

Original Paper

Cold Chain Synergy of Chain Restaurant

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Received: April 26, 2019

Accepted: May 7, 2019

Online Published: May 16, 2019

doi:10.22158/jepf.v5n2p219

URL: <http://dx.doi.org/10.22158/jepf.v5n2p219>

Abstract

With the economic development and social progress, the modern catering industry represented by chain operation is gradually moving towards industrialization, chain operation, and modernization. The chain restaurant industry relies more on professional and efficient cold chain supply chain design and services. The cold chain supply chain system includes a distribution center based on the central kitchen, specialized third-party logistics based on its own or outsourced cold chain logistics, and food taste quality research and development represented by new technologies.

Keywords

Chain restaurant, logistics distribution, catering industry, core competency, synergy

1. The Importance of Logistics Distribution in Catering Industry

The supply chain of the chain catering industry is based on chain restaurants and information technology network to manage the production, processing, storage and transportation of materials to processing, and ultimately realize the process from farmland, pasture to table. This process involves the transmission and flow of information and logistics among the members of the catering supply chain, in order to achieve the perfect connection of purchase, sales, inventory, and processing of raw materials, semi-finished products and finished products, so that all the parties of the supply chain can make profits. At the same time, the combination of new food processing technology and cold chain technology provides high value-added output for the supply chain operation of chain catering industry. At present, the level of cold chain logistics in catering industry is uneven. For China, foreign enterprises or domestic large-scale enterprises have invested in logistics management early, and have already possessed modern supply chain and logistics management mode. However, private catering chain enterprises that have developed rapidly in recent years do not have professional cold chain equipment and lack effective process control, which may cause many food safety problems. How to sort out their own business processes, establish an efficient supply chain system and install appropriate

cold chain facilities is a difficult problem for all catering enterprises. Meanwhile, catering chain enterprises lack effective coordination of cold chain logistics resources.

Without an effective distribution network, store managers of catering restaurants need to place many orders to various suppliers and take delivery for many times, which will increase the operating cost, and then affect the business development. Therefore, the establishment of distribution centers in catering chains can greatly reduce the complexity of distribution, and then effectively guarantee the cold chain control and food safety. In addition, the cost of delivery and the cost of food waste can be reduced through the integration of cold chain distribution, store distribution routes and receiving time.

Cold chain, as a whole system, is a strict temperature control process. Whether in the low-temperature warehouse storage and central kitchen processing area, or in the process of loading and unloading, as well as during the transport of refrigerated trucks, temperature must be strictly controlled. At present, the weakest link in chain catering supply chain is the storage and transportation of cold chain. The success or failure of chain catering brand depends on the process of cold chain control. Yikang Company and First Finance Channel present the Seven Stars Award for Food Safety in the Catering Industry every year. All the winners have perfect and strict cold chain control.

Western chain restaurants have built a green supply chain system from farmland and pasture to customer's dining table by referring to the standard model from the parent company abroad to improve the cold chain logistics system. Most of them already have a complete cold chain logistics system. But what Chinese consumers need is a popular and reassuring Chinese food chain that conforms to consumption habits. How to improve the operation of Chinese catering chains through industry exchanges and appropriately learning from abroad is a top priority.

Chain catering industry centers on network platform and is the control center of a virtual network. In catering chains, information sharing is realized through ERP system of back-end supporting department and POS/MENU LINK system of front-end store, achieving effective collaboration among suppliers, service providers and customers.

This electronic supply chain provides strong support for visibility, intelligence and synchronous decision-making in cold chain operation. Through the real-time monitoring and early warning mechanism of cold chain temperature by RFID, the deterioration loss in the circulation and storage of goods can be reduced, information traceability can be facilitated, and the responsibility of quality accidents can be identified. It also improves the safety of cold chain food, enhances the consumer confidence, and establishes the enterprise brand. WMS management of cold storage, GPS positioning of refrigerated car and management of car loading by using TMS system have all played a positive role. The implementation of electronic cold chain in catering chain enterprises can enhance the reaction speed of cold chain and create a complete and competitive supply chain consortium.

