COMBINED METHODS FOR FOOD PRESERVATION. HURDLE TECHNOLOGY APPLIED ON SALAMI

Petronela Cristina Cazacu [1*], C.E. Nistor[1], Al. A. Casapu[1], B. Păsărin[1]

[1]Faculty of Animal Sciences, University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania

Abstract

Ensuring food quality and safety will remain a major challenge for agri-food sector as consumers are increasingly aware of natural food benefits on human health that can satisfy their nutritional needs and desired senzorial characteristics.

The main purpose of food processing is its preservation used in order to maintain the integrity of the products and to extend the shelf life improving their quality. In this way, processed food products can meet customers demands from al points of view: nutritional, safe and health and good sensory experience.

It is well known that applying only one preservation method at high intensity (temperature), beside the pathogenic microflora, it may destroy some important nutrients (vitamins, proteins).

In this paper it is highlighted the advantage of preserving food using combined conventional methods at lower intensities without affecting the integrity of the food product.

The Hurdle effect is an illustration of the fact that in food, several factors contribute to microbiological stability, safety and quality. The Hurdle effect has major importance in preserving food since the hurdles control microbiological spoilage and food poisoning.

Hurdle technology (also called barrier technology, combined methods, combined process) advocates the deliberate combination of existing preservation techniques in order to establish a series of hurdles that cannot be overcome by the existing microorganisms from the product. These hurdles may be temperature, water activity, pH, additional preservatives, redox potential, ultrahigh pressure, ultrasounds, etc.

Being processed food products, obtained by combined methods, salami can remain stable and safe for extended periods of time, being very appreciated by consumers all around the world due to the special taste and high nutritional properties.

Key words: food preservation, Hurdle technology, combined methods, salami

INTRODUCTION

Unless using adequate technological conditions for preserving food, between obtaining the product and its consumption factors that may affect food safety and quality may appear.

In this sense, a variety of techniques and technologies of preservation are applied to a food product, depending on its specificity and characteristics.

An altered food product is no longer suitable for consumption as it may affect customer`s health.

By definition, a depreciated food product has undergone changes of its initial composition or properties and has other values outside the permitted, agreed or regulated ranges. These changes are caused by a wide range of reactions of physical nature (the substance exchange between the product and the environment that may lead to humidity increase of the product), chemical nature (rancidity due fat oxisation, enzyme activity), and microbiological (developement of pathogenic microorganisms).

First of all, the microbiological alteration produces a wide range of commercialy undesirable changes, the shelf life decreases and the sensorial charachteristics are impaired. Particular attention is required when the presence and activity of pathogenic microorganisms that may endanger the health of the customer are confirmed in the product.

[*]Corresponding author: ccazacu77@yahoo.com
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The majority of existing methods of preservation are based on modifying the favorable environment for sporulation of microorganisms and inactivating the activity of enzymes (high or low temperature, dehydration, use of preservatives) and less on their total destruction (UHT). Although a wide range of conservation methods are used in food industry, applied individually, they cannot ensure the stability of food products because they use a single factor as a barrier against the development of microorganisms eg: low or high temperature, water content reduction, use of preservatives, packing in modified atmosphere, high pressure. Moreover, those single hurdles are used at high intensity and it may affect some important nutrients, deprecating the quality of the product.

Hurdle technology (named combined methods) was discussed for the first time by L. Leistner in 1981, giving as an example the manufacture of sausages. Leistner`s opinion was that the microbial stability and safety of most food products are based on a combination of several factors (hurdles) that cannot be overcome by the existing microorganisms and that the complex interactions between temperature, water activity, pH, redox potential, etc. are significant for the microbial stability of foods.

HURDLE TECHNOLOGY

Food product deprecation is determined by a number of external and internal factors. The Hurdle technique aims to control the internal factors, related to the product, represented mainly by the water activity, pH, redox potential but also the temperature, the structure of the foods with available nutrients and the presence of antimicrobial agents either natural or added (preservatives). From compositional point of view, agri-food products are polydisperse systems in which water is the main component.

