ASPECTS REGARDING THE CONDITIONING OF HORTICULTURAL PRODUCTS IN FRESH STATE

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ABSTRACT

This paper presents the conditions and equipment underlying the work processes within the flow of conditioning technologies of horticultural products, in order to prolong the life and freshness of fruits, from the time of harvest and storage, to their marketing for consumption.

INTRODUCTION

Fresh fruits were undoubtedly the first food in human nutrition at the beginning of its evolution. Fresh fruits from the fruitful trees have been and continue to be the only finished product of the nature, which is consumed in the state in which there is, without the involvement of other energy consuming products or processes. Therefore, due to the balance and harmony of physico-chemical components, the fruit is one of the nature ready foods that can be eaten fresh. These products are living organisms inside which tissues complex metabolic processes occurring also after harvesting, under the action of their own enzymes. The conservation technologies are intended to reduce the intensity of metabolic processes, in particular of the breath and perspiration, as well as pathogenic microorganisms activity generating decomposition processes.

Establishing the optimal moment of harvesting is done using criteria, tests and indexes. In order to obtain a more precise appreciation is used the simultaneous analysis of the criteria, testings and indexes.

The choice of the optimal timing of harvesting depends on the following factors: the evolution of the fruits during all their development phases, the capitalization mode of the products and their maturation capacity.

- *The evolution of the fruits during all their development phases.* The fruits of the tree species generally can have usage value almost throughout their development from the early stages to the advanced stages of development, from the growth phase and up to their harvest. The fruit evolution duration in all its development stages depends on species, variety, environmental factors and agrotechnical factors and lasts 5-6 weeks at strawberries and 5-7 months at the apples and the pears of autumn and winter. In this period of time, the fruits go through three stages: growth, first fruits, maturation and over-maturation.
- *The capitalization mode of the products.* The horticultural products, are valorised for consumption in fresh condition and for conservation on the way of industrial processing. The choice of the optimal timing of harvest for a particular destination of the production shall be made at a certain stage of their evolution. There are several well-defined stages in the evolution of the fruits, these being determined according to the time of consumption and of how to use:

a) The maturity of consumption is the stage at which the fruits have reached the optimum specific to variety and species regarding the taste, size, colour and flavour, having at the same time the corresponding nutritional and energy value for consumption immediately after harvest.

b) The harvesting maturity is the stage in which are harvested the fruits intended to the long distance transportation or for conservation by storage a long period of time. The sensorial qualities of the fruits at the harvest maturity are weaker expressed, but having a very good firmness of the tissues. For the fruits intended to the long-term preservation in fresh condition, harvesting at this stage is determined by the climatic conditions that become unsuitable for continuation of the vegetation. The fruits from this category reach the maturity of consumption during the period of storage.
c) The industrial maturity is the stage at which the fruits, by their physical, chemical and sensorial properties, correspond to a certain mode of conservation by industrial processes. They may be harvested at any stage of the evolution of a fruit.

- *The maturation capacity* - influences the optimal timing of harvest. Depending on the capacity of maturing, the horticultural products are grouped into two categories:

1. Horticultural products that are harvested in different moments of first fruits phase have the capacity to mature, reaching biochemical and organoleptic characteristics of the variety and species. They improve their sensorial properties as a result of continuing the biochemical changes during the storage of long and short duration (apples and pears of autumn and winter), or of long distance shipments in order to capitalize them (peaches).
2. Horticultural products that remain at the stage of development and maturation which they had at harvesting, having not the ability to mature after being detached from the plants. The fruits in this category are harvested at full maturity to correspond from the sensorial point of view to the immediate consumption, presenting at the same time resistance to handlings and transport.

For both groups of products, the harvest in another stage than the optimum moment, is correlated with an incomplete increase of the fruits, with insufficient accumulation nutritive substances and implicitly with quantitative reductions of crop, decrease of the storage capacity, the adulteration of products, a very little resistance to transportation [1, 3].

MATERIAL AND METHOD

Biochemical and physiological characteristics of the fresh horticultural products

The process of transpiration is a physiological process of physical nature and consists in the loss of the water in form of vapours from the horticultural products in the environment and in the atmosphere of the storage spaces, being determined by the difference between the water vapours pressure from the horticultural products tissues and the one from the atmosphere.