The cold chain business should be a high value-added service provided by third-party logistics companies for chain catering enterprises. A typical example is Xia Hui's cold chain service for McDonald's and Subway. HAVI Group, founded in 1974 in Chicago, USA, is a logistics company with

world-leading multi-temperature food distribution technology. With a global presence, it provides quality distribution services to McDonald's restaurants around the world and is an important member of the McDonald's food supply chain. HAVI provides high-quality supply chain management services to more than 8,000 McDonald's restaurants in the US, Europe, China and Southeast Asia, including multi-layer food logistics services. The distribution of Subway in China is also completed by Xia Hui, which adopts the VMI (Vendor Managed Inventory) model. We are looking forward to more Chinese food chain enterprises to improve the competitiveness of the industry through the successful application of cold chain logistics operations. We can export our national brands to the world and build our China's selling/KFC brand.

2. HACCP Management in Chain Catering Cold Chain Control Process

HACCP (Hazard Analysis Critical Control Point) is a preventive food safety management system based on GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operation Procedures). It mainly supervises, controls and prevents safety risks in processing by predicting potential risks. There is no doubt that HACCP management is the continuation of food processing. HACCP attaches great importance to the analysis and control of all links in catering chain operation, pays attention to food safety in each link, carries out hazard analysis from raw material procurement, transportation storage, production and processing, to packaging, warehousing and cold chain distribution, and formulates key control points, so as to ensure that food safety is organically integrated into cold chain logistics operation.

At the same time, HACCP management should be instilled in the distribution center, the central kitchen and the third-party logistics warehouse. When receiving the goods, the vehicle inspection is required, and the temperature control record must be exported to prevent pollution, odor, water leakage and damage. When harvesting the receipt, it is necessary to check the delivery date, batch number and specifications, especially to see if there are signs of thawing. When stacking the film, the information such as the high-strength wrap film of the mixed code layer needs to be clearly marked. When storing, it needs to be placed in the corresponding freezer or refrigerator according to the required temperature. When leaving the warehouse, attention must be paid to cleanliness and hygiene to prevent cross-contamination. Pre-cooling temperature should be set according to the cold chain requirements. The following table records the temperature range of cold chain logistics and the temperature and pressure settings for the ultra high pressure treated food.

Table 1. Cold Chain Temperature for Different Foods

Deep Frozen	>-36°C	Tuna
Frozen	>-12/-18/-25°C	Frozen meat / poultry / aquatic / frozen vegetables / ice cream, etc.
Chilled	>-2/-5°C	chilled meat/poultry/aquatic
Refrigeration	-2-7°C	Dairy / Soy Products / Fruits / Vegetables / Juice
Preservation	7-15°C	fruits and vegetables
Constant temperature	15-25°C	wine / chocolate / coffee beans / food additives

3. Application of Cold Chain and Non-thermal Processing Technology in Chain Catering

The food requiring cold chain logistics in the chain catering industry includes: vegetables, fruits, meat, poultry, eggs, aquatic products, flowers and other primary products; frozen food, poultry, meat, aquatic products, and other packaged cooked food, and ice cream, dairy products, chocolate, fast food raw materials and wine, etc. The quality assurance of frozen food proposed by Assad from United States depends on the "3T": the food's freezing time, temperature, and tolerance, which means, the time and the temperature experienced in the circulation have a decisive influence on the tolerance of the quality. Additionally, the quality of frozen food also depends on the pre-freeze quality (produce), processing, packaging and other factors, namely the "3P" theory. All of these will affect the quality of the dishes in the chain restaurants.

Color, taste and texture are important quality characteristics of vegetables, fruits and seafood meats, they also are the main factors affecting the sensory quality and customer's acceptance of the food. Various processing methods have been used to increase the edibility and palatability of vegetables, fruits and meat, and to extend their shelf life. Food is affected by various internal and external factors, which will cause changes in its original physical and chemical properties, reducing or losing its nutritional value and commodity value. For example, the decay of fruits and vegetables, the deterioration of meat, the spoilage of seafood, and the mildew of grain. The methods for extending the shelf life of food mainly include stopping growth, inhibiting growth and promoting growth. Stopping growth is to kill microbes and destroy the activity of enzymes by stopping all life activities and biochemical reactions in food. Growth inhibition refers to delaying the spoilage of food by inhibiting the life activities and biochemical reactions of microorganisms and food. Growth promotion means preventing the food spoilage by promoting the life activities of the organism and the fermentation of beneficial bacteria. The ultra-high pressure sterilization method is a combination of all of the three methods.

