL

April 1	Theodore Roosevelt	with finishing
April 11	Woodrow Wilson	with finishing
	Theodore Roosevelt	without finishing
May 6	Woodrow Wilson	without finishing
	Theodore Roosevelt	with finishing
May 15	Theodore Roosevelt	without finishing
	Woodrow Wilson	without finishing
May 23	Woodrow Wilson	with finishing

APPENDIX M

Memo to Principals

(KSU Letterhead)

MEMO TO: Principals

FROM: Della Rieley

REGARDING: Foodservice Quality Study

DATE: March 22, 1985

Attached is a schedule of the days we will be collecting data. On these days we will need the following:

3 tables set up in the eating area
(two for collecting plate waste, and 1 for the taste panel)

3 chairs for the taste panel; 2 chairs for plate waste table

1 garbage can for use when collecting plate waste

Also we would like the teachers to hand out the student evaluation forms and pencils to the students before they come to lunch.

If you have any questions about this study, please feel free to contact me at any time. My phone number is 532-5521.

Thank you for your cooperation in this study.

APPENDIX N

Memo to Students

KANSAS STATE UNIVERSITY

Department of Dietetics, Restaurant and Institutional Management

Justin Hall
Manhattan, Kansas 66506
913-532-5521

MEMO TO:

FROM: Della Rieley

When you have finished eating, please comolete these cards. A pencil has been provided for you and is in the envelope. Only fill out the cards if you ate school lunch today.

After you have completed filling out the cards, take them along with your tray to the plate waste table.

Thank you for helping with this study.

APPENDIX O

Chi-square Analysis of Student Evaluations
for Chicken Nuggets (Tables 16-19)

Table 16. Student acceptability ratings by school and system* for flavor of chicken nuggets

school	system	N†	acceptability ratings				
			awful	bad	so-so	good	great
			← % →				
A	satellite	16	-	-	18.75	25.0	56.25
A	satellite with finishing kitchen	16	-	12.5	12.5	18.75	56.25
B	satellite	18	5.56	5.56	-	27.78	61.11
B	satellite with finishing kitchen	15	-	-	6.67	26.67	66.67
C	satellite	30	6.67	-	16.67	46.67	30.0
C	satellite with finishing kitchen	29	13.79	-	27.59	20.69	37.93
O	satellite	14	-	-	-	71.43	28.57
D	satellite with finishing kitchen	13	-	-	30.77	61.54	7.69
E	conventional	69	-	-	20.29	27.54	52.17

*Analysis by school and system: $\chi^2 = 71.72$ df = 32 p = .0001.

†N = number of students responding.

Table 17. Student acceptability ratings by school and system* for appearance of chicken nuggets

school	system	N†	acceptability ratings				
			awful	bad	so-so	good	great
			←		%		→
A	satellite	16	-	12.5	12.5	56.25	18.75
A	satellite with finishing kitchen	16	12.5	12.5	31.25	31.25	12.5
B	satellite	17	-	5.88	23.53	17.65	52.94
B	satellite with finishing kitchen	13	-	7.69	30.77	15.38	46.15
C	satellite	28	10.71	3.57	28.57	42.86	14.29
C	satellite with finishing kitchen	28	14.29	3.57	42.86	14.29	25.0
D	satellite	14	-	7.14	35.71	42.86	14.29
D	satellite with finishing kitchen	13	15.38	15.38	15.38	46.15	7.69
E	conventional	66	3.03	3.03	30.3	39.39	24.24

*Analysis by school and system: $\chi^2 = 64.78$ df = 32 p = .07.

†N = number of students responding.

Table 18. Student acceptability ratings by school and system* for temperature of chicken nuggets

school	system	N†	acceptability ratings		
			too cool	just right	too hot
			← % →		
A	satellite	16	37.5	62.5	-
A	satellite with finishing kitchen	16	37.5	62.5	-
B	satellite	18	55.56	44.44	-
B	satellite with finishing kitchen	15	33.33	60.0	6.67
C	satellite	29	48.28	51.72	-
C	satellite with finishing kitchen	28	35.71	64.29	-
D	satellite	15	46.67	53.33	-
O	satellite with finishing kitchen	12	50.0	50.0	-
E	conventional	69	21.74	78.26	-

*Analysis by school and system: $\chi^2 = 26.35$ df = 16 p = .05.

