Int.J.Curr.Res.Aca.Rev.2020; 8(12): 127-131

EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 8 Number 12 (December-2020)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2020.812.013

An Analysis of Food Freezing and Thawing Techniques

G. Velayudham*

Department of Poultry Engineering, College Poultry Production and Management, Hosur, Krishnigiri District – 635 110, India

**Corresponding author*

Abstract

Freezing process is the one of the best method of food preservation techniques for high quality of food for long storage. The cold storage follows both chilling and freezing processes for the preservation of vegetables from between -18°C and -35°C to avoid the physical, microbiological and chemical activities that causes deterioration in foods. To preserve the food material various freezing equipment's are followed like blast freezer, plate freezer, contact freezer, immersion freezer, cryogenic freezer, individual quick freezer etc. To continue the freezing process, thawing technique of food is most important process, to avoid the food spoilage during the long time storage period before consuming. Nowadays, the preservation of food is transformed into food processing sector. To achieve that freezing is essential process to manufacture and preserve such foods like meat, ice cream, etc. To understand the freezing process, phase change, heat loads, freezing time prediction, factors affecting the freezing and thawing process is essential. During the freezing process, some of ice crystals are damage the food products. Hence, it is essential to know about the thawing of food.

Article Info

Accepted: 08 November 2020
Available Online: 20 December 2020

Keywords

Food products, temperature, heat, transport, retailing, refrigeration process

Introduction

Freezing is one of the most preferable methods of preservation of food products and inhibit microbiological growth and help to preserve the qualities. The fundamentals of freezing are normally required to produce products with high quality for quick freezing and storing at a constant sub – freezing temperature (Petzold *et al.,* 2009). In cold storage, the ready - to - eat meals are normally quick – frozen to a temperature near -15°C to -20°C (Evan, 2008) using cryogenic technique. The above method controls ice nucleation in the way that water can transform into small ice crystal (Kennedy, 2000). In additional to freezing techniques, ice formation (i.e., ice nucleation and growth) is effected by characteristics of food being frozen like mass (Degner *et al.,* 2013). In freezing operation the temperature of usually reduce to - 18°C or less. (Fennema *et al.,* 1975). Freezing considerably the safe storage, but ice crystal formation might result in damaging to the quality of the food. For storage of safe food, we must give an attention to the taste, colour, texture, smell and appearance. The cold storage involves both chilling and frozen process.

Removing the required amount of heat from the food is done thorough refrigeration process only and has to maintain the temperature during storage, transport and retailing etc. During the process, the ice crystals are formed in the food products is named as frozen food. The main aim is to maintain the temperature of meat product

at optimal level. Most frozen food using mechanical process of refrigeration process called freezers. It results fast device to reduce the heat transfer phenomenon from the food. The removing the required amount of heat from the meat product is time consuming operation. The number of recent publications are stated that the meat pasteurization by (Ozkan *et al.*, 2004).

Water evaporation will occur through the evaporation from the product to the air. The original characteristics of the product the heat transfer mechanism is finalized and obtained the final product. The time – temperature of food and food preservation by freezing is explained by Rahman (1999b).

Cold storage is one modern food preferable system and it use from farm to customer. Salvadori, Reynoso, de Michelis, and Mascheroni (1987) gave a graphical method to estimate freezing times of foods with high water content and it is widely accepted. The products can preserve from chilling to frozen state.

Principle of Food Freezing

Mechanism of vapour compression refrigeration system

Compressor

The low pressure and temperature vapour refrigerant from evaporator drawn into the compressor through the inlet or suction valve A, where it is compressed to a high pressure and temperature. This high pressure and temperature vapour refrigerant is discharged into the condenser through the delivery or discharge valve B.

Condenser

The condenser or cooler consists of coils of pipe in which the high pressure and temperature vapour refrigerant is cooled and condensed. The refrigerant while passing through the condenser, gives up its latent heat to the surrounding condensing medium which is normally air or water.

Receiver

The condensed liquid refrigerant from the condenser is stored in a vessel known as receiver from where it is supplied to the evaporator through the expansion valve or refrigerant control valve.

Expansion valve

It is also called throttle valve or refrigerant control valve. The function of expansion valve is to allow the liquid refrigerant under high pressure and temperature to pass at a controlled rate after reducing its pressure and temperature. Some of the liquid refrigerant evaporates as it passes through the expansion valve, but the greater portion is vaporized in the evaporator at the low pressure and temperature.

Evaporator

An evaporator consist of coils of pipe in which the liquid vapor refrigerant at low pressure and temperature is evaporated and changed into vapor refrigerant at low pressure and temperature. In evaporating the liquid vapour refrigerant absorbs its latent heat of vaporization from the medium (air, water or brine) which is to be cooled.

