

Institutional Foods Development Perspectives Review

Ranganathan Kumar*, Tamilselvan Kathiravan, Ramalingam Rajamanickam,
Shanmugam Nadanasabapathi

Food Engineering & Packaging, Defence Food Research Laboratory, Mysore, India.
Email: *kumardfrrl@gmail.com

Received October 6th, 2012; revised January 3rd, 2013; accepted January 9th, 2013

Copyright © 2013 Ranganathan Kumar *et al.* This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Development of food service institution has been initiated by industrialization and has grown rapidly over the last half century. Institutional Food Service includes planning, preparation, distribution and supply of foods outside home. Consumer perceptions towards institutional foods are influenced by marketing, advertising and lifestyle changes. Food service systems/catering units promote new processing methods and bulk packaging of food to conquer problems like skilled labour shortage and reduce the operation cost. This review emphasizes on the evolution of food services (vending, industrial food services, school lunch, hospital etc.) and its importance. It also highlights the attributes for making institutional foods more acceptable for consumers and their role of human engineering.

Keywords: Institutional Foods; Commercial Food; Industrial Food Service

1. Introduction

The awareness of mass feeding operations as ‘food service systems’ developed with the growth of multiunit food service operations, and the introduction of new methods for increasing worker productivity. In one form or another, these methods included the divorce of food production from food service, either in time, in place, or in both. Over the last few decades, many types of food service systems such as cook-freeze, cook-chill and *sous vide* have been developed to overcome the problems of the shortage of skilled labour and the need to reduce operational costs. Subsequently, many other advantages have emerged which have made these systems widely used in institutions such as hospitals, schools and staff canteens as well as restaurant chains and a wide range of transport catering. There was professional resistance at the time to the introduction of institutional food service systems because of the fear of taking away the traditional skills of the chef.

Industrialization has been the basis for the development of the catering operation through adopting methods of food processing technology such as centralized production, large-scale equipment, consistent heat treatments and sophisticated packaging facilities. The triumph of such systems depends on the incorporation of a “time buffer” that interrupts the necessarily continuous flow of

food through the traditional “cook and serve” system for meal preparation. The “time buffer” has been defined as a stage during which the food is preserved safely and conveniently, usually by chilling or freezing [1] but often the operational benefits of which have been at the expense of the sensory and nutritional quality of the foods, especially important in institutional feeding systems such as cook-freeze, [2,3] cook-chill) and *sous vide* [4] have been based on centralized production units supplying complete meals in individual or multi-pack portions to satellite kitchens or restaurants. Cook-chill systems were promoted by manufacturers of large-scale cooking and refrigeration equipment working with electric industry [5] at a time when food service operations were becoming more aware of the need to economize on energy and labour costs [6]. The manufacturers of specialized equipment for vacuum packing, cooking, cooling, chilled storage, reheating and heat-resistant packaging materials also co-operated in creating complete *sous vide* process, systems for customers. The *sous vide* process is preferred and has reputation for higher quality which relies on vacuum packing raw food materials before low temperature cooking and rapid cooling [7]. A food service system has been defined as an integrated program in which procurement, storage, preparations and service of food and beverage and equipments and method required to accomplish these objectives are fully coordinated for minimum labour, optimal customer satisfaction, quality and cost control [8].

*Corresponding author.

2. Development of Food Services in Institutions

Food services in institutions include those in which planning; preparation and usually the services of the food are carried on outside the home or in quantities than those characteristics of the usual family needs. Although the development has been rapid and widespread within the last half century, those services have their roots in the habits and customs that characterize our civilization and date back before the middle ages.

The countries that have most largely determined American food habits and customs are England, France, Germany, Norway and Switzerland. These countries are contributed to the living habits of that would lead naturally to the evolution of institution food services. The economic level and the type of food eaten were also such as to promote institution food services. In the early days, as in the present, factors affecting the organization and the administration of food services were the type of institution, the plant in which the services was housed, the personnel available, and the income level or per day allowance. It will be of interest to consider some of the types of food services that existed long ago and contrast them with their modern equivalents. In medieval times quantity food production was the rule rather than the exception in religious order, royal household and colleges. Records of the religious orders give a fair concept of what was regarded as adequate food allowance per person and show the early days of cost accounting. The royal household with its hundreds of retainers, and household of nobles, often numbering as many as 150 to 259 persons, also necessitated a food service on an institutional basis. There was a wide variance in the rank and in the subsequent food allowances within the groups. For more than 140 persons, serving of 10 different breakfasts is recorded, the best for the earl and his lady, the poorest for the lowest workman or scullion. The kitchen of these medieval households would appal the present day dietician by the disregard of all sanitary standards in food storage, preparations and food handling.