†N = number of students responding.

Table 19. Student acceptability ratings by school and system* for serving size of chicken nuggets

school	system	N†	acceptability ratings		
			too little	just right	too much
			← % →		
A	satellite	16	93.75	6.25	-
A	satellite with finishing kitchen	16	100	-	-
B	satellite	18	77.78	22.22	-
B	satellite with finishing kitchen	15	60.0	40.0	-
C	satellite	30	66.67	30.0	3.33
C	satellite with finishing kitchen	28	67.86	28.57	3.57
D	satellite	15	86.67	13.33	-
D	satellite with finishing kitchen	12	100	-	-
E	conventional	69	89.86	8.7	1.44

*Analysis by school and system: $\chi^2 = 27.0$ df = 16 p = .04.

†N = number of students responding.

APPENDIX P

Chi-square Analysis of Student Evaluations
for Broccoli (Tables 20-23)

Table 20. Student acceptability ratings by school and system* for flavor of broccoli

school	system	N†	acceptability ratings				
			awful	bad	so-so	good	great
			← % →				
A	satellite	16	43.75	25.0	12.5	12.5	6.25
A	satellite with finishing kitchen	16	50.0	6.25	31.25	12.5	-
B	satellite	18	61.11	-	11.11	11.11	16.67
B	satellite with finishing kitchen	15	46.67	13.33	26.67	-	13.33
C	satellite	28	64.29	17.86	10.71	7.14	-
C	satellite with finishing kitchen	29	72.41	6.90	13.79	-	6.90
D	satellite	14	42.86	14.29	28.57	-	14.29
D	satellite with finishing kitchen	10	70.0	10.0	10.0	10.0	-
E	conventional	64	39.06	20.31	7.81	25.0	7.81

*Analysis by school and system: $\chi^2 = 48.26$ df = 32 p = .03.

†N = number of students responding.

Table 21. Student acceptability ratings by school and system* for appearance of broccoli

school	system	N+	acceptability ratings				
			awful	bad	so-so	good	great
			← % →				
A	satellite	16	43.75	25.0	25.0	6.25	-
A	satellite with finishing kitchen	16	50.0	6.25	37.5	6.25	-
B	satellite	16	43.75	18.75	12.5	12.5	12.5
B	satellite with finishing kitchen	12	58.33	25.0	16.67	-	-
C	satellite	27	66.67	18.52	14.81	-	-
C	satellite with finishing kitchen	26	69.23	23.08	3.85	-	3.85
D	satellite	14	50.0	14.29	21.43	7.14	7.14
D	satellite with finishing kitchen	10	60.0	20.0	-	20.0	-
E	conventional	61	55.74	11.48	18.03	9.84	4.92

*Analysis by school and system: $\chi^2 = 32.24$ df = 32 p = .45.

+N = number of students responding.

Table 22. Student acceptability ratings by school and system* for temperature of broccoli

school	system	N†	acceptability ratings		
			too cool	just right	too hot
			← % →		
A	satellite	16	87.5	12.5	-
A	satellite with finishing kitchen	16	81.25	18.75	-
B	satellite	18	55.56	38.89	5.56
B	satellite with finishing kitchen	14	35.71	50.0	14.29
C	satellite	27	85.19	14.81	-
C	satellite with finishing kitchen	26	76.92	19.23	3.85
D	satellite	14	64.29	35.71	-
D	satellite with finishing kitchen	9	88.89	11.11	-
E	conventional	64	50.0	45.31	4.69

*Analysis by school and system: $\chi^2 = 30.82$ df = 16 p = .01.

†N = number of students responding.