Principle of Freezing Process

Vapour compression refrigeration system is improved type of air refrigeration system in which a suitable working substance termed as refrigerant, is used. It condenses and evaporates at temperature and pressure close to the atmospheric conditions. The various refrigerants usually used for this purpose. The refrigerant used does not leave the system, but is circulated throughout the system alternately condensing and evaporating. In evaporating, the refrigerant absorbs its latent heat it around the cold chamber. While condensing it gives out its latent heat to the circulating water of the cooler. The vapour compression refrigeration system is now used for all purpose refrigeration. It is generally used for all industrial purposes for food freezing.

Types of vapour compression cycles

The vapour compression cycle essential consist of compression, condensation, throttling and evaporation. Many scientist have focused their attention to increase the co-efficient of performance of the cycle.

Cycle with dry saturated vapour after compression

Cycle with wet vapour after compression

Cycle with superheated vapour after compression

Cycle with superheated vapour before compression

Cycle with undercooling or subcooling of refrigeration

The rate of heat removal from the food ($Q_{products}$J/s) accounts of majority of refrigeration load can be determined from

$$Q_{products} = \frac{mC_p(T_{initial} - T_{final})}{\Delta t}$$

m = total mass, kg

c_p = specific heat capacity, J/kg

$T_{initial}$ = initial temperature of the food,

T_{final} = final temperature of food,

Δt is the time taken to remove the heat

Chilling process

The chilling process used in meat preservation for short term storage, it limits the spoilage rate by reduce microbial growth. The storage of food is done at refrigeration temperature of 0˚C to 4˚C after that freezing process has too immediately. Chilling is essential for food hygiene; it improves shelf life, appearance and nutritional quality. Chilling process like immersion chilling and air circulation chilling of food product, the relative humidity is kept at 90% in order to avoid to excessive shrinkage due to loss of moisture. High quality food can store up to a days at refrigerated temperature. Ultra – rapid chilling process can adopt for preservation. Chilling is critical for food hygiene, safety, shelf life, appearance and nutritional quality. Chilled food is food that is stored at refrigeration temperatures, which are at or below 0˚C to −4˚C. Sometime in refrigerated temperature, the growth of psychrophilic organism causing spoilage of food.

Freezing

Freezing is the perfect method of keeping of fresh food. Meat contains mostly 75% of water and it convert to water to ice during freezing. During the freezing process, microbial growths are controlled and nutrition loss will be minimum. Food frozen is done through by calculating the freezing time of product. Sometimes, ice crystals are formed on surface; it causes physical damage to tissue. The water content in meat products is freeze at -20^0c. Total drip losses during thawing are considerably low as water freeze within muscle fibre. Microbial growth stops at -120c. During freezing, about 60% of viable microbial population dies. Sometimes, fresh food can wrap with suitable packaging film before freezing, otherwise food undergoes freeze burn. Freezing, also known as solidification, is a phase transition where a liquid turns into a solid when its temperature is lowered below its freezing point. In accordance with the internationally established definition, freezing means the solidification phase change of a liquid or the liquid content of a substance, usually due to cooling. Although some authors differentiate solidification from freezing as a process where a liquid turns into a solid by increasing the pressure, the two terms are used interchangeably. For most substances, the melting and freezing points are the same temperature; however, certain substances possess differing solid–liquid transition temperatures. Freezing is a common method of food preservation that slows both food decay and the growth of micro-organisms. Besides the effect of lower temperatures on reaction rates, freezing makes water less available for bacteria growth. Freezing is one of the oldest and most widely used methods of food preservation as far back as 1842, freezing has been immensely used in an ice and salt brine. In freezing, flavours, smell and nutritional content most generally remain unchanged. Freezing became commercially applicable after the advent (introduction) of mechanical refrigeration. Freezing has been successfully employed for long term preservation of many foods providing a significant extended shelf-life. Freezing preservation is generally regarded as superior to canning and dehydration with respect to retention in sensory attributes and nutritive attributes.The freezing technique itself, just like the frozen food market, is developing to become faster, more efficient and more cost-effective. Faster freezing means smaller ice crystals and a better-preserved product. For producing a frozen food, using the vapor-compression refrigeration technology and it is similar to ordinary freezers. Nevertheless, a wide variety of processes have been devised to achieve faster heat transfer from the food to the refrigerant.

