

# Transport of Tropical Fruits to Central Europe

## *Prijevoz tropskog voća u Srednju Europu*

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DOI 10.17818/NM/2016/2.4

UDK 656.07:621.56/.59

Review / Pregledni rad

Paper accepted / Rukopis primljen: 1. 10. 2015.

### Summary

The paper analyses the transport of exotic fruit from tropical and subtropical areas to the shopping malls located in Central Europe. The exotic fruit belongs to the group of perishable goods. After its harvest and stowage into transport boxes, it is transported in the refrigerated containers by container vessels. Specific conditions (the temperature, the humidity of air) have to be provided in these containers so that the fruit would not be spoiled.

### Sažetak

*U radu se analizira prijevoz tropskog voća iz tropskih i suptropskih područja u trgovačke centre u Srednjoj Europi. Tropsko voće pripada skupini kvarljive robe. Nakon berbe i skladištenja u transportnim kutijama voće se prevozi u rashladnim kontejnerima na kontejnerskim brodovima. U ovim kontejnerima moraju biti osigurani posebni uvjeti (temperatura i vlažnost zraka) kako se voće ne bi pokvarilo.*

### KEY WORDS

tropical fruits  
refrigerated containers  
bananas

### KLJUČNE RIJEČI

tropsko voće  
rashladni kontejneri  
banane

## 1. INTRODUCTION / Uvod

The term exotic (tropical) fruit is known as wild or cultivated fruit that is grown in the tropical and subtropical areas. The only common feature for this fruit is its intolerance to freezing. The Slovak Republic lies in the temperate zone, so it is not possible to grow tropical fruit. Therefore, this fruit has to be imported from the tropical and subtropical countries. The following tropical fruit such as bananas, oranges, tangerines, figs, mango, etc. are transported to Slovakia [3].

Nowadays, it is not a problem to buy this kind of fruit in the shopping malls every day as it used to be. People do not realize how many factors have to be taken into consideration during its transport, transfer and storage.

Tropical fruit that is transported by seagoing vessels is generally picked semi-ripe. If it was picked ripe the ripening process would depreciate it during its transport. This kind of fruit, which is located into specialized containers (refrigerated containers) during its transport, is carried by container ships from the tropical and subtropical countries. The fruit has to be transported at a constant temperature. These containers can be set for the required temperature so that the ripening of fruit would be slowed down. On average, tropical fruit is transported at a temperature from 8 °C to 10 °C [4].

Tropical fruit, which is imported to Europe, can be divided into three classes. These classes are the following:

- extra class,
- I. class,
- II. class.

Imported fruit has to be healthy, undamaged and free of pests.

In 2013, 157 263 t of tropical fruit was consumed in Slovakia, of which citrus fruit was 97 057 t. It was 29.1 kg of tropical fruit per capita. Oranges were the most favorite fruit. It was about 8.9 kg. Then, there were bananas (8.1 kg per capita) and mandarins (4.8 kg per capita). People preferred tropical fruit to domestic fruit. They ate only 21.7 kg of domestic fruit [2].

## 2. BANANAS / Banane

Bananas that are imported to Slovakia are divided into two groups, namely:

- ECP - bananas from former European colonies.
- ACP - bananas from African, Caribbean and Pacific Group of States.

The difference between these groups of bananas is that the ECP bananas are duty-free for the EU member states. The group of ECP includes the countries such as the Dominican Republic, Cameroon, Ivory Coast, and Ghana. The group of ACP consists of the states like Ecuador, Colombia, Panama and Mexico. The most frequent ports in Europe, where bananas are imported, are the ports of Hamburg, Bremenhaven (both located in Germany), Rotterdam (the Netherlands) and Porto Vado (Italy) [7].

Refrigerated containers are used for transport of bananas. It is necessary to ensure a permanent temperature during transport. They are usually transported at a temperature of about 13.5 °C. Into a refrigerated container, 24 pallets with dimensions of 80 x 120 cm can be loaded.

The main principles when handling bananas are the following:

1. The banana is very sensitive to mechanical damages as dropping a box of 30 cm height can cause the abrasions and subsequent browning of bananas.
2. Bananas are kept at a temperature from 11 to 18 °C (optimum temperature is 14 °C), a lower temperature or draught may cause damage to bananas.
3. In the early stage of ripeness, bananas are stored in a sealed foil (microclimate), this foil is opened during the maturation because of ventilation.
4. Boxes with bananas should not be covered by the plastic film, natural ventilation has to be provided [7].