With the passage of time and knowledge of the causes of food spoilage led to improved practices of food storage and preparations in the noble household. Advances in understanding of the law of physics resulted in the replacement of the open hearth with iron stove and in refinement of much of the kitchen equipment. The dress of the employees showed some regard for the task they assumed. The convenience in kitchen arrangement and equipment reduced the number of workers required and thus tended to relieve disorder and confusion.

Lowering food losses is a potential measure to overcome hunger and reduce the ecological side effects from the food system. It shows that about one-fifth of the food is lost. Plate waste is the single largest source of loss, at

11% - 13% of the amount of food served. Losses in food service institutions can be of significant economic value, and arable land equivalent to 1.5% of the area under cultivation in Sweden may be used to produce food eventually lost in food service institutions [9].

3. Consumer Perception towards Institutional Foods

Consumers will be influenced by attitudes formed over many years through their own experience and cultural background, social situation and the surroundings unlike scientists and engineers who mainly focus on developing of new technology and conquering the consequent problems of practical application [10]. The marketing and advertising have a high impact on the mindset of the consumers regarding the quality of prepared foods [11,12]. Work on attitudes towards military and institutional food contrasted the acceptability of prepared foods in different settings. It can be summarized that the consumers hold "strong negative attitudes about both quality and acceptability of institutional foods", perceive these foods as poorer in sensory quality due to negative media exposure with their expectation influencing actual liking of the same food choice depending on the setting. Many factors affecting food choice change with age [13] like older people may compensate for loss of taste by using more salt and sugar on their food or rely on colour as a clue to food quality [14]. The older people do not prefer the processed foods due to their prior experience of 1930s and 1940s of limited diet and poor quality. On the contrary the younger age groups accept processed foods although more emphasis is on "minimal" processing through irradiation, high-pressure treatment, pulse electric field etc [15].

In the contrast to the food service situation for ready meals, the concept of eating at home a meal wholly manufactured outside the kitchen has become much more acceptable judging by recent figures on sales of prepared ready meals, snacks, desserts. The reason for this contrast may be due to recent lifestyle changes influencing eating habits. These include changes in family structure, an increase in holiday travel abroad and the redistribution of disposable income [16]. The question must be then raised in the reason for the differences in consumer perception of quality of manufactured meals between those brought for consumption at home and those which are eaten out in the institutional or restaurant setting.

4. New Packaging for Food Service Systems

Packaging for food service applications has traditionally been very similar to that used for retail food distribution. The main difference has been the size of the unit: the larger: so called "institutional" sizes of containers and

packages having been developed to lower the cost of packaging per serving. Shelf stable foods are available in cylindrical containers, flat metal containers, polymeric containers and flexible packaging.

Now a day Research and development of antimicrobial materials for food applications such as packaging and other food contact surfaces is growing with the advent of new polymer materials and antimicrobials. It helps to safe guard the food material better improvement [17].

5. Commercial Food Services

Historically the evolution of public eating-places was stimulated by the desire for travel both for spiritual enrichment and commercial gain. It is said that the custom of pilgrimages played a vital role in the evolution of French and English inns. The slow rate of transportation often limited the day's trip to 10 miles and necessitated provision for rest and refreshment at regular intervals. Similarly the merchant making round of the villages within his wares, took what he found in primitive institutions to maintain his well being during his absence from home. The provision for the needs of travellers through inns and taverns was perhaps the earliest but far from the best organized and administered the forerunners of our present food services. The in sanitary conditions under which the food was prepared and served, the monotony of the menus, the meagre attempts at servings, and the ignorance of the inn-keeper and his slatternly help have been kept vivid by descriptions in the early literature and by the survival of such inns into more recent times.

It was about this time that the evolution of the restaurants began as public eating places, separate and apart from provisions for sleeping. The beginning of the concept has been traced to the cook shops of France, which were licensed to prepare *ragouts* or stews, to be eaten on the premises or taken to inns or homes for consumption. The shops had menus pasted on the wall or by the door to what the interest of the passer-by.