The water loss occurs through lenticels, stomata, calyx, and peduncle, damaged tissues and determines the decrease of tissues turgidity, the fruits becoming soft and with the juiciness reduced. Due to the perspiration, the soluble dry substance is concentrated, having as effect the lowering of the freezing temperature, the change of the taste (significantly sweeter, more sour or more astringent), depending on the content of horticultural products in soluble carbohydrates, acids and tannins.

The level of the intensity of transpiration for the fresh fruits depends on where they are. When they are on plants, they sweat, but the water removed is replaced by the water absorbed from the soil by plant. In this case, the physical and chemical changes occur, but they are very small. The fruits harvested stored under the conditions of a certain environment are devoid of the possibility to recover the water lost through sweating, becoming obvious the irreversible biochemical changes. The higher is the air temperature and the relative humidity lower, the difference between the two pressures of water vapours is greater and the intensity of transpiration is higher. In the situation of the fresh horticultural products stored in the storage spaces (warehouses cells), the transpiration

intensity is controlled by maintaining at the optimal values of the system storage conditions or factors.

The process of breathing represents a whole chain of reactions, a physiological process of biochemical nature, which is characterized by the consumption of organic substances (carbohydrates, protide, lipids) and of oxygen, with the elimination of free energy and thermal energy. The relationship between free energy and heat in the case of living cells is governed by the laws of thermodynamics. Their breath of fresh fruit can be aerobic and anaerobic, depending on the time when take place the physiological process, on the storage conditions and on the degree of their health.

The aerobic respiration occurs in the presence of the atmospheric oxygen, being in fact an oxidation reaction. As a result of the consumption of oxygen in the process of breathing and of releasing of carbon dioxide, take place a modification of the atmosphere in the storage space, constituting itself as principle of keeping the fruits in the modified atmosphere (controlled).

The respiration of the fruits is influenced by many factors: the state of biological activity, the degree of health, the air temperature, the air composition etc. The respiration take place with low intensity during the rest periods, in the case of the healthy products, at the optimal storage temperatures, in an environment where the oxygen content is low and the carbon dioxide content is increased.

The water in the form of vapours and the heat released during respiration creates inappropriate conditions of storage, leading to the rising of the relative humidity into the storage areas, to the moistening of the products and to increasing the temperature of the products and of the air.

The intensity of the respiration is different during the fruits growth and maturation. It is very high during the formation period and the beginning of the fruits growth, after which gradually decreases. At some fruits, in the growth stage, take place a modification in the sense of intensifying its breath, called climacteric respiration. The fruits at which appears this climacteric respiration are those at which take place maturation processes.

The anaerobic respiration is a respiration of fermentative type, encountered in the storage areas, wherein the oxygen is in an amount less than 3%, for the fruits passing in the over-maturation phase.

The degree of maturation at the harvesting of the fruits and to the introduction in storage. The fruit maturation is a complex of chemical reactions which transforms the complex chemical components into simple chemical components. During the maturation the process of hydrolysis predominates. As a result of the biochemical modifications that begin in the first fruits phase and continues in the maturation phase, fruit acquires new properties that improve the taste, aroma, juiciness and colour.

RESULTS AND DISCUSSIONS

Conditioning the horticultural products in view of the consumption in fresh state

The general technological flow of conditioning of horticultural products

Conditioning involves a series of operations aimed at bringing the products to the characteristics set of standards, specific to a particular way of capitalization. By conditioning is achieved a unique and homogeneous quality to the product consignments intended for delivery. Sometimes they are carried out and some additional operations, provided in the specifications, requested by the external beneficiaries or imposed by the quality legislation from the country of destination of the goods.

According to [2, 3, 4], the main operations of conditioning the vegetables and fruits are running from the time of harvesting and up to the moment of packing in view of marketing: adhering soil removal, trimming and pruning leaves or roots, pre-sorting /

sorting, calibration, washing - airing, tying in bunches or sheaves, brushing, polishing, waxing, treatment. They can be mandatory, optional or may be missing from flow.