Table 23. Student acceptability ratings by school and system* for serving size of broccoli

school	system	N†	acceptability ratings		
			too little	just right	too much
			←	%	→
A	satellite	16	-	37.5	62.5
A	satellite with finishing kitchen	16	-	50.0	50.0
B	satellite	18	5.56	50.0	44.44
B	satellite with finishing kitchen	15	13.33	60.0	26.67
C	satellite	28	10.71	21.43	67.86
C	satellite with finishing kitchen	26	3.85	26.92	69.23
D	satellite	14	21.43	42.86	35.71
D	satellite with finishing kitchen	9	11.11	44.44	44.44
E	conventional	65	27.69	29.93	43.08

*Analysis by school and system: $\chi^2 = 31.74$ df = 16 p = .01.

†N = number of students responding.

APPENDIX Q

Chi-square Analysis of Student Evaluations for Tater Tots (Tables 24-27)

Table 24. Student acceptability ratings by school and system* for flavor of tater tots

school	system	N†	acceptability ratings				
			awful	bad	so-so	good	great
			← % →				
A	satellite	16	18.75	12.5	37.5	25.0	6.25
A	satellite with finishing kitchen	16	6.25	-	62.5	31.25	-
B	satellite	18	-	5.56	-	27.78	66.67
B	satellite with finishing kitchen	15	-	-	26.67	13.33	60.0
C	satellite	30	23.33	16.67	26.67	20.0	13.33
C	satellite with finishing kitchen	29	27.59	-	31.03	31.03	10.34
O	satellite	15	20.0	6.67	26.67	33.33	13.33
D	satellite with finishing kitchen	13	-	15.38	53.85	23.08	7.69
E	conventional	66	3.03	3.03	18.18	30.30	45.45

*Analysis by school and system: $\chi^2 = 94.02$ df = 32 p = .0001.

†N = number of students responding.

Table 25. Student acceptability ratings by school and system* for appearance of tater tots

school	system	N	acceptability ratings				
			awful	bad	so-so	good	great
			← % →				
A	satellite	16	25.0	18.75	25.0	31.25	-
A	satellite with finishing kitchen	16	-	6.25	81.25	12.5	-
B	satellite	16	-	6.25	12.5	25.0	56.25
B	satellite with finishing kitchen	13	-	7.69	23.08	23.08	46.15
C	satellite	25	28.0	4.0	36.0	20.0	12.0
C	satellite with finishing kitchen	27	25.93	11.11	33.33	25.93	3.70
D	satellite	15	-	20.0	20.0	33.33	26.67
O	satellite with finishing kitchen	13	7.69	7.69	38.46	38.46	7.69
E	conventional	61	1.64	6.56	19.67	37.7	34.43

*Analysis by school and system: $\chi^2 = 88.17$ df = 32 p = .0001.

†N = number of students responding.

Table 26. Student acceptability ratings by school and system* for temperature of tater tots

school	system	N+	acceptability ratings		
			too cool	just right	too hot
			← % →		
A	satellite	16	81.25	18.75	-
A	satellite with finishing kitchen	16	75.0	25.0	-
B	satellite	18	61.11	38.89	-
B	satellite with finishing kitchen	15	26.67	73.33	-
C	satellite	29	65.52	31.03	3.45
C	satellite with finishing kitchen	29	68.97	31.03	-
O	satellite	15	60.0	40.0	-
O	satellite with finishing kitchen	12	58.33	41.67	-
E	conventional	67	41.79	58.21	-

*Analysis by school and system: $\chi^2 = 27.69$ df = 16 p = .03.

+N = number of students responding.

Table 27. Student acceptability ratings by school and system* for serving size of tater tots

school	system	N†	acceptability ratings		
			too little	just right	too much
			← % →		
A	satellite	16	12.5	50.0	37.5
A	satellite with finishing kitchen	16	31.25	50.0	18.75
B	satellite	18	61.11	33.33	5.56
B	satellite with finishing kitchen	15	60.0	26.67	13.33
C	satellite	30	46.67	33.33	20.0
C	satellite with finishing kitchen	29	48.28	27.59	24.14
D	satellite	15	26.67	73.33	-
D	satellite with finishing kitchen	12	58.33	41.67	-
E	conventional	67	82.09	16.42	1.49

*Analysis by school and system: $\chi^2 = 60.01$ df = 16 p = .0001.

