Marina Bobar [50]
Technical College of Applied Sciences in Zrenjanin, Zrenjanin/Serbia
Milana Drašković [51]
Technical College of Applied Sciences in Zrenjanin, Zrenjanin/Serbia
Danijela M. Jašin [52]
Technical College of Applied Sciences in Zrenjanin, Zrenjanin/Serbia

PRESERVATION OF VEGETABLES WITH INDIVIDUALLY QUICK FROZEN (IQF) TECHNOLOGY

DOI: 10.5937/PIM26179B

Abstract: *Vegetables spoil quickly because they contain a lot of water and have active enzymes. This makes effective preservation methods necessary. Individually Quick Frozen (IQF) technology allows for fast freezing and creates small ice crystals. This helps maintain the structure, texture, and nutritional value of vegetables. This method also boosts food safety by slowing down the growth of bacteria and enzyme reactions, which extends shelf life. While IQF requires special equipment and costs more than regular freezing, it offers better product quality and is commonly used in the modern food industry.*

Keywords: *IQF technology, frozen vegetables, preservation, quality, food safety*

Introduction

Vegetables, due to their chemical composition, represent a highly favorable medium for the growth of microorganisms. The main causes of vegetable spoilage are bacteria of the genera Erwinia, Pseudomonas, and Clostridium, molds such as Botrytis, Penicillium, and Aspergillus, as well as yeasts of the genus Saccharomyces. There are various methods of vegetable preservation that slow down the development of microorganisms and extend the microbiological stability of food. In order to obtain food that is safe for human consumption, vegetables must be preserved [1],[2], and one of the most advanced technologies is Individually Quick Frozen (IQF). The aim of this paper is to present the advantages of IQF compared to conventional freezing methods, while preserving the nutritional and sensory characteristics of vegetables.

[50] marinabobar7@gmail.com, ORCiD: 0009-0004-8635-8472
[51] draskovic.milana@gmail.com, ORCiD: 0009-0002-2085-4356
[52] danijelajasin@gmail.com, ORCiD: 0009-0005-9675-2067

1. IQF tehnology

Individually Quick Frozen technology represents a modern method of food preservation that enables freezing of individual pieces of products at very low temperatures and high rates of heat transfer. Unlike conventional freezing, where slower cooling leads to the formation of larger ice crystals, IQF technology ensures the formation of small crystals that minimally damage the cellular structure of plant tissues [3].

The freezing rate is a key factor affecting the quality of frozen vegetables. Slower freezing leads to water migration and the formation of large ice crystals, which cause mechanical damage to cells and result in texture loss after thawing. In contrast, rapid freezing characteristic of IQF technology allows uniform distribution of ice within the cells, thereby preserving the physical and sensory properties of the product [4].

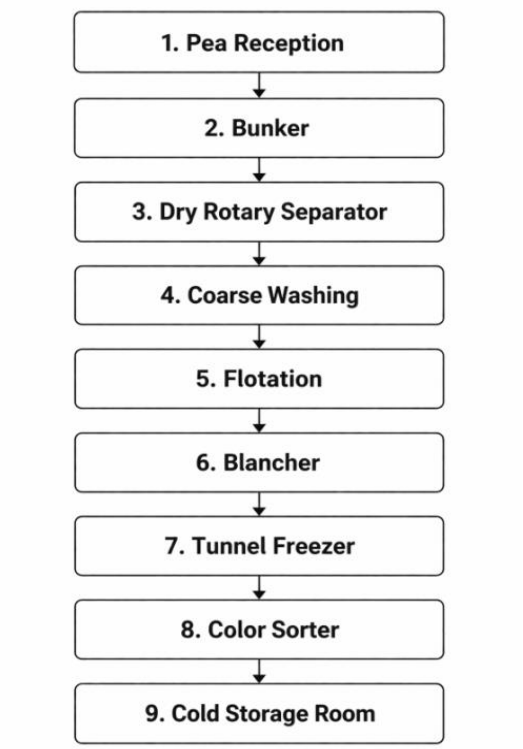
Furthermore, due to rapid freezing and reduced surface damage, the occurrence of dehydration and so-called “freezer burn” is minimized, which extends shelf life and preserves quality during storage [8]. In addition to quality preservation, IQF technology has a significant impact on food safety. Rapid temperature reduction slows down enzymatic activity and the growth of microorganisms, thereby extending product shelf life and reducing the risk of spoilage. Although freezing does not completely destroy microorganisms, it brings them into a state of reduced activity, contributing to microbiological stability during storage [5]. An additional advantage of IQF technology is that products remain individually frozen without sticking together, which allows easier handling, portioning, and reduction of food waste. Due to these characteristics, IQF technology is considered one of the most efficient methods of vegetable preservation in the modern food industry. Research shows that freezing, especially rapid freezing, enables high retention of vitamin C and antioxidant activity in vegetables [7]. Compared to slow freezing, nutrient losses are lower due to reduced cell damage and lower levels of oxidation.

However, despite its many advantages, the IQF method also has certain drawbacks. First of all, it is a technologically complex process that requires specialized and expensive equipment, such as fluidized-bed freezing tunnels or cryogenic systems. This significantly increases initial investment costs compared to conventional freezing methods [6]. In addition, some systems may have higher energy consumption, which

further affects production costs. Moreover, in more sensitive types of vegetables, mechanical damage may occur during transport through the freezing system.