Conditioning is differentiated and specific for each product and for each direction of recovery in part.

Technological phases of conditioning

- *The qualitative and quantitative reception* enables an accurate records of products in terms of the management and of establishing the destination each consignment.
- *Discharging* must be well organized, as fast as possible and adaptable to all situations that may arise. The products can arrive in bulk, in non- standard packs (baskets), in sacks or crates, and in certain situations it can organize and their palletised transportation (palletized crates or ”box-palettes” in common terms), with a superior labour productivity. Discharging the products transported *in bulk* can be done mechanically by tilting in bunkers. Can be used dumpers transportation means (transport vehicles). For the railway ramps there are also variants there are also variants of discharging of the railway wagons in takeover bunkers, located under rails or laterally. Discharging of *packaged* products is effectuated manually, in the case of those unpalletized, either mechanically those palletized, with different handlers. Emptying the packages of transported goods can be done manually or mechanically (by a dry way), by using of the arresters with drum or of the tilting over throwers of crates. Also exist installations with band for the crates unloading by immersion.
- *The handling of the products during conditioning* is performed in packs or in bulk, manually or mechanically. *The mechanical handling in bulk* of the products with good structural and textural firmness is done with conveyor belts, elevating bands and mechanical shovels of different lengths.
- *Short-term storage prior to conditioning,* although contraindicated, can occur accidentally. The perishable products must be kept in protected spaces, cool and well ventilated, with an optimum relative humidity. The initial state of the products and the air access inside the packaging stacks are decisive factor. Stationing in improper conditions, the products may be degraded.

Cleaning of products may be carried out in the form of removing of adhering or attendant soil, wiping, brushing, washing, airing etc. At some highly perishable products, the cleanliness state is found at harvest / presorting for the fresh consumption, being forbidden to wash (strawberries, fruits of shrubs).

Shaping and cutting the leaves or roots. They aim at improving of their commercial appearance. Non-showy leaves, yellowed or with traces of attack of diseases at the outside of the heads of lettuce, cabbage and other similar species are removed. The exfoliated outer tunics of bulbouses are eliminated. The inedible leaves of some root vegetables, and the roots of onion or green garlic are cut. The operations are executed in most cases manually, but there are also possibilities of mechanization at onion or root vegetables.

Refining the table grapes assumes the removal of some grains or portions of bunches, usually the tip and some secondary branches. Refining is made by hand, at the sorting tables, with special scissors which have the tip rounded and curved. It organizes and lines with mechanical feeding (two superposed conveyors that bring the packaging’s and the caskets with grapes for conditioning), in the case of large quantities. The table grapes intended for the storage does not normally refine, being preferred the choice by selective harvesting and presorting of some corresponding bunches, which can be conditioned after the period of storage.

Sorting or selection, as well as the separation of the products by categories can be made in the initial form of presorting, concomitant with the harvesting, but mainly in

distinct forms technologically of sorting by qualities (qualitative sorting) or by calibres (calibration).

The qualitative sorting is performed specifically for each product, accordance with the provisions from standards. It is estimated visually (authenticity, consistency, shape, colour, appearance, health and cleanliness) or by palpation (the consistency). These elements also allow the evaluation of the freshness or of the maturity degree, offering finally the possibility to the qualified personnel performing manually or half-mechanized this operation să to separate the horticultural products by quality categories.

The calibration is an operation which consists in grouping the products according to size, by the size of the maximum diameter (mm) or by weight (mass, g), into categories or on classes of calibration. The calibration ensures the products uniformity, and among the qualities appreciated at a variety is included and this selection criterion.

The post-harvest treatment: *Waxing of horticultural products* is the operation of applying a film of wax (natural or paraffin) as an emulsion, by spraying or immersion, on their surface. Sometimes are added and various fungicides substances. It is recommended for tomatoes, peaches, pears, apples, melons, cucumbers, peppers, eggplant etc. Polishing after waxing evens the thickness, smoothest the surface and gives shine to the wax film. Waxing has advantages in that it reduces the intensity of respiration and transpiration. Prevents appearance of physiological disturbances by absorbing the cellular oxidation compounds. Allows reduction of losses, a better storage and recovery (peaches). Sometimes deficiencies can occur, given that the protective wax layer prevents the normal metabolic processes. They manifest in the form of browning, steeps or changes in taste and smell. For this reason, the waxed fruits must be kept at an optimal low temperature of refrigeration. For tomatoes, waxing can be performed only at the peduncle area, on where occur the intense metabolic exchanges.