Water from food products represents the environment for the main chemical reactions that occur in food both during processing and food storage. Also, water itself participates as a reactant in hydrolytic process. The stability of agri-food products is a characteristic intrinsically linked to the variation of the water content.

From microbiological point of view, water activity (a_w) can be defined as the amount of water available for growth of microorganisms. This does not represent the total water content of foods because a part of it can be linked to water-soluble salts, proteins and carbohydrates not available for growth of microorganisms(L. Leistner).

Water activity in food is responsable for the multiplication and metabolic activity (including the production of toxins) of microorganisms, their survival and resistance to various stressors. This applies not only to degradation and pathogenic microorganisms, but also to selected ones used for certain technologies in food industry.

Water activity is the ratio of the vapor pressure of water in food to the vapor pressure of pure water at the same temperature.

If a_w decreases, the growth and multiplication of certain microorganisms is stopped depending the a_w allowance limit of the microorganism.

A decrease in a_w value is therefore an extension of shelf life of the product. This can be achieved by adding salt or suggar for osmosis process or by drying or freezing the product. The value of a_w = 0.7, at the temperature of 20^{o}C varies for different products depending on humidity. For free fat meat, the a_w of 0.7 is recorded at 10% humidity.

An important phenomen in Hurdle technology is the homeostasis of microorganisms. They have the property to adapt and to maintain their stability and balance within the internal environement. For example, even if during the process of obtaining a food product, the pH value may varry, microorganisms have the property of keeping their pH value within normal limits without being affected using specific mechanisms. For example, in acid food, microorganisms will expel protons against the pressure of a pasive proton influx.

Another important mechanism of homeostasis concerns osmotic pressure (inversly related to the eater activity). It has a particular effect on the ability of microorganisms to proliferate. The microbial cells must maintain the osmotic pressure of their cytoplasm higher than the pressure of the developing environement using osmoprotective compound like proline and betaine.

Preservative factors may affect one or several homeostatic mechanisms either permanently or temporarily. As a result, the microorganisms will not be able to multiply, they will remain inactive or die.

The optimal way to ensure the stability of a food product is the one that can disturb several homeostasis mechanisms by affecting simultaneously the cell membrane, water activity, pH, DNA structure, redox potntial.

The great advantage of using combined methods is that due to the synergistic effect, the hurdles may be used at lower intensities than it would be required if the method were applied individually. In this way, can be avoided the reduction of important nutrients sensitives to high intensities.

The example given in Fig. 1a, indicate a food product containing six different hurdles: high temperature applied during preocessing (F), low temperature used during storage (t), low water activity (a_w), low redox potential (Eh), and additional preservatives.

Some of the existing microorganisms in the product are able to overcome some hurdles but none of them can defeat all the hurdles used together.

Each hurdle is related to a specific microorganism, therefore the final product will answer to all safety and quality requirements.

The first example is a theoretical one because all the hurdles are used at the same intensity and it is rarely used.

In practice, the hurdles are used at different intensities (fig. 1b). In this case the method is based on the control of the water activity and the addition of preservatives as major obstacles and controlling the processing and storage temperature as well as the pH as secondary obstacles. The method is very efficient and cost effective.

If a low number of microorganisms is initially present in the product, the action of a small number at low intensity hurdles is sufficient, but it is recommended to apply all of them to improve the organoleptical quality (fig. 1c).

However, if the product is initially in a state of advanced contamination, certain microorganisms will survive to all the methods applied (fig. 1d).

Also, if the product is rich in nutrients that may favor the growth of microorganisms, their number will increase rapidly. In this case, in order to ensure microbiological stability, additional or higher intensity methods will be considered (Fig. 1e).