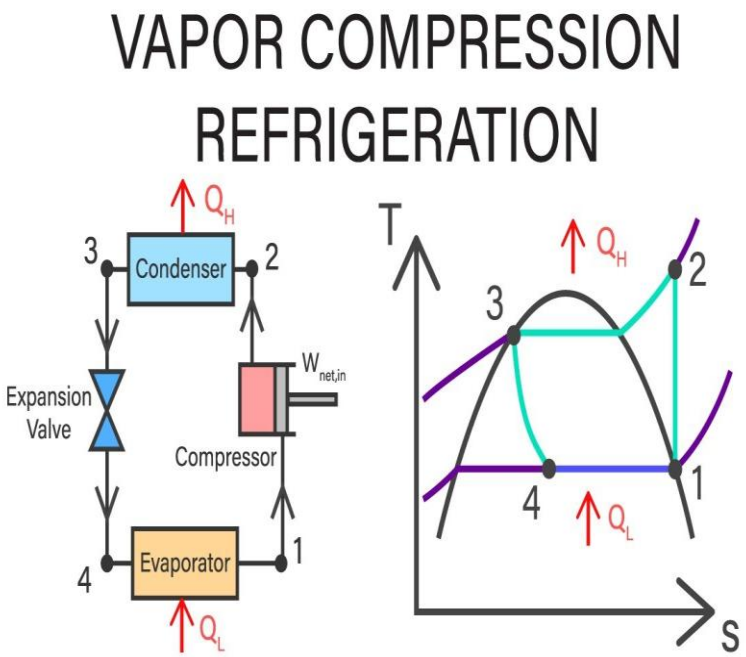
Thawing Process

Frozen food should not thaw at room temperature, to prevent food bacteria growth that may be present from multiplying to high levels. Frozen food is recommended to be thawed in the chiller or by using a microwave oven. They can also be thawed under running water or in tap water but it must be placed in proper package or container.

Table.1 Storage conditions of perishable food products

S. No.	Food products	Short term storage	Long term storage	Air circulation	Forced air circulation	Freezing point in ^{0}c Celsius	Composition in % water	Maximum storage period
1.	Ice cream	-17.8 to -12.2	-28.9 to -17.8	85	85	-2.8 to -17.8	15	6mnonths
2.	Milk	1.7 to 4.4	1.7 to 4.4	70	70	-0.6	87.5	5 days
3.	Poultry (fresh)	-2.2 to -1.1	-2.2 to -1.1	84	87	-2.8	74	10 days
4.	Poultry (Frozen)	-9.4 to -6.7	-17.8 to -15	85	85	-2.8	74	10 months
5.	Apples	1.7 to 4.4	-1.1 to 0	85	88	-1.94	85	8 months

Fig.1 Working principle of refrigeration



The defrost of small amounts of food in the refrigerator and space in chiller, when you need to thaw the food. Thaw food is placed in the refrigerator or chiller room at all times until is used. The thawing food is kept at the safe temperature or lowest temperature of refrigerator or chiller room to prevent bacterial growth. Another method of thawing, place the food in microwave oven on the defrost setting and facilitate for thawing. Final method is thawing of food in running water with that package. The package is kept at safe temperature. Freezing is a preservation process to obtain a high-quality product for consumption; the quality is depending upon by the freezing process and frozen-storage conditions. The freezing rate or time allowed for the product temperature to be decrease from above to below the initial freezing temperature will impact product quality. The storage temperature conditions influence frozen food quality in a significant manner.

The freezing process depends on the product characteristics. The various freezing systems are available, each designed to achieve freezing of a particular product at maximum quality by freezing time prediction. To attain freezing of a food product, the product must be exposed to a low-temperature medium for short time to remove sensible heat and latent heat of

fusion from the product. On continue that the thawing process is most important process for preserving the food quality. The freezing process can be achieved by using either indirect or direct contact systems. The type of freezing system used will depend on the product characteristics, both before and after freezing is completed with thawing process.

References

Degner B. M, Olson K. M, Rose. D, Schlegel. V, Hutkins. R, McClements D. J. Influence of freezing rate variation on the microstructure and physicochemical properties of food emulsions. J. FoodEng.2013;119:244–253.

Evan. J. A. Frozen Food Science and Technology. Wiley Online Library, 2008.

Fennema. O. R, Karel. M, Lund. D. B. Freezing preservation. In O. R. Fennema (Ed.), Principles of food sciences part II. Physical principles of food preservation, 1975, 173-215.

Petzold et al., 2009. Introduction to Food Engineering, R. Paulsingh, fourth edition, 2009. 455 – 530.

Kennedy. C. J. Future trends in frozen foods. In: Kennedy C J. (Ed.), Managing Frozen Foods. Wood head Publishing Limited, Cambridge, 2000,263–278.

Ozkan, N., I., Farid, M., 2004. Combined ohmic and plate heating of hamburger patties: quality of cooked patties. Journal of Food Engineering 63, 141–145.

Rahman. S. F (1999b) Food preservation by freezing. In: Handbook of Food Preservation. Rahman. S. F (Ed), Marcel Dekker, NY. pp: 259, 262, 268.

How to cite this article:

Velayudham, G. 2020. An Analysis of Food Freezing and Thawing Techniques. *Int.J.Curr.Res.Aca.Rev*. 8(12), 127-131. doi: https://doi.org/10.20546/ijcrar.2020.812.013