Commercial food services at present time range from the most common a la carte (by the menu) or a table d'hôte (Table of host) services used in exclusive restaurants and hotel dining rooms to that available at drive-inns, pizzerias, or soda fountains. The custom of dining out side the home for some or all meals has increased rapidly. The changes in the mode of modern living are responsible for the increased number of eating-places. The factors contributing to this change include: the tendency towards urban living, the improvement in economic status and the corresponding rise in standard of living: increased interest in and improved transport facilities: a shorter work week providing more leisure time: the decrease in the availability of household help, with more untrained labours diverted towards industry: the availability of meals is more highly specialized type of

food services: the increased number of women going into professions and industrial work: and popularity of small house units such as apartments and retirement homes or cottages that are not conducive to extensive meal preparation. The restaurant industry is defined in its broadest sense to mean all establishments where food is consumed for a consideration away from home.

6. Vending

Latest trend in the commercial field has been towards speedy types of operations as evidenced by the rapid growth of the vending business and the "do-it-yourself" types of cafeterias. Acceptance of vending by public has made it an important supplement to manual types of services Food vending machines may be prepared by the institutions for their individual purpose. In institutions having no kitchens, foods are provided by an outside catering company, which delivers fresh foods at frequent intervals and keeps the machines in good working order.

7. Industrial Food Service

The importance of industrial food service as it is known today has had an exciting yet slow developing history. Provision of food for employees has become a necessity since those early days when labour either forced or hired to work in the fields or on the monuments of antiquity such as pyramids and great walls of the world. The industrial revolution in the latter part of 18th century brought about changes in the socio-economic systems. In 1800's, employers were provided meals free of charge or at subsidized rates. This philosophy of subsidizing the meal service has continued in most industrial units and represents a real addition in savings to the employees. The importance of industrial feeding was not fully realized until World War II when manufacturing plants found that nutritious and well-balanced meals contributed much to the health, efficiency and satisfaction of the employees. Types of services other than cafeteria are used to replace supplement or extend industrial food services to the employees. In large plants particularly mobile carts are used to carry limited number of items like soups, milk, coffee, sandwiches, fruits, cookies and pie.

Innovation in food service technology offers differentiation and cost leadership in strategic terms. The majority of food service businesses do not have research and development laboratories. At present, the innovations in equipment design and layout, packaging and service techniques are of a defensive or reactive nature. Examples of defensive innovation include faster and better preparation methods, improved temperature control, even heating, energy and labour savings, less waste, better sanitation, faster service and flexibility. In contrast, developments in offensive or pro-active innovation, which

can radically change current practices, are rare. Novel food service processes can evolve as a result of adoption of technological breakthroughs in “high tech” fields of the economy. It justifies investments in offensive research and highlights the importance of technical competencies for a food service professional [18].

8. School Lunch

The school lunch is inevitably a part of the rapid development of public education. In order to encourage school attendance, parents and civilians bonded together to provide school lunch at low cost. The children’s Aid society of New York City opened an industrial school in 1853 as an effort to persuade the children of the slum to seek “instruction in industry and mental training” and offered food to all comers. Growth in the knowledge of nutrition in the later years placed emphasis on importance of wise selection of food and the need for nourishing school lunches at low cost or without charge.

Food service organization and management in school program varies from one cook-manager operation in small and independent schools to a complex centrally managed unit in a large city school system. In addition to centralized management some school systems have established centralized food preparation centres. The food on arrival to school are reheated and made “table-ready” by giving finishing touches to make the food attractive to the children. Food services in all schools are limited to noon meals or sometimes extended to include breakfast and mid morning lunch for the malnourished and young children.

9. Hospitals

The evolution of food services in hospital is interesting as little or no importance was given to provide therapeutic diet for hospital patients. Dieticians as well as nurses should honour the reverend Florence Nightingale as the pioneer in this profession. Through her efforts a diet kitchen was set up in 1855 to provide clean, nourishing food for the ill and wounded soldiers. Irrespective of the source of support (operated by government: state or country, city funds or their combination, maintained by religious orders, majority is privately owned), the food service in these institutions is unique and complex, requiring a staff of well-qualified dieticians.