†N = number of students responding.

APPENDIX R

Sensory Panel Ratings by Day of Study
(Tables 28-30)

Table 28. Chicken nugget mean sensory rating and temperature by school for each day of study

sensory characteristic	day of study	school				
		A	B	C	D	E
		← mean* sensory rating temperature+ →				
moistness‡	1	11.1 (F)# 52°C	11.3 (F) 82°C	9.4 (F) 46°C	5.75 (F) 61°C	11.8 (C) 65°C
	2	7.9 (S) 37°C	10.76 (S) 55°C	11.6 (S) 44°C	9.55 (S) 41°C	10.55 (C) 52°C
	3	8.4 (F) 34°C	11.87 (F) 52°C	10.23 (S) 47°C	10.75 (F) 45°C	
	4	7.8 (S) 45°C	12.55 (S) 45°C	8.97 (F) 54°C	11.7 (S) 38°C	
tenderness‡	1	10.5 (F) 52°C	12.75 (F) 82°C	10.25 (F) 46°C	9.45 (F) 61°C	12.16 (C) 65°C
	2	9.9 (S) 37°C	10.81 (S) 55°C	10.7 (S) 44°C	9.4 (S) 41°C	11.9 (C) 52°C
	3	8.4 (F) 34°C	9.5 (F) 52°C	9.4 (S) 47°C	10.6 (F) 45°C	
	4	9.3 (S) 45°C	12.4 (S) 45°C	9.07 (F) 54°C	11.9 (S) 38°C	
coating crispness‡	1	7.7 (F) 52°C	11.2 (F) 82°C	10.0 (F) 46°C	4.35 (F) 61°C	1.57 (C) 65°C
	2	9.65 (S) 37°C	10.4 (S) 55°C	5.17 (S) 44°C	5.55 (S) 41°C	8.2 (C) 52°C
	3	9.8 (F) 34°C	8.27 (F) 52°C	8.27 (S) 47°C	10.45 (F) 45°C	
	4	7.53 (S) 45°C	11.75 (S) 45°C	10.83 (F) 54°C	5.9 (S) 38°C	

*2 or 3 panelists randomly assigned to each site, N will vary accordingly.

+Temperature taken at sensory evaluation.

‡Scale = 0, lowest to 15, highest intensity.

#(F) = satellite with finishing kitchen; (S) = satellite; (C) = conventional.

Table 29. Broccoli mean sensory rating and temperature by school for each day of study

sensory characteristic	day of study	school				
		A	B	C	D	E
		mean* sensory rating temperature†				
purity of green‡	1	5.65 (F)# 33°C	6.15 (F) 48°C	5.95 (F) 49°C	3.65 (F) 46°C	3.23 (C) 51°C
	2	6.35 (S) 38°C	7.03 (S) 51°C	5.17 (S) 39°C	2.25 (S) 50°C	8.75 (C) 53°C
	3	12.0 (F) 38°C	10.73 (F) 42°C	4.03 (S) 49°C	10.3 (F) 54°C	
	4	6.37 (S) 42°C	5.2 (S) 56.5°C	12.9 (F) 37°C	6.0 (S) 55°C	
firmness‡	1	6.5 (F) 33°C	6.5 (F) 48°C	6.25 (F) 49°C	2.95 (F) 46°C	5.97 (C) 51°C
	2	7.75 (S) 38°C	5.4 (S) 51°C	9.87 (S) 39°C	5.5 (S) 50°C	9.6 (C) 53°C
	3	10.30 (F) 38°C	10.0 (F) 42°C	2.9 (S) 49°C	7.25 (F) 54°C	
	4	7.30 (S) 42°C	6.9 (S) 57°C	12.23 (F) 37°C	5.85 (S) 55°C	

*2 or 3 panelists randomly assigned to each site, N will vary accordingly.

†Temperature taken at time of sensory evaluation.

‡Scale = 0, lowest to 15, highest intensity.

