POSITIVE EFFECTS OF STARTER CULTURES ON SENSORY CHARACTERISTICS OF MEAT PRODUCTS

Aleksandra Silovska Nikolova
Faculty of Agricultural Sciences and Food, Ss. Cyril and Methodius University in Skopje,
Republic of North Macedonia, silovska@fznh.ukim.edu.mk
Daniela Belichovska
Institute of Animal Science, Ss. Cyril and Methodius University in Skopje,
Republic of North Macedonia, daniela.belichovska@gmail.com

Abstract: With the development of microbiology, modern technique and technology, a large number of types of microorganisms in concentrated form (starter cultures) have been selected.
Today, starter cultures are widely used in the meat processing industry. Their use prevents the growth of pathogenic microorganisms and improves the sensory characteristics of the finished products. Furthermore, they have a standard quality, they reduce the variation in the product quality, and they control and accelerate the fermentation process in some meat products. With their biochemical activity, starter cultures contribute to the development of color, improve the consistency, affect the taste, smell and aroma of the finished product. The use of starter cultures contributes to the finished product having superior sensory characteristics, and at the same time starter cultures affect the greater microbiological safety of the product. For these reasons starter cultures should find greater use in the meat processing industry.
Keywords: starter culture, meat products, sensory characteristics, positive effect

1. INTRODUCTION

Starter culture is a culture of preparations containing actively growing or dormant forms of microorganisms whose metabolic activity causes the desired effects during fermentation. (Hammes and Hertel, 1998).
The use of starter cultures in meat processing industry in the production of fermented sausages is increasing. This use has shown a number of advantages: the hygienic safety of the product is increased, the quality of the product is improved and equalized. The biochemical activity of the starter cultures causes a change in the pH of the meat, promotes the development of color, consistency, flavour, aroma, and generally affects the development of the characteristic properties of the product (Incze, 2002). Also, Kovačević (2001) points out for the positive effect that many microorganisms have. They, with their growth and metabolism, cause a change in the flavour, the nitric quality, texture, aroma and safety of the product. The use of starter cultures in meat products, according to Laranjo et al., (2017), offers numerous advantages: the level of quantity and quality is known; they reduce the maturation time; they increase safety by dominating the unwanted microorganisms and they enable the production of products of constant quality throughout the year in any climate zone, under adequate natural conditions or fermentation /curing chambers.
Starter cultures play a significant role in the production of meat products. Starter cultures containing lactic acid bacteria produce lactic acid, which affects meat proteins, reducing their water binding ability. This will have a beneficial effect on the texture, moisture content, flavour, aroma and microbiological safety of the product. Bacteriocins produced from gram-positive lactic acid bacteria, such as nisin and other lantibiotics, play a microbial role in the preservation and safety of the product. (Laranjo et al., 2017).
The most commonly used starter cultures in meat products are: lactic acid bacteria, coagulase-negative staphylococci and *Micrococcaceae*, moulds or yeasts (Laranjo et al., 2017; Laranjo et al., 2019), because products of their metabolism are compounds that have antimicrobial action. These starter cultures can be used individually or in a mixture of cultures.
The lactic acid bacteria that are present in starter cultures, and are used in the production of fermented meat products are facultative anaerobes and they most commonly belong to the genera *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Lactococcus* and *Enterococcus* (Fraqueza et al., 2016; Laranjo et al., 2017), whereas the most commonly used coagulase-negative staphylococci are the facultative anaerobes *Staphylococcus carnosus* and *Staphylococcus xylosus* (Stavropoulou et al., 2018; Laranjo et al., 2017). As for the family *Micrococcaceae*, it is most often represented by the genus *Kocuria*. They are the anaerobes most commonly used in fermented sausages (Cocconcelli and Fontana, 2015; Laranjo et al., 2017).
Nuang and Huan (2016) found that fermented sausages in which a combination of three starter cultures was added showed superior sensory characteristics compared to the sausage model. Ikonić et al. (2016) point out that the addition of starter cultures has a positive effect on the sensory properties of traditional fermented sausage (Petrovská

Klobása) produced in a traditional and industrial way. Silovska-Nikolova et al., (2019) also found superior sensory properties in the traditional Macedonian sausages (Krushevo sausage and Vevchanski lukanec).