The pellicular protection of the horticultural products can be accomplished also with other inert substances in terms of food, which do not alter their external appearance. Of these are mentioned various natural macromolecular compounds, natural, modified or synthetics (modified forms of starch, plastics etc).

Preservation of horticultural products: in fresh state is a complex of mechanical and physical operations and a complicated physiological process and biochemical process whose purpose consists in maintaining of the commercial and food acceptability of the products for a period of time as long as possible.

Biological principles of conservation of the horticultural products

By *conservation* is achieved the relative stabilization of the properties of a product. The conservation ensures the increase of the stability of the products concerned. A large part of the horticultural products are altering easily, considerably shortening their duration of preservation. The extension of the duration of storage of them is necessary to eliminate the seasonal character of the consumption, increasing the availability to the consumers and reduction of losses at the perishable products. In this respect, it recourse to the use of some methods of relative stabilizing of the properties of these products. The use of one or another of the methods of preservation involves various additional technological operations, after which the products undergo physical, chemical and even biochemical changes. Usually the nutritional and gustatory value is improving.

The final goal of the conservation by a particular process, or by conjugated applying of several methods of preservation is to inhibit or even to destroy the products enzymes and of the microorganisms which are found in products, so that the storage stability of horticultural products to be as high [1, 9].

The conservation procedures are based on the following biological principles: *anabiosis, ceno-anabiosis and abiosis*.

- ***Anabiosis:*** *(the principle of latent life)* underlies preserving of products conserved by procedures preventing the deployment of the vital processes, both of the horticultural products, and of the factors of alteration of them (micro-pests, microorganisms, parasites etc) [5]. Blocking the enzymes, stopping the growth of microorganisms or of macro-pests and consequently, preventing the alteration of products by anabiosis, can be ensured by using of several methods:
  - storage cold by refrigeration at temperatures below 6ºC, but above the freezing point;
  - freezing of products;
  - reduction of water content to the optimum value, by dehydration, concentration or other proceedings, at which the activity of the biological factors is minimum;
  - increasing the osmotic pressure, through the addition of salt, sugar or dehydration and concentration;
  - the use of inert gases (carbon dioxide, nitrogen) bio-inhibiting agents;
  - carbonation (impregnation with CO_2) of liquid products (juices, refreshments).
- ***Ceno-anabiosis:*** consists in creating the optimal conditions to the development of certain favourable microorganisms, which, by their activity, issue into the environment in which there are the horticultural products, substances with bacteriostatic action towards the microflora of alteration of them; simultaneously stimulates and the biochemical processes of the products maturation. Ceno-anabiosis applies to pickling of vegetables and fruits, at the maturation of meat, fish and cheeses or when stopping the alteration processes during the alcoholic fermentation used to produce wine, beer or even draffs or of the mashes in the industry of the strong alcoholic drinks.
- ***Abiosis:*** (the principle of lifelessness) underlies the keeping of the products preserved by procedures that achieve a partial or complete destruction of microorganisms from the product, by the use of the high temperatures (pasteurization, sterilization), of the radiation, chemicals (antiseptics, antibiotics) or of the other methods.