#(F) = satellite with finishing kitchen; (S) = satellite; (C) = conventional.

Table 30. Tater tot mean sensory rating and temperature by school for each day of study

sensory characteristic	day of study	school				
		A	B	C	D	E
		← mean* sensory rating temperature† →				
crispness‡	1	3.0 (F)# 33°C	6.30 (F) 40°C	6.25 (F) 40°C	5.5 (F) 37°C	11.33 (C) 42°C
	2	5.85 (S) 31°C	6.77 (S) 40°C	4.77 (S) 33°C	6.15 (S) 32°C	8.5 (C) 55°C
	3	3.40 (F) 41°C	12.17 (F) 44°C	7.0 (S) 38°C	4.15 (S) 33°C	
	4	4.0 (S) 33°C	4.6 (S) 37°C	8.47 (F) 43°C	8.5 (F) 38°C	

*2 or 3 panelists randomly assigned to each site, N will vary accordingly.

†Temperature taken at time of sensory evaluation.

‡Scale = 0, lowest to 15, highest intensity.

#(F) = satellite with finishing kitchen; (S) = satellite; (C) = conventional.

APPENDIX S

Graphs of Time-Temperature Data
(Figures 1-3)

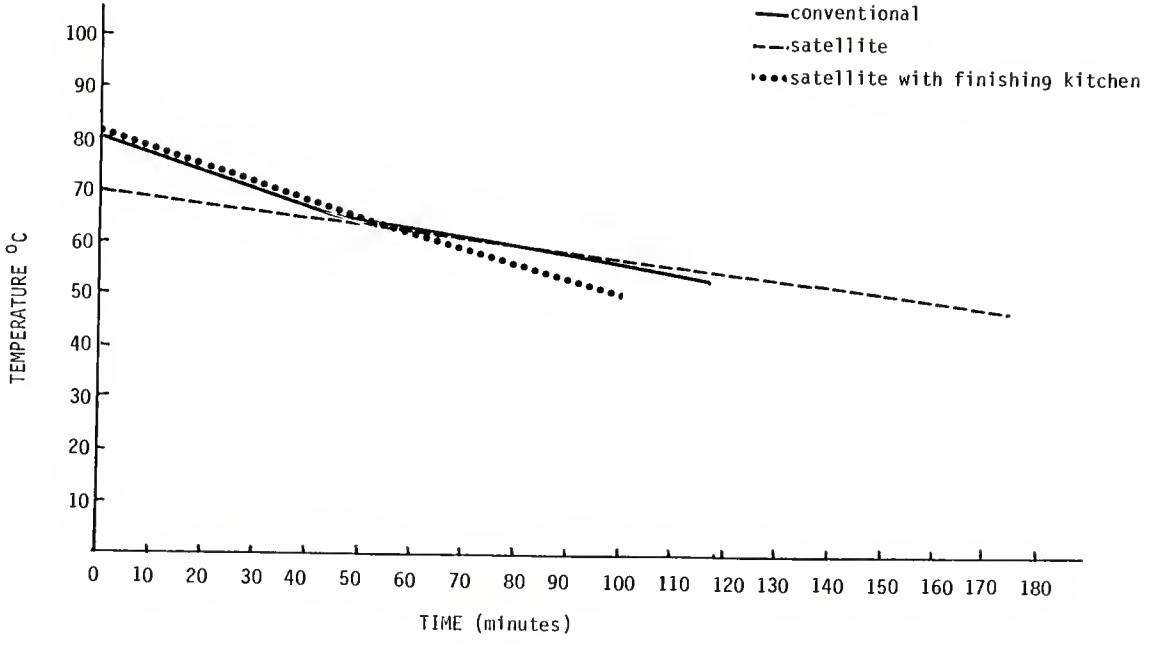

Figure 1. Time-temperature relationship from end of production to end of service for chicken nuggets.