10. Portable Meals

A fairly new development among food service is that of delivering meals to the residence of the aged, chronically ill, or infirm individuals not requiring hospitalisation. This plan, sometimes called “meals-on-wheels” attempts to meet the need for nutritious meals for those person who are temporarily disabled or aged, usually living

alone and unable to cook for them. In communities where such plan is in operation, meals are contracted and paid directly by the individual in need of the service, or some community agency or volunteer organization may provide funds for the person unable to pay for service. A dietician or a nutritionist working cooperatively with the organization providing the meals plans menus desirably. Food is prepared by the restaurant, hospitals, or other food services and may be delivered by them or by volunteer workers.

11. Space Feeding

Man’s urge to explore the unknown outer space has created many heretofore undreamed of problems in food service field. Since April 1957 when seven men were selected to become astronauts for the United States, research has gone forward to determine the type, variety, and form of food best suited to the needs of the space traveller. The more basic concern of the nutritionist and dietician is the problem of providing suitable, acceptable, and nutritionally adequate meals for man to live effectively for extended periods in the zero gravity environment encountered in the outer space. Packaging of foods must provide protection against such environmental conditions as radiations, moisture pickup, and oxidation. They should be light in weight and edible, yet permit the addition of water for reconstitution. The restrictions imposed by the limitations of space also call for research in equipment design suitable for storage, preparation, and serving of the food and weight and available fuel or power.

12. Quality in Institutional Foods

The goal of food service institution is the maintenance of acceptable standards of food preparation that will result in a product of high quality, served in the best condition and manner possible. The prerequisites for the attainment of the above goal are:

- Knowledge of meal planning
- Food selection
- Preparation
- Service
- Coherent thinking
- Clear-cut organization
- Successful personnel direction
- Cost control
- Wise planning of layout and selection of proper equipment

Consumer acceptability, meal quality and visual aspects will be affected during re heating stage for service to the consumer of prepared meals. A reliable method is essential for preserving and distributing the cooked meals, causing a minimal effect on the “hidden” microbiological

and nutritional qualities as well as the tangible sensory qualities. The microbial load of the raw material inputs must be kept low through stringent inspection and monitoring procedures as the heat processing often only eliminates a proportion of the microorganisms. Safety problems, arising from the potential for growth of pathogenic and spoilage microorganisms must be minimized especially through temperature monitoring during cooling and refrigerated storage. Sensory problems caused by colour and texture changes, separation of food components, drying out, rancidity and development of off-flavours, must be minimized through careful recipe development and shelf life evaluation. Reduction in nutritional levels during storage and reheating, especially for the heat-labile B group vitamins must be minimized. The consumer acceptability of the reheated product should be the final criterion for judging the success of institutional food service meal system. While the use of institutional food service systems has been growing potentially, changing life styles for consumers combined with their need for increased convenience, have seen the prepared meals adapted for retail sale as chilled or frozen ready meals to be used in the home. By adopting institutional food service system concepts, retailers have been moving into the rapidly growing “home meal replacement” sector to take advantage of profitable chilled meals and to give the consumer a greater choice of menu and portion size than pre-packaged ready meals [19-21].

The most acceptable and usual method for assessing consumer acceptability of institutional foods has been some form of experimental evaluation, comprising the comparison of the sensory qualities of cook-freeze, cook-chill and *sous vide* versions of the same product [22] or of the nutrient retention in cook-serve, cook-chill, *sous vide* and meal assembly hospital system [23]. However, an evaluation may not provide a straightforward answer; consumers rated prepared meals from various food service systems were very highly under taste panel condition. But in practice, these precooked foods were subject to high level of wastage in hospital food service system [24]. In other work based on *sous vide* processed foods, the sensory quality of food is a highly important as a factor contributing to the consumer pleasure during the “eating out” occasion, non-food environmental factors, characterized by perceived level of “customer care” were much more influential.

Food safety is crucial in institutional food services given the large number of meals served every year. With chill-chain procedures, many meals (thousands per day and per kitchen) are cooked, cooled soon after cooking, kept cold, transported to 33 catering facilities, and reheated just before serving. Cooling, reheating and distribution operations have been identified as the main causative factors for *Clostridium perfringens* outbreaks [25, 26].