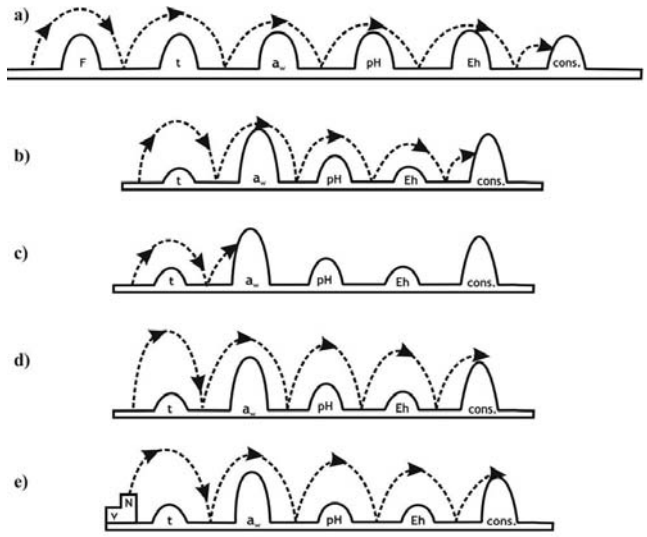

Fig. 1 Hurdle efect in food products(*L. Leistner)*
F- high temperature durring processing; t- low temperature during storage, a_w- water activity; pH-pH value, Eh- redox petential, cons. – preservatives, VN- high nutritional value

HURDLE TECHNOLOGY APPLIED ON SALAMI

Talking about processed meat products, salami have an increased shefl life ensured by using combined methods for preservation. Raw dried, cold smoked and fermented betwen 25-50 days salami are high nutritional products obtained without using heat treatment.

The obtaining process including steaming, drying and smoking, reduces the total amount of water from the product. As a result, raw fermented salami, have the microbiological stability ensured by low water activity, having a total water content of maximium 30%.

Preservability and superior taste characteristics are achieved by using a combination of hurdles very important in different stages of the ripening process of salami.

At the very begining, the most important hurdles are preservatives, salt and nitrites that are used with a double purpose: inhibing many of the existing bacteria and fermentation.

Nitrites favor the development of bacteria necessary for fermentation, leading to a low redox potential. In this way, the growth of pathogenic microorganisms such as Salmonella ssp, Listeria monocytogenes, Staphylococcus aureus, Clostridium botulinum is imposible. With a low redox potential, the competitive flora- lactic bacteria- is growing, the pH value is decreasing in detrimental to the development of aerobic microorganisms.

Therefore, the Hurdle technique used to obtain raw-dried, cold-smoked and ripened sausages is based on the decrease of water activity and the addition of preservatives represented by salt and nitrogen as major hurdles. As secondary hurdles, the technique considers the control of the redox potential, of the pH value and of the temperature. Also, the bacteriostatic action of the smoke is not to be neglected.

Regarding meat processed products obtained by using heat treatment such as pasteurisation or hot smoking, the number of preservation methods used is higher. In this way, more hurdles are created against the development of microorganisms, thus ensuring a long preservation.

In order to obtain hot smoked, pasteurized and cold smoked salami, the Hurdle technique is based on the action of the high temperature used during smoking (80-120˚C) and pasteurization (70-80˚C), on the action of preservatives and smoke with antiseptic properties as well as low water activity.

In this case, the pH value and low potatntial redox are used as secondary hurdles.

At the same time, the packaging method can be considered as an additional method of preservation, the products packaged under vacuum or controlled atmosphere, have a high stability compared to wholesale salami.

CONCLUSIONS

Combined methods of preservation have high potential to produce safe, high quality food. Hurdle technique can minimize the undesirable effects that a single high intensity method can have. Thus, the finished product will retain the particular nutritional value of the raw material used and will respond to the consumer's demands regarding the quantity and quality of the bioactive compounds, the sensory experience ensuring food safety standards.

The technique is very efficient and offers the possibility of diversifying food products by creating new ones.

The food products obtained using the Hurdle technique, in addition to their special nutritional and organoleptic properties, have the possibility to be used for a long term.

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