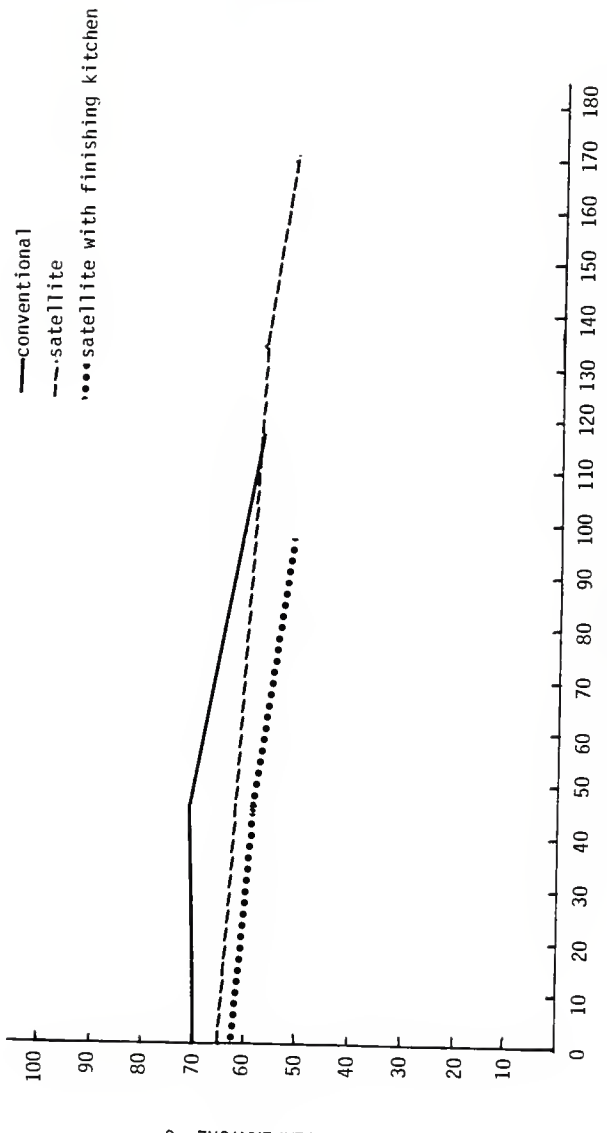

Figure 2. Time-temperature relationship from end of production to end of service for broccoli.