Because of its impact-and pressure-sensitivity, the fruit has to be handled with appropriate care. The required refrigeration temperature always has to be maintained, even during cargo handling. In the damp weather (rain, snow), the cargo has to be protected from moisture, otherwise there is a risk of premature spoilage. Bananas may be divided into seven different degrees of ripeness in accordance with their external colour.

Because of its considerable impact-and pressure-sensitivity, packages of this cargo have to be secured in such a way that they are prevented from damaging each other. Spaces between packages or pallets have to be filled, to prevent slippage or tipping [5].

### 2.1. Distribution to the Slovak shopping malls / Širenje po slovačkim trgovačkim centrima

In Slovakia, there are many companies that import tropical fruit to the Slovak shopping malls. We will focus on the Hortim company that has a branch in Bratislava. The company specializes in the import of bananas and subsequent storage for their ripening. Then bananas are ready to eat and are transported to shopping malls.

Company Hortim prefers to import 90% of bananas from the former French colonies (Cameroon, Ghana and Ivory Coast). In 2013, the company Hortim imported about 180 trucks of bananas (200 thousand boxes) to Slovakia. It was about 3 900 tones (one box of bananas weighs about 19.5 kilograms).

Table 1 Degree of ripeness of banana [5]  
Tablica 1. Stupanj zrelosti banana [5]

Degree of ripeness	Appearance of skin	Characteristics
1	Green	Color at time of loading
2	Green with faint hint of yellow	Color at time of unloading
3	More green than yellow	Incipient discoloration of skin indicates continuing ripening process
4	More yellow than green	Correct degree of ripeness for ordering by wholesalers and retailers and delivery from ripening warehouse
5	Yellow with green tip	Best condition for retail sale, as the fruit can still be kept for several days
6	Completely yellow	Fruit appears at its best and is very tasty. When the fruit is this ripe, the skin is very sensitive to mechanical influences
7	Yellow with brown spots	Small brown spots indicate that the fruit is fully ripe. Its aroma and flavour are at their best

The computer software controls ripening of bananas. It guarantees a high quality for customers during a whole year [7].

### 3. REFRIGERATED AND INSULATED CONTAINERS / Rashladni i izolacijski kontejneri

Refrigerated and insulated containers have a low heat transfer value of the walls. The tropical cargo that arrives in Europe has to pass through warm zones. During its transport, a large amount of water evaporates into the air of a container which condenses on the underside of the roof of the container. The products are divided into the refrigerated and frozen cargoes, depending on the temperature during transport. Fruit, vegetables, meat and dairy products such as butter and cheese belong to these products. Nowadays, cargo that requires its refrigeration is mostly transported in containers with integrated units than in the porthole containers [1].

Refrigerated and insulated containers are usually available as 20 "and 40" containers. They are used with two different systems.

#### 3.1. Containers with integrated cooling units / Kontejneri s integriranim rashladnim jedinicama

This type of refrigerated container has an integrated cooling unit for regulating the temperature inside of container. The cooling unit is located in such a way that the external dimensions of the container meet the ISO standard. On the other hand, the integrated cooling unit reduces the internal volume of a container.

During transport by seagoing vessels, integrated refrigeration units have to be connected to the system board power supply. The number of refrigerated containers, which can be connected, depends on the power capacity of the ship. If the mentioned capacity is too low for connection of refrigerated containers, diesel generators can be used. They have to meet the requirements of ISO. When refrigerated containers are in the container terminal they are connected to the power supply system of the terminal.

Air flows in containers from the bottom up. In general, warm air flows from the internal space of the container. It cools in a cooling unit, and then it returns to the container as cold air. [6]

The floor grating in refrigerated container ensures a sufficient flow of cold air. The air can be dispersed between cargos. The pallets form an additional space between the floor and the load of the container, creating additional space for air circulation. Moreover, the corrugated container sides ensure good air circulation.