The inhibition of food spoilage can be achieved by controlling the low temperature of cold chain. Low temperature can inhibit the growth of microorganisms and kill some microbial pathogens. However, biological pathogens die more slowly at low temperature. Low temperature can also inhibit the activity

of the enzyme, but general it cannot be completely inhibited by refrigeration and freezing. Therefore, in order to improve the shelf life of food, it is necessary to simultaneously obtain the effect of cold chain processing and storage by ultra-high pressure sterilization, which is a combination of growth stop, growth inhibition and growth promotion.

When the temperature is lowered, the respiration of vegetables and fruits is weakened, the transpiration is reduced, and the shelf life is extended, but the taste and freshness are affected. Since the high-pressure processing method has little effect on the covalent bond of food, its influence on food nutrition and texture is minimized. Therefore, high-pressure processing is a good alternative to traditional food processing and preservation methods.

Unlike traditional high temperature sterilization methods, ultra-high pressure processing (HPP) refers to food processing technology that seals food in containers, uses water or oil as pressure transmitting medium, and presses food at normal temperature or low temperature, to kill microorganisms effectively after a certain period of time and maximize the original quality of the product.

High-pressure processed meat can promote the release of protein, eliminate some allergens, and remove pathogens. These fresh foods are highly susceptible to deterioration and are easy to reduce freshness during long-distance transportation and sales, which directly affects the final market demand. According to the experimental results, the coordinative treatment of ultra-high pressure and freezing can greatly improve the tenderness of pre-made steak. The combination of these two methods can be more effective in sterilizing steaks. In the cold chain, the total number of colonies under the same pressure will be lower than that under normal temperature and ultra-high pressure. Thus, this processing operation can significantly extend the shelf life of steak, and its taste can be better. When beef tastes bad due to insufficient acid-discharging period, this method can improve the taste and increase customer satisfaction through ultra-high pressure cold chain processing. Table 2 below lists the pressure parameters of ultra-high pressure processing for good taste and bactericidal effect, which can be used as reference for food production enterprises. The relevant data was provided by Kefa High-Pressure Technology Company in Baotou, a Chinese ultra-high pressure equipment manufacturer (Study on the development of non-thermal processing equipment and new technology research projects of the Ministry of Science and Technology of the Twelfth Five-Year Plan).

Therefore, considering the transportation distance of products, how to manage the cold chain transportation and inventory, and how to guide and control requirements through appropriate strategies, in order to achieve effective matching of the fresh product supply chain, and thereby improving profits and reducing waste, is particularly important for upstream and downstream enterprises in the food supply chain and is a common challenge for chain restaurants. At the same time, the ultra-high pressure processed food have strict requirements for the cold chain. Therefore, only through reasonable optimization of cold chain logistics can the cost be reduced, the shelf life and taste of the products be improved, and the consumption of ultra-high pressure foods be popularized. Otherwise, ultra-high pressure foods can only become so-called high-end foods, and cold chain innovation will only become

a high-cost technology application. In the process of ultra-high pressure sterilization, different combinations of pressure and temperature can be used to achieve the desired color, taste and texture of the food. However, when endogenous enzymes or microorganisms are not completely inactivated, the quality of processed vegetables and fruits may change during storage due to coexisting chemical reactions (e.g., oxidation and biochemical reactions). Therefore, the design of the cold chain should base on how to prevent the above chemical reactions.