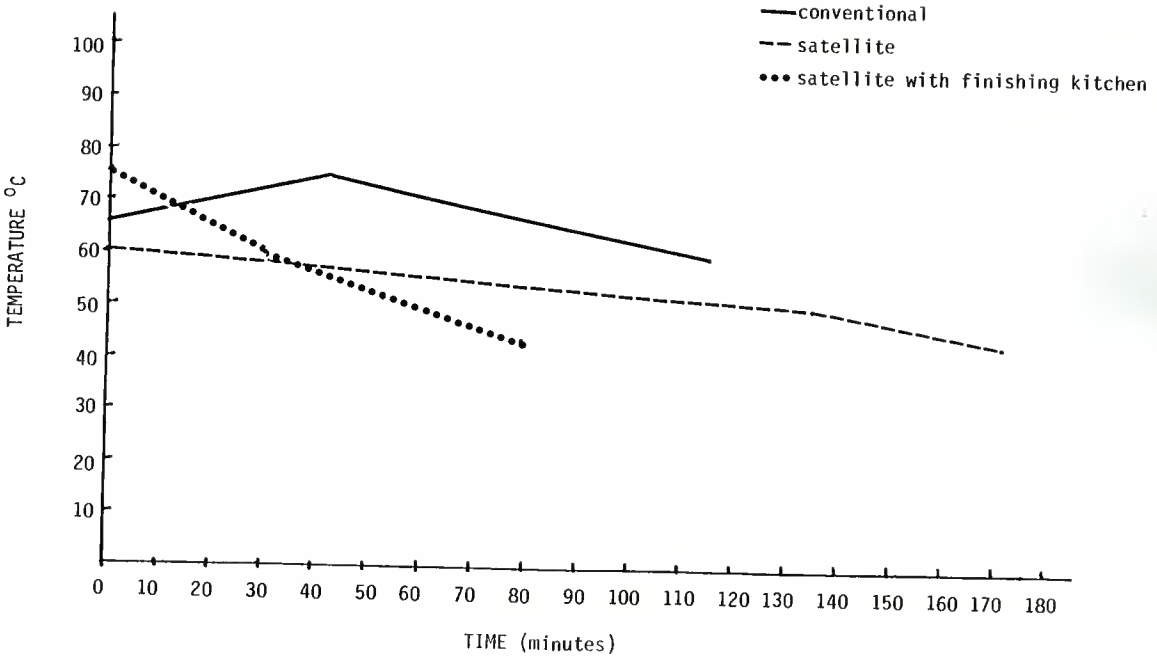

Figure 3. Time-temperature relationship from end of production to end of service for tator tots.

APPENDIX T

Time-Temperature Data by Day of Study
(Tables 31-33)

Table 31. Time-temperature relationships for chicken nuggets from end of production to end of service by school and type of system for each observation

school	day of study	system*	temperatures and holding times†															
			end of production	ship to satellite		arrival at satellite		beginning of service		beginning of break‡		end of break‡		service to first 6th grader		service to last 6th grader		end of service	
			°C	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min
A	1	F	92					47	70	46	90			45	105	45	106	40	115
	2	S	65	50	45	51	95	41	155	40	165	40	190	40	193			45	200
	3	F	75					65	40	58	65			62	73	56	75	52	80
	4	S	83			64	45	47	100	51	120			59	130			56	135
B	1	F	79					67	20	60	34			79	62			72	67
	2	S	80	59	40	51	85	63	140	58	153	62	170	57	178			50	180
	3	F	85					62	25	60	45			54	63			43	66
	4	S	75	68	15	52	85	55	135	50	155			45	177			45	181
C	1	F	66					65	45	66	70			68	90			57	95
	2	S	63	63	15	57	30	54	150	52	175			41	200			40	205
	3	S	58	58	30	62	50	64	150	54	180			44	212			50	225
	4	F	73					71	90	60	115			59	135			59	145
D	1	F	75					73	80			70	120					65	130
	2	S	71			56	25	47	130	36	150	66	175					50	185
	3	F	83					66	50	60	70	62	95					58	103
	4	S	65	65	15	52	35	50	145	41	165							43	190
E	1	C	74					64	40	58	60			63	101			50	117
	2	C	87					65	50	57	80	63	107	64	113			58	118

*F = satellite with finishing kitchen, S = satellite, C = conventional.

†Holding time in minutes from end of production.

‡Break refers to time between serving periods.

Table 32. Time-temperature relationships for broccoli from end of production to end of service by school and type of system for each observation

school	day of study	system*	temperatures and holding times†															
			end of production	ship to satellite		arrival at satellite		beginning of service		beginning of break‡		end of break‡		service to first 6th grader		service to last 6th grader		end of service	
			°C	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min
A	1	F	61					48	25	45	45			44	60	40	61	37	70
	2	S	57	60	15	63	65	53	125	43	135	52	160	40	163			38	170
	3	F	75					50	30	55	55			44	63	40	65	70	70
	4	S	63			70	30	55	185	59	105			59	115			52	120
B	1	F	74					60	31	55	45			52	73			47	78
	2	S	60	60	45	62	90	55	145	50	158	54	175	65	183			63	185
	3	F	72					61	30	60	50			51	68			50	71
	4	S	62	62	25	57	95	69	145	58	165			47	187			57	191
C	1	F	68					68	45	48	70			58	90			53	95
	2	S	61	60	15	56	30	57	150	57	175			54	200			50	205
	3	S	82	82	30	81	50	74	150	61	180			52	212			50	225
	4	F	45					58	65	50	90			45	110			45	120
D	1	F	61					58	80			60	120					53	130
	2	S	53			54	25	53	130	47	150	51	175					29	185
	3	F	53					60	69			68	105					64	113
	4	S	75	75	12	65	32	62	142	82	162							57	187
E	1	C	72					78	40	72	60			77	101			59	117
	2	C	69					65	50	57	80	63	107	64	113			58	118

*F = satellite with finishing kitchen, S = satellite, C = conventional.