At the top of the container, there also has to be adequate clearance (at least 12 cm) for the airflow. Therefore, a refrigeration container cannot be loaded up to the ceiling of container. The maximum load height is marked on the side walls. The packages also need to be appropriately designed for the ensuring of vertical air flow from down to up. Cargo has to be properly located in the container. Except the regulation of the temperature of integrated refrigerated unit, it also allows the controlled change of fresh air, for example for the removing of metabolic products such as CO<sub>2</sub> and ethylene during transport of fruit.

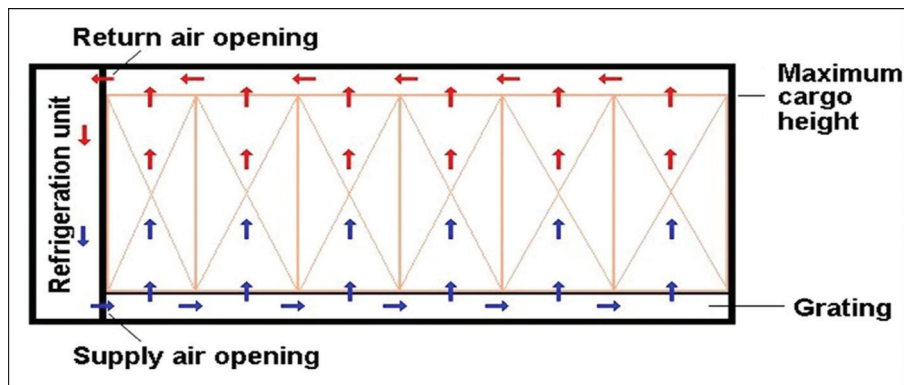


Figure 1 Airflow in refrigerated containers [6]  
Slika 1. Protok zraka u rashladnim kontejnerima [6]



Figure 2 Floor refrigerated container [6]  
Slika 2. Rashladni kontejner s hladnim dnom

The temperature of containers is continuously measured and the temperature display is located outside of the cooling unit so that the operation unit could be controlled any time.

Refrigerated containers with integrated cooling units can be stored below or above deck of the ship. The advantage of location of container on deck is that, there is a better circulation of heat from container into the environment. On the other hand these containers have to face direct sun light. It increases the requirements for the cooling unit [6].



Figure 3 Maximum load height in refrigerated container [6]  
Slika 3. Maksimalna visina opterećenja u rashladnom kontejneru [6]

### 3.2. Porthole containers / Izolacijski kontejneri

This type of containers is often marked not as refrigerated containers, but as isolated containers because they do not have an integrated cooling unit. These containers have a bigger internal space because of the absence of a cooling unit. The air flows in the same way as in containers with integrated units. Cold air is blown in the bottom and a warm air is removed at the top.



Figure 4 Porthole container [8]  
Slika 4. Izolacijski kontejner [8]

These containers also have the vents that are located opposite the door of container. They enable the change of air between the internal area of container and the environment.

Generally, the supplied air is diffused into the lower hole and is distributed by means of the gratings in the container floor. Then, this air passes through cargo and is discharged through the hole on the air outlet. This type of container also requires adequate airflow. For this purpose, they have to be appropriate air ducts that are led under the floor or under the ceiling of container. Cargo has to be carefully packaged and stored [6].

### 3.3. The weaknesses of refrigerated containers / Nedostaci rashladnih kontejnera

The doors represent a weak point in the refrigerated containers for integrated cooling units and porthole containers. During unsuitable handling with the doors of containers, rain water

can get into the container because the doors do not fit tightly. During transport of refrigerated and frozen cargo, supply water can cause damage to cargo or it can freeze on the container door. In addition, the cooling capacity has to be increased to balance the losses due to the leakage of cold air.

Respiring products (e.g. fruit, vegetables, plants) require the supply a quantity of fresh and cool air, depending on their metabolic activity. It limits the metabolism processes and the exchange of gases such as ethylene and carbon dioxide. Fresh air is supplied through fresh air flaps.

#### 4. CONCLUSION / *Zaključak*

The article focused on transport of tropical fruit, especially transport of bananas. During transport of bananas from tropical areas the carriers have to ensure the constant air temperature in the container because of the slowdown of the ripening process. Isolated containers can be used for transport of containers on shorter distances. Bananas are imported in the EU states through big seaports. The company Hortim was mentioned in the article. It is specialized in the transport of containers of bananas to the Slovak shopping malls. This company has specialized warehouses where bananas ripen before their transport to the malls.

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