Compared with traditional processed foods, ultra-high pressure foods also have differences in the coordination of supply chain members. Based on the choice behavior of the final customers foods and juices with different freshness, this study adopts a stochastic modeling and optimization method to analyze transport and sale strategies, as well as the coordination of upstream and downstream production and logistics enterprises. The rational design and implementation of the cold chain can improve the freshness of the products, extend the shelf life of the foods that are easily spoiled after the ultra-high pressure treatment, and improve the customer satisfaction as well as the core competitiveness of the enterprise. By applying the supply chain model, the innovation of the cold chain management can be studied from the relationship between the independent variables and the dependent variables of the impact factors. As mentioned above, color, taste and texture are important quality characteristics, as well as the decisive factors influencing customer's acceptance of the food. In ultra-high pressure processing, different combinations of pressure and temperature can be used to achieve the desired color, taste and texture of the food.

In addition, the packaging design and packaging materials should also match the temperature of cold chain storage and transportation, avoiding the safety problems caused by packaging breakage. At the same time, only soft materials can be used for packaging under ultra-high pressure, so the packaging material is not required to have heat resistance, but its airtightness must be good and must be able to transmit pressure, it also needs to prevent the penetration of high-pressure medium and cannot be destroyed under high pressure. Therefore, the food container can be mainly hexagonal, so that when the ultra-high pressure sterilization is performed, the force is balanced without causing expansion or breakage.

Table 2. The Typical Process Parameters of Ultra-high Pressure Treatment for Various Foods

Food Item	The Pressure Value of Ultra-high Pressure Processed Food	
	MPa	Psi
Fruit		
Fruit juices		
Orange juice	100-800	14,504-116,030
Apple juice	150-621	21,756-90,068
Peach juice	600	87,023
Jam/Jelly	100-400	14,504-58,015

Apple cubes	400	58,015
Strawberry coulis	200-500	29,008-72,519
Banana puree	500-700	72,519-101,526
Vegetables		
Fresh raw vegetables		
Lettuce	200-400	29,008-58,015
Tomato	200-400	29,008-58,015
Asparagus	200-400	29,008-58,015
Onion	200-400	29,008-58,015
Cauliflower	200-400	29,008-58,015
Lamb	200	29,008
Luncheon meats	600	87,023
Pork	200-827	29,008-119,946
Poultry	350-500	50,763-72,519
Rabbit	<200	<29,008
Sausage	400-550	58,015-79,771
Turkey	200-400	29,008-58,015
Seafood		
Fish	200-700	29,008-101,526
Minced Fish Gels	200-375	29,008-54,389
Octopus	400	58,015
Oyster shellstock	207-345	30,000-50,000
Prawns	400	58,015
Salmon	150	21,756
Squid mantle	150-400	21,756-58,015
Surimi	100-600	14,504-87,023
Beer	300	43,511
Vegetative bacterial cells	300-700	43,511-101,526
Green peas	400-900	58,015-130,534
Crushed/Liquid extract of vegetables		
Carrot	600	87,023
Tomato	335-600	48,588-87,023
Broccoli	600	87,023
Salsa	545	79,046
Tofu	400	58,015
Olive and seed oils	700	101,526
Sprout seeds	250-400	36,259-58,015
Dairy products		
Eggs	100-400	14,514-58,015

Fresh cheese	50-1000	7,252-145,038
Milk	100-600	14,504-87,023
Yogurt	200-800	29,008-116,030
Meat		
Beef	50-1000	7,252-145,038
Fatty duck liver	550	79,771
Frankfurters	300-700	43,511-101,526
Ham	300	43,511

4. The Collaboration of Cold Chain Logistics in Chain Restaurant Industry

In general, the development trend of the chain restaurant catering industry is to establish a cold chain logistics distribution center based on the central kitchen. The cold chain synergy includes coordination among suppliers, coordination between central kitchen and suppliers, as well as cold chain logistics distribution centers and suppliers, coordination among delivery centers, and coordination between restaurant and cold chain logistics providers. The coordination involves all aspects of operation, including capital, production, and comprehensive utilization of equipment, effective use of cold chain facilities, and information sharing. The synergies will ultimately enhance the core competency of supply chain, which allowing all parties to achieve a win-win situation in the end.

The contribution of this research will be the devotion of cold chain synergies in chain restaurant and the author will continue the foods and beverage cold chain research in the application of non-thermal process in the future.

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