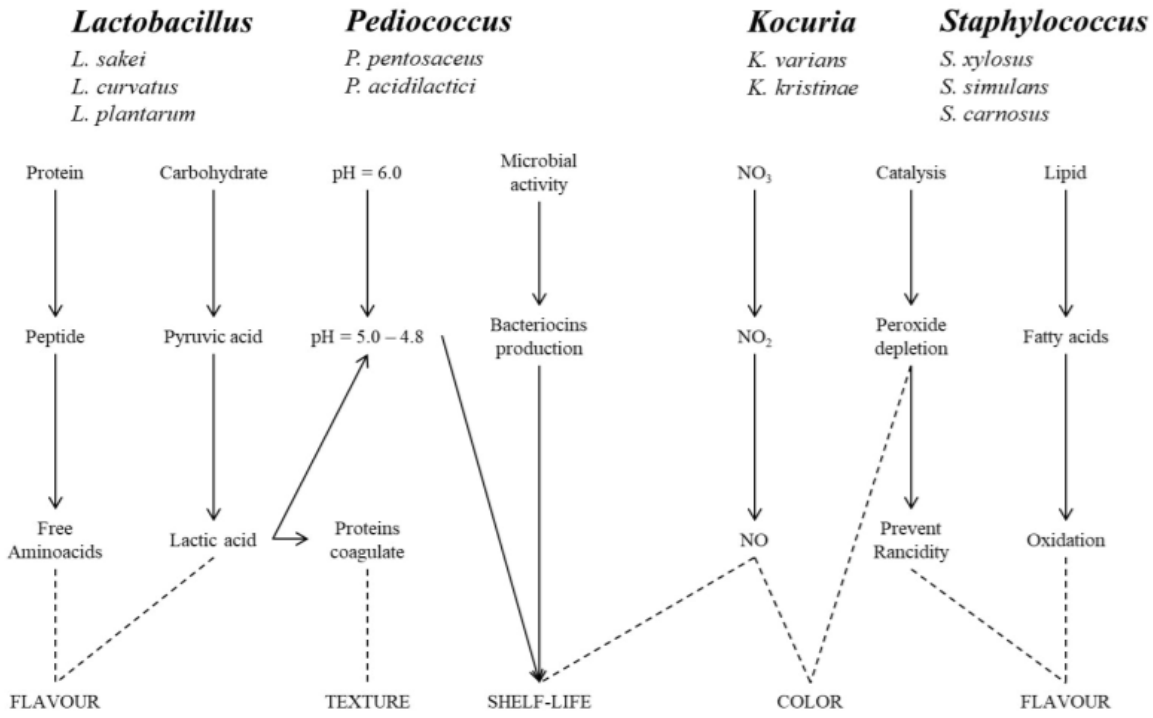
2. POSITIVE EFFECT OF THE USE OF STARTER CULTURES ON THE SENSORY PROPERTIES OF MEAT PRODUCTS

The use of starter cultures enhances the development of color, texture, aroma and flavour of the finished product. However, the sensory characteristics largely depend on the type and amount of strains used in the starter cultures and the processing conditions themselves (Toldrá, 2008). Therefore, individually, it is important to know about microorganisms and their role, in order to be able to predict what will be the sensory characteristics of the finished product if certain microorganisms are used.

The most common bacteria genera used in starter cultures are: *Lactobacillus, Pediococcus, Micrococcus (*or *Kocuria)* and *Staphylococcus.* Figure 1 shows a brief overview of the biochemical activity of certain bacteria.

The microorganisms from the starter cultures participate in the formation of a stable color in the finished product, with their ability to reduce nitrates, the pH value of the charge and affect the Eh value. Their catalase activity and inhibition of