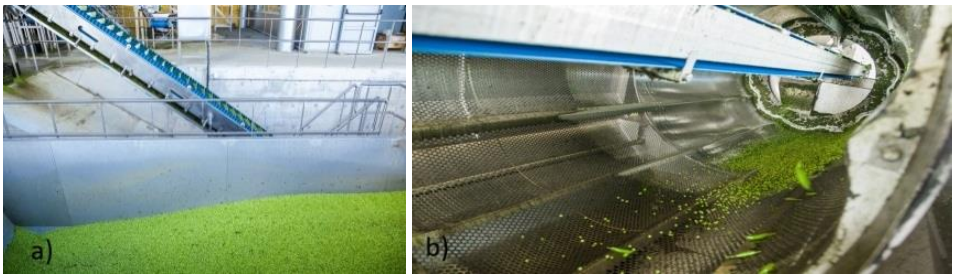
2. Processing of Vegetables Using IQF Technology

At the production facility of Friglo LLC, freshly harvested vegetables are delivered during the season. The raw material is weighed, and samples are taken for analysis. The production process is shown in Scheme 1.



Picture 1. *Block scheme of the vegetable production process*

From the receiving bunker, the vegetables are transported to a dry rotary separator, where larger and smaller waste materials are removed (Picture 2.). With the help of a conveyor line, the raw material is then transferred to the processing plant for further processing.



Picture 2. *a) Receiving bunker b) Dry rotary separator [9]*

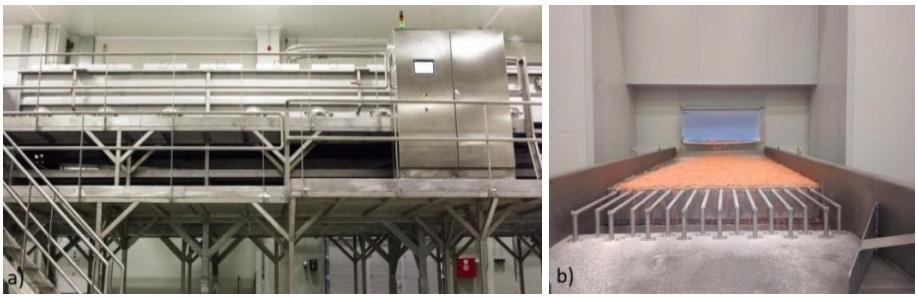
The vegetables enter the washing line, where initial coarse rinsing is performed using water jets to remove the majority of soil, sand, and organic residues. This is followed by flotation, where the vegetables enter a water tank in which air jets create mild turbulence. Lighter materials (leaves, stems) float to the surface, while heavier impurities sink to the bottom (Picture 3.). This stage enables gentle and efficient cleaning without causing damage.



Picture 3. *a) Coarse washing b) Flotation[9]*

After flotation, the vegetables undergo final rinsing with clean water and are then transported to the next stage: blanching. Blanchers are machines in which vegetables are subjected to short-term heat treatment—most commonly hot water or steam at temperatures of 85–95°C for 1 to 5 minutes. Blanching serves several purposes: it inactivates undesirable enzymes, reduces microbiological activity, and improves product stability during storage [1].

The cut (if necessary) and cleaned vegetables are then conveyed to the freezing tunnel, where the temperature ranges from −30 to −40°C (Picture 4.).



Picture 4. *a)Blacher b) Product discharge from the tunnel [9]*

The raw material passes through an air separator and then reaches the color sorter. A color sorter, also known as an optical or digital sorting machine, is a highly advanced device used in the food industry for automated separation of products based on color, shape, and other characteristics.

After sorting, the product is discharged into jumbo bags with a capacity of up to 1050 kg and transported to cold storage chambers.



Picture 5. *a) Color sorter b) Cold storage chamber [9]*

3. Conclusion

IQF technology has proven to be a highly suitable method, as it enables rapid freezing with minimal changes in the structure and composition of the product. In this way, good preservation of sensory and nutritional properties is ensured, along with extended shelf life and satisfactory microbiological stability.

Although it requires higher investment and is technically more demanding, its advantages in terms of final product quality and process efficiency make it an important solution in the modern vegetable processing industry.

REFERENCES

[1] Fellows, P. J. (2009). *Food processing technology: Principles and practice* (3rd ed.). Cambridge, UK: Woodhead Publishing.

[2] Law on Food Safety (2009). Official Gazette of the Serbia, No. 41/2009 and 17/2019.

[3] Noriega-Juárez, A. D., Rubio-Carrillo, J. D., García-Magaña, M. L., González-Aguilar, G. A., Meza-Espinoza, L., Chacón-López, M. A., Aguilera-Aguirre, S., Osuna-García, J. A., & Montalvo-González, E. (2024). Comparison of individual quick freezing and traditional slow freezing on physicochemical, nutritional and antioxidant changes of four mango varieties harvested in two ripening stages. *Food Chemistry Advances*, 4, 100590.

[4] Van der Sman, R. G. M. (2020). Impact of processing factors on quality of frozen vegetables and fruits. Food Engineering Reviews, 12, 399–420.

[5] Alhamdan, A. M., et al. (2016). Freezing of fresh dates for quality preservation. *Journal of Food Processing and Preservation*, 40(6), 1233–1242.

[6] Sun, D. W. (2016). *Handbook of frozen food processing and packaging* (2nd ed.). Boca Raton, FL, USA: CRC Press.

[7] Rickman, J. C., Barrett, D. M., & Bruhn, C. M. (2007). Nutritional comparison of fresh, frozen and canned fruits and vegetables. *Journal of the Science of Food and Agriculture*, 87(6), 930–944.

[8] Rahman, M. S. (2007). *Handbook of food preservation* (2nd ed.). Boca Raton, FL, USA: CRC Press.

[9] Friglo d.o.o. . *Official website*. Retrived from: https://www.friglo.hr/