Methods of preservation of horticultural products

The most important methods of conservation [3, 6, 7, 8] are:

- ✓ ***Conservation methods based on the principle biosis***: these methods generally apply to fruits and vegetables, which are capable of physiological breathing after harvest and storage. Their conservation will consider providing the optimum environmental factors recommended for long storage, so the biochemical processes of the products and the speed of the multiplication of spoilage microorganisms is greatly reduced.
- ✓ ***Conservation methods based on the principle of anabiosis***
  - *The use of low temperatures*. The low temperature decelerates up to the complete stop the vital processes of the microorganisms and reduces almost completely the intensity of enzymes activity from the product. Conservation at low temperatures is achieved by two methods: *refrigeration and freezing.*
  - *Refrigeration* is more a mean of preserving than of conservation. The refrigeration temperature aims to minimize the biochemical processes and microbiological. It depends on the biological, structural and biochemical properties of horticultural products. The refrigeration temperature is usually of 0 ... 4°C, but variable depending on the product (vegetables 0 ... 1^0C, fruits -1 ... 1°C, citruses 2 ... 7°C, etc).
  - *Freezing* is a method of conservation widely used for the conservation the food industry products obtained from fruits and vegetables. Freezing takes place at temperatures between -18°C and 40°C.
  - *The partial dehydration or drying* is a procedure of drying based on the reduction of water content, namely increasing the concentration of soluble substances up to

values allowing the stability of horticultural products at storage. By reducing the humidity of products slows down (up to stagnation) the enzymatic activity and stops the development of microorganisms (to a moisture content below 15% stops the growth of yeasts and moulds).

The main methods of dehydration are: natural drying, dehydration directed in specific facilities at normal pressures, dehydrating in a fluidized bed, concentration in vacuum, lyophilization (cryodesiccation or cryosublimation). A method for reducing the content of water is the *concentration,* applied to juices of fruits and vegetables. Concentration is made at temperatures of about 65°C and in vacuum. The vegetable juices can be concentrated by slowly freezing at -10° ... -18°C, followed by the removal of the ice crystals by centrifugation.

- ✓ ***Conservation methods based on the principle of ceno anabiosis:*** *Conservation by natural acidification* is a biochemical method of preserving, based on the formation in the conservation environment of the lactic acid by the fermentation of the fermentable sugars under the action of lactic acid bacteria. This method is applied to pickling vegetables and fruits.
- ✓ ***Conservation methods based on the principle of abiosis:*** *The use of high temperatures.* By heating the products at high temperatures, the enzymes and microorganisms can be destroyed partially or completely. At the temperature of 60-70^{0}C, the vegetative forms of some microorganisms are destroyed in 5-10 minutes; at the temperature of 70°C, are destroyed for 1 hour some non-sporulated microorganisms; at the temperature of 105...125°C are destroyed both the vegetative forms, and the spores of microorganisms. Two processes are known for conservation by means of heat: *pasteurization and sterilization.*

Conservation techniques of the fresh fruit using the artificial cold

Refrigeration represents the cooling method of the fruits up to temperatures close to the freezing point. The level so low of the refrigeration temperature, for the products in which metabolic processes occurring, determines the reduction of the reaction speeds of the endogenous enzymes. In order not to cause mass loss in the chilled products, it is necessary that the relative humidity to be maintained at an appropriate level on the one hand, and on the other hand is important to ensure the conditions for eliminating the possibility of microbiological contamination of the products, in all the steps leading to the refrigeration. The refrigeration temperature is usually of 0.. ..+4°C, but variable depending on the nature of the product. For fruits, the optimal limits, depending on the species, is between -1... + 1°C.

Modern methods of preservation of horticultural products

Category of modern conservation methods includes thermic and athermic methods.

- ✓ ***The conservation methods athermic modern*** more important are:
  - *conservation by means of high pressures* - destruction of vegetative forms of microorganisms under the action of high pressures (4000-10000 bar). The high pressures affects the hydrogen bonds, hydrophobic, ionics of the microorganisms, having the following effects:

- inactivation of some enzymes due to their protein part distortion (preservation of fruits and vegetables);
- stimulation of some enzymes such as thermolysin and cellulases;
- decreasing the activity of some enzymes such as trypsin and carboxypeptidase;
- modification of tertiary and quaternary structure of the proteins, increasing the digestibility and the susceptibility of them to the proteases attack;
- gelation of starch and proteins;
- modification of the melting point of fats, of increasing the triglyceride crystals;

- enhancing the flavour of some food products by the disorganization of some cellular organelles which release proteolytic enzymes acting on the proteins with formation of taste substances;

- *conservation by means of the magnetic field* – the oscillating magnetic field and static exercises fatal effect on microorganisms because of the following deteriorative actions:
  - at the level of cellular membranes;
  - on DNA and modification of DNA synthesis;
  - modification of ion flow (Ca^{2+}) through the membrane.
- *conservation by means of ionizing radiation* (mainly γ) is used for the following purposes:
  - elimination of pathogenic microorganisms (radicidation);
  - eliminating the microorganisms of alteration - vegetative forms (radurization - radio pasteurization);
  - eliminating the microorganisms - vegetative forms and spores, respectively radappertization or radio-sterilization.