13. Role of Human Engineering in Designing Food Service System

The field of human factors engineering is concerned with two major human system components: those who are involved in operating the system and those who are recipients of the systems output. In food service system the main focus of concern is the food service worker with second attention paid to the customer. The human engineer is typically a psychologist and or an engineer who applies psychological engineering, and other principles to characterize the role of the human in the system. The human engineer is specifically concerned with those aspects in design that will ensure the system conforms to the capabilities of the human who is expected to be a part of it. Environmental conditions (e.g.: optimum temperature and noise levels), workspace layout, design of specific pieces of equipment, safety and training all are considered in terms of fitting the human and non human parts of the given system together. Human factors checklist used to compare three alternative military field-feeding concepts is represented in the **Table 1** below. It is not difficult to draw similar guidelines for human factor evaluation of non-military institutional or commercial

Table 1. Human factors/safety check points.

1. Environmental conditions	
a)	Lighting
b)	Temperature
c)	Humidity
d)	Noise
e)	Effects of rain, snow or wind
2. Work space dimension/layout (to accommodate 5 th to 95 th percentile of users)	
a)	Arm reach
b)	Height of the equipment
c)	Clearance for the whole body, head, limbs etc
1.	In the equipment operation
2.	In entry and exit
3.	In moving around the kitchen
4.	In relation to other operators
d)	Visual functions
e)	Work flow
(Workspace elements arranged in anticipated sequence of operation)	
f)	Customer flow
3. Psychological factors	
a)	Poor postural control in operation
b)	Fatigue inducing activity
4. Specific equipment design (ranges, burners, gills, coffee makers)	
a)	Displays (gauges, indicators)
b)	Controls
c)	Ease of operation
d)	Safety
5. Storage space	
a)	Organisation of storage area (Ease of storage and removal)
b)	Reach distance to storage area
c)	Lighting
d)	Safety

food service operation.

