Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2019, 6(10):94-97**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Examining the Current State and the Structural Characteristics of the Cold Storage Facilities Used for the Foodstuff of Animal Origin

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Abstract The purpose of this study was to examine the current state and the structural characteristics of the cold storage facilities used for the foodstuff of animal origin which were located in the Anatolian side of Istanbul, Marmara region, Turkey. The data obtained from the study were evaluated in the light of the construction rules standard for cold storage facilities (TSE 9048) and the principles for the storage of food products specified in Turkish Food Codex. As a result of the research, it was found that the cold storage facilities complied with the principles specified in the standard and codex in question in terms of the structural characteristics and storage conditions. The most negative aspect of the storage facilities was the fact that they were located in or near the residential areas due to wrong choices in terms of location.

Keywords Cold storage, structural characteristics, storage conditions, food of animal origin

Introduction

From past to present, people have been in need of storing, conserving, and preserving the surplus products left after the consumption or sales. Because it makes the individuals and thereby the societies economically and socially safer and stronger to keep the surplus products for a longer period of time and to consume these products when needed or to offer them for consumption.

Today, the cooling sector has become a major industry by means of being supported by the advanced engineering technologies. Cold storage has radically affected the national economies and created a very profitable sector that benefits both the producer and the consumer.

Cold storage has many different purposes. These purposes are as follows; delaying the loss of quality in the perishable foodstuffs, optimizing the processing activities, balancing the discrepancy between in the supply and demand, ensuring the continuity of raw material input, and ensuring the strategic supply of food products [1, 2].

In the early years of the storage operations in Turkey, the cold storage for the agricultural products was not developed much; instead, the storage facilities for the meat and dairy products were more common. With the incentives and supports provided by the state for the cold storage in recent years, 1696 cold storage facilities were established between 2010 and 2018. Of these storage facilities, 49% are used for the fruits and vegetables and 51% for the foods of animal origin. Of the cold storage facilities in Turkey, 93.33% are run by private firms, 3.39% by cooperatives, and 3.28% by the public [3].

The construction material used in the cold storage facilities in Turkey are as follows; conventional reinforced concrete, prefabricated concrete, and steel construction systems. In general, there is a transition from the conventional construction system to the prefabrication construction systems [4].

The cooling in the storage facilities is provided in many different ways. Today, the most commonly used technology in the world functions by means of directing the low heat created by refrigerants into the ambient air. The most commonly used refrigerants are ammonia and freon gases.

The purpose of this study was to examine the current state and the structural characteristics of the cold storage facilities used for the foodstuff of animal origin which were located in the Anatolian side of Istanbul, Marmara region, Turkey. The data obtained from the study were evaluated in the light of the TSE 9048 standards and the principles for the storage of food products specified in Turkish Food Codex.

Material and Method

The cold storage facilities used for the foodstuff of animal origin which were located in the Anatolian side of Istanbul, Marmara region, Turkey were chosen as the research material. The study area is located between the latitude of 41° 01' North and the longitude of 28° 58' East and its average altitude from the sea level is 40 m [5]. The study was carried out in 12 facilities in which only the foods of animal origin were stored. The capacities of the facilities varied between 100 tons and 5000 tons [3].

The study was carried out in three stages: field studies, survey study, and office studies. In the field studies; the followings were examined through the on-site measurements and observations: site selection, construction materials, dimensions of the construction elements, positioning, ventilation, insulation, and the cooling techniques. In the survey study, face-to-face interviews were conducted with the business owners to obtain information about their businesses and the problems they faced. In the office study; the data obtained in the first two stages were evaluated in terms of the compliance with the construction rules standard for cold storage facilities (TSE 9048 issued by Turkish Standards Institution) and the principles for the storage of food products specified in Turkish Food Codex (Notification no: 2012/74).

Results and Discussion

It has always been a current and important issue how to preserve the foodstuffs for a long time without spoilage. The rapid increase in the world population and the increase in the needs of the people for food as a result of the population increase have made it necessary to carry out studies on these fields. These studies have been mainly focused on preserving the food for a longer period without any loss in the quality of the food. This need has paved the way for the development of the modern cooling and freezing techniques. The cooling and freezing process is widely used in different fields including the fruit and vegetables, meat and meat products, dairy products, and bakery products. It is obligatory to comply with the principles stipulated in TSE 9048 standard and Turkish Food Codex regulation, which are in force in Turkey, for the planning, design, construction of the cold storage facilities, the most important part of the cold chain, and the storage of the products.

The educational background of the owners of the cold storage businesses in the study area was specified through a survey and was given in the Table 1.

Table 1: Distribution of the business owners by their educational background

Their educational	Number of the businesses	Percentage distribution (%)
High School	3	25
Undergraduate	8	66.7
Postgraduate	1	8.3
Total	12	100

As seen in the Table, of the business owners, 66.7% were high school graduates, 25% were undergraduate graduate, and 8.3% were postgraduate graduates. It is important that the cold storage facilities used for the foodstuffs closely related to the human health are run by the people with high educational level. In this regard, it was seen that 91.7% of business owners were the undergraduate and postgraduate graduates. In TS-9048, there is an obligation to have at least high school graduates responsible for the hygiene and sanitation in the cold storage facilities [6]. The Turkish Food Codex also recommends that the education level of the employees working in the fulfillment of hygiene requirements in the cold storage facilities, in which the food products are stored, be at least the high school graduates. It is also recommended that at least one employee be a Food

Engineer or an Agricultural Engineer for the food safety [7]. When considered from this point of view, 83.3% of the enterprises in the study area had the employee at the engineer level, while 16.7% did not have.