The action of accelerated electrons and of the radiation γ is manifested at the level of atoms and molecules with negative effects on the nutritional principles and on the enzymes in the foods.

- *conservation using pulsating electric field of high voltage* - is applied to the liquids, the effect manifesting itself when the transmembrane potential exceeding 1 V across the cell membrane. The procedure does not have negative effects on nutritional and sensory properties of treated products;
- *conservation with ultrashort pulses of light* - produced by laser generators or lamps (flash); a destruction of microorganisms occurs at the inner surface of the packaging, leading to the extension of the duration of preservation, mai especially when it is practiced the storage in chilled or frozen state;
- *conservation /extension of the storage duration using UV.* The lethal action of the UV-C radiations is explained by:
  - inhibition, inactivation of enzymes containing groupings - SH active (sulfhydryl);
  - the action of radiolysis products of water;
  - disorganization of protein structure by splitting the links – SS (disulphide) and breaking of peptide bonds;
  - the formation of thymine dimers which causes the distortion of DNA.

✓ ***Modern thermal preservation methods*** are the following:

- *conservation through ohmic heating* - applies to the liquid food products more or less viscous, with a certain ratio solid / liquid. This procedure falls under the category of a system UHT and the lethal effect on microorganisms is due to the heat and electricity;
- *conservation by heating with radio waves* - is a procedure considered as heating in dielectric, being made simultaneously pasteurization and freezing in continuous flow;
- *conservation by indirect heating with Joule effect (Actijoule)* - The principle of this method is that the heat energy, generated by Joule effect in the mass of a metal tube, is transmitted by forced convection to the product flowing through the tube. Applies to fruit juices, fruit purees, syrups, creams;
- *conservation with antiseptic substances* - antiseptics are substances that stop the development and action of some microorganisms (bacteriostatic substances) or destroy them (bactericidal substances), depending on the concentration and the species of the microorganism. The factors influencing the action of antiseptics are: the concentration of substances, contact time, temperature, species and number of

microorganisms in the substrate, the stage of development of the microorganisms, the chemical composition of the environment and the pH of this;

- *sterilizing filtration (sesto abiosis)* - consists of the retention of microorganisms by certain filtering membranes which allows the passage of liquids that are to be conserved, the latter having to be aseptically packaged.

CONCLUSIONS

Fruits and vegetables, although they have a content much lower in energetic substances than the products of animal origin are important for their contribution in vitamins, minerals, fibres, enzymes, volatile aromatic substances, etc. contributing to the good development of metabolic processes in the human body. As a result of the role that they have in nutrition, the fruits and vegetables enter in the diet in a proportion of 20-25% and is one of the indicators of living standards in a country.

Conditioning involves a series of operations aiming at bringing the products to the features provided by the standards of a particular way of capitalization.

On the other hand, keeping the horticultural products in fresh state represents a complex of mechanical-physical operations and a complicated physiological and biochemical process whose purpose is to maintain the commercial and food acceptability of the products for a longer period of time.

By *conservation* is achieved the relative stabilization of the properties of a product. The ultimate goal of conservation through a particular procedure, or by the conjugated applying of several methods of conservation is to inhibit or even to destroy the enzymes of products and of the microorganisms that live in products, so that the storage stability of horticultural products to be as high.

The conservation procedures are based on the following biological principles: *anabiosis, ceno anabiosis and abiosis.* Refrigeration is based on the fizio anabiosis principle and represents the method of cooling of the fruits up to temperatures close to the freezing point. The main methods of refrigeration of fruits are: refrigeration with cooled air, refrigeration with chilled water, refrigeration in vacuum and refrigeration with hydric ice.

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