REFERENCES

- [1] P. G. Creed, "Equipment Systems," In: R. Pine, Ed., *Catering Equipments Management*, Hutchinson, London, 1989, pp. 51-60.
- [2] J. Millross, A. Speht, K. Holdsworth and G. Glew, "The Utilization of Cook Freeze Catering Systems for School Meals," University of Leeds, Leeds, 1973.
- [3] N. Light and A. Walker, "Cook Chill Catering: Technology and Management," Elsevier Applied Science, London, 1990.
- [4] P. G. Creed and W. G. Reeve, "Principles and Applications of Sous Vide Processed Foods," In: S. Ghazala, Ed., *Sous Vide and Cook Chill Processing for the Food Industry*, Aspen Publishers Inc., Gaithersburg, 1998, pp. 25-26.
- [5] "Planning for Cook-Chill," Electricity Council, London, 1982.
- [6] W. G. Reeve, P. G. Creed and B. J. Pierson, "Institutional Food Service Systems: Does Technical Innovation Work against Consumer Satisfaction," *International Journal of Contemporary Hospitality management*, Vol. 11, No. 1, 1999, pp. 51-53.
- [7] P. G. Creed, "Sensory and Nutritional Aspects of Sous Vide Processed Foods," In: S. Ghazala, Ed., *Sous Vide and Cook Chill Processing for the Food Industry*, Aspen Publishers Inc., Gaithersburg, 1998, pp. 57-88.
- [8] G. E. Livingston, "Food Technology, Vol. 20," Institute of Food Technologists, Chicago, 1966, p. 76.
- [9] R. Engstrom and A. Carlsson-Kanyama, "Food Losses in Food Service Institutions Examples from Sweden," *Food Policy*, Vol. 29, No. 3, 2004, pp. 203-213. [doi:10.1016/j.foodpol.2004.03.004](https://doi.org/10.1016/j.foodpol.2004.03.004)
- [10] P. E. Rozin and H. Tuorila, "Simultaneous and Temporal Contextual Influence on Food Acceptance," *Food Quality and Preference*, Vol. 4, No. 1, 1993, pp. 11-20. [doi:10.1016/0950-3293\(93\)90309-T](https://doi.org/10.1016/0950-3293(93)90309-T)
- [11] A. V. Cardello, "Consumer Expectations and Their Role in Food Acceptance," In: H. J. H. MacFie and D. M. H. Thomson, Eds., *Measurement of Food Preferences*, Blackie Academic & Professional, London, 1994, pp. 253-297. [doi:10.1007/978-1-4615-2171-6_10](https://doi.org/10.1007/978-1-4615-2171-6_10)
- [12] A. V. Cardello, "The Role of the Human Senses in Food Acceptance," In: H. L. Meiselman and H. J. H. MacFie, Eds., *Food Choice, Acceptance Consumption*, Blackie Academic & Professional, London, 1996, pp. 1-82. [doi:10.1007/978-1-4613-1221-5_1](https://doi.org/10.1007/978-1-4613-1221-5_1)
- [13] S. Herne, "Research on Food Choice and Nutritional Status in Elderly People: A Review," *British Food Journal*, Vol. 97, No. 9, 1995, pp. 12-29. [doi:10.1108/00070709510100136](https://doi.org/10.1108/00070709510100136)
- [14] F. M. Clydesdale, "Changes in Colour and Flavour and Their Effect on Sensory Perceptions in the Elderly," *Nutrition Review*, Vol. 52, No. 8, 1994, pp. 19-20. [doi:10.1111/j.1753-4887.1994.tb01441.x](https://doi.org/10.1111/j.1753-4887.1994.tb01441.x)
- [15] G. V. Barbosa-Canovas, U. R. Pothakamury, E. Palou and B. G. Swanson, "Non Thermal Preservation of Foods," Marcel Dekker, New York, 1998.
- [16] P. G. Creed, "A Study of the Sensory Characteristics of Food Produced by Sous Vides System—The Measure of Pleasure," Ph.D. Dissertation, Bournemouth University, 1998.
- [17] P. Appendini and J. H. Hotchkiss, "Review of Antimicrobial Food Packaging," *Innovative Food Science & Emerging Technologies*, Vol. 3, No. 2, 2002, pp. 113-126. [doi:10.1016/S1466-8564\(02\)00012-7](https://doi.org/10.1016/S1466-8564(02)00012-7)
- [18] S. Rodgers, "Innovation in Food Service Technology and Its Strategic Role," *International Journal of Hospitality Management*, Vol. 26, No. 4, 2007, pp. 899-912. [doi:10.1016/j.ijhm.2006.10.001](https://doi.org/10.1016/j.ijhm.2006.10.001)
- [19] O. P. Carroll, "Ready Meals Trends/Supermarkets Awakened to HMR," *The World of Ingredients*, 1998, pp. 36-46.
- [20] C. E. Morris, "HMRs Challenge Manufacturers," *Food Engineering*, Vol. 70, No. 5, 1998, pp. 67-70.
- [21] P. G. Creed, "Chilling and Freezing of Prepared Consumer Foods," In: D. W. Sun, Ed., *Advances in Food Refrigeration*, Leatherhead Food Research Association, Leatherhead, 2001, pp. 422-455.
- [22] J. S. A. Edwards, J. M. Schafheitle, W. G. Reeve and A. Edwards, "Food Production Techniques in Catering Today—A Comparative Study," In: J. S. A. Edwards and D. Lee-Ross, Eds., *Culinary Arts and Sciences 2*, Worshipful Company of Cooks, Bournemouth, 1998.
- [23] A. West, A. Walker and J. Lawson, "The Effects of Food Processing in Hospital Atering," In: J. S. A. Edwards and D. Lee-Ross, *Proceedings of Culinary Arts and Sciences II—Global and National Perspectives*, Bournemouth, 1998, pp. 283-289.
- [24] J. S. A. Edwards and A. Nash, "The Nutritional Implications of Food Wastage in Hospital Food Service Management," *Nutrition in Food Science*, Vol. 29, No. 2, 1999, pp. 89-98. [doi:10.1108/00346659910254394](https://doi.org/10.1108/00346659910254394)
- [25] A. E. I. de Jong, F. M. Rombouts and R. R. Beumer, "Behavior of *Clostridium perfringens* at Low Temperatures," *International Journal of Food Microbiology*, Vol. 97, No. 1, 2004, pp. 71-80. [doi:10.1016/j.ijfoodmicro.2004.03.030](https://doi.org/10.1016/j.ijfoodmicro.2004.03.030)
- [26] A. E. I. de Jong, R. R. Beumer and M. Zwietering, "Modeling Growth of *Clostridium perfringens* in Pea Soup during Cooling," *Risk Analysis*, Vol. 25, No. 1, 2005, pp. 61-73. [doi:10.1111/j.0272-4332.2005.00567.x](https://doi.org/10.1111/j.0272-4332.2005.00567.x)