While in 75% of the facilities, similar products were stored in the same place, in 25% of them the products were stored in a mixed way. In the TS-9048, it is recommended that the cold storage businesses store the same type of food in one place due to the hygiene and sanitation [6].

It may not be economical for the small businesses to build their own cold storage facilities due to the financial burdens in terms of investment and operating costs. Instead, it can be more economical to rent these facilities. As a matter of fact, a law was enacted in 2005 to provide support and incentives by the state for the licensed warehousing. The purpose of the law is to facilitate the trade of agricultural products, to establish a common system for storage, to ensure the safety of product owners' goods, and to regulate the principles and procedures to protect the quality [8]. On the other hand, leaving the fee setting for the cold storage to the business owners may cause grievance to the product owners. Therefore, transition to the licensed warehousing in cold storage and extending it are also important for the protection of both the business owner and the product owner and thus, the price gouging and the uncertainties in pricing will be eliminated.

In the study area, in the 75% of the cold storage facilities ammonia was used as the refrigerants and in the 25% of them freon was used. Ammonia is a refrigerant that has been widely used in the industrial applications. For the cost-effectiveness, ammonia is recommended to be used especially in large warehouses with a storage capacity of over 500 tons [9]. Freon, known as Hydrofluorocarbon in chemistry, is an artificial gas commonly used in industrial cooling. Today, freon is a good refrigerant for the warehouses with a storage capacity of less than 2000 tons [10].

In the Turkish Food Codex, it is recommended that many products of animal origin be pre-cooled before the storage. While 67% of these enterprises had a pre-cooling system, 33% did not have.

In the survey study carried out for the structural characteristics of the cold storage facilities, the buildings of the businesses were examined in terms of their project status.67% of the buildings were designed as special projects and 33% of them used the standard projects prepared by the related companies. In selecting the site of the facility, 58% of the businesses took as a basis the transportation and 48% of them the closeness to the market.

When the carrier systems used in the cold storage facilities were examined, it was found that 66.2% of the businesses used the conventional reinforced concrete, 25% of them the prefabricated concrete, and 8.3% of them the steel construction systems. The reinforced concrete is commonly preferred due to its advantages over other materials used for the same purpose, such as cost-effectiveness and high resistance to the environmental conditions. The prefabricated warehouses can be preferred due to their advantages such as the ease of installation, saving on time and the possibility of increasing the capacity of the warehouse in the future. Regardless of the carrier system of the cold storage facility, it is stipulated in TS-9048 Standard that the structure be resistant to the fixed loads and live loads during its service life. Furthermore, the floor and walls of the storage facility should be made of waterproof and non-slippery material that does not allow the pest and microorganism to settle and is easy to clean and disinfect [6].

When the dimensions of the cold storage facilities were examined, it was determined that their wall heights varied between 3m and 11m, their lengths between 4m and 130m, and their widths between 2.5m and 85m. The standard does not stipulate any value for the dimensions of the cold storage facilities. When determining the dimensions of the cold storage facilities, it is recommended in the standards to take into account the characteristics of the product, the quantity of the product, the storage method, the duration of the storage and the financial power of the enterprise.

Ventilation is the basis of air conditioning systems. Mechanical ventilation systems are preferred and applied in order to provide a controlled ventilation in the cold storage facilities. The natural ventilation system is widely used for the ventilation of the closed areas outside the cold storage area. It was determined that 66% of the cold storage businesses used the mechanical ventilation systems and 33% used the combined ventilation systems. In the cold storage facilities built in recent years, the air of each room can be cleaned automatically by means of a central ventilation system.

PU (polyurethane) panels, bricks, and briquette-PU panels were preferred as the wall construction material in the cold storage facilities examined within the scope of the study. In the survey, it was determined that 33% of the businesses used PU panel, 8% used brick, and 59% used briquette-PU panel.

Insulation is of capital importance for the cold storage facilities. The quality of the insulation is very important in terms of the energy saving, the profitability of the cold storage business, continuity and the preservation of the product quality. TS-9048 standard emphasizes the importance of heat and moisture insulation in the cold storage for energy saving and the preservation of stored product in terms of quality [6]. In the Turkish Food Codex, it is emphasized that the heat and moisture flow is extremely important in terms of the food health and safety, especially in the cold storage facilities in which the animal products are stored and therefore, the business owners should pay strict attention to the insulation of these facilities [7]. Of the cold storage facilities examined within the scope of the study, 83.4% used sandwich panel, 8.3% used styrofoam, and 8.3% used as the wall insulation material. Likewise, the expanded polystyrene hard foam (EPS) and polyurethane (PU) panels were preferred as the roofing materials by the enterprises.

Conclusion

In the cold storage facilities examined within the scope of the study, there was no situation against the principles stipulated in TSE 9048 standard and Turkish Food Codex in terms of the structural characteristics of the facilities and the storage conditions of animal products. The cold storage facilities were highly suitable for the food safety and the most negative aspect was the fact that they were located in or near the residential areas. This situation can sometimes cause negative conditions for the human and environmental health.

Acknowledgement

This study was derived from Murat BERBER's master's thesis, which was accepted in August 2019 by Department of Biosystems Engineering, Institute of Natural and Applied Sciences, TekirdağNamık Kemal University.

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