†Holding time in minutes from end of production.

‡Break refers to the time between serving periods.

Table 33. Time-temperature relationships for tater tots from end of production to end of service by school and type of system for each observation

school	day of study	system*	temperatures and holding times†															
			end of production		ship to satellite		arrival at satellite		beginning of service		beginning of break‡		end of break‡		service to first 6th grader		service to last 6th grader		end of service	
			°C	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min	°C	min
A	1	F	83					59	40	56	60			55	75	53	76	43	85
	2	S	63	45	45	41	95	42	155	40	165	42	190	43	193			42	200
	3	F	75					55	27	43	52			44	60	40	62	45	67
	4	S	75			59	45	44	100	38	120			41	130			40	135
B	1	F	78					57	18	52	32			49	60			51	65
	2	S	53	50	30	45	75	67	130	53	143	56	160	56	168			53	170
	3	F	77					77	3	52	23			42	41			42	44
	4	S	63	57	15	50	85	54	135	43	155			41	177			42	181
C	1	F	55					64	45	53	70			58	90			51	95
	2	S	55	54	15	54	30	50	150	50	175			52	200			50	205
	3	S	58	58	30	61	50	56	150	50	180			44	212			40	225
	4	F	80					60	55	54	80			49	100			41	110
D	1	F	85					61	45			50	85					48	95
	2	S	51	55	25	43	130	35	150	43	175							40	185
	3	F	74					53	20			48	65					45	73
	4	S	66	66	15	55	35	44	145	31	165							40	190
E	1	C	54					84	40	75	60			70	101			72	117
	2	C	78					65	45	69	75	60	102	50	110			49	115

*F = satellite with finishing kitchen, S = satellite, C = conventional.

†Holding time in minutes from end of production.

‡Break refers to the time between serving periods.

EVALUATIDN OF THREE SCHOOL FDDDSERVICE SYSTEMS: STUDENT AND EXPERT SENSORY PANEL RATINGS, PLATE WASTE AND TIME-TEMPERATURE DATA

by

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AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

The purpose of this research was to evaluate the effect of type of school foodservice system on the quality and acceptability of selected food items. Chicken nuggets, tater tots, and broccoli were chosen because of their popularity and the quality loss from holding for several hours at high temperatures. The three systems evaluated were conventional, satellite, and satellite with a finishing kitchen.

Sixth grade students in five schools in a Kansas school district participated in this study. One school had a conventional system and the other four were satellites. During data collection at the satellite facilities, the menu items were prepared twice at the central kitchen and twice in the finishing kitchens. Acceptability was evaluated by the students and by aggregate plate waste. Student evaluations consisted of their responses to queries about the appearance, flavor, temperature, and serving size of each of the three food items. A professional sensory panel evaluated the quality characteristics of coating crispness, moistness and tenderness of chicken nuggets, crispness of tater tots; and purity of green color and firmness of broccoli. Time-temperature relationships were measured by a research assistant. Food temperatures were taken at intervals from the end of production to the end of service.

Students rated flavor and appearance of the food items for the conventional system significantly higher than for the other two systems. For all three food items, temperature was rated as "too cool" with the conventional system being rated significantly higher than the satellite

system. For broccoli, the conventional system temperature was also rated significantly higher than the satellite with finishing kitchen.

Sensory panel ratings of coating crispness, tenderness, and moistness for chicken nuggets, purity of green color and firmness of broccoli, and crispness of tater tots showed no significant difference between the three systems. A high degree of variability of scores from one data collection to another was noted in all schools. No one school or system consistently had higher ratings than the others.

Temperatures were the highest for the conventional system for all the food items; whereas, the satellite system had the longest holding times. In most cases, the mean temperatures at the beginning of service were at or below 60°C for the satellite system and satellite with finishing kitchen. At the end of service, the mean temperatures were at or below 60°C for all three systems.

Plate waste was negligible for chicken nuggets and tater tots in all three systems, but was significantly lower in the conventional system than in the satellite. Broccoli waste was significantly lower in the conventional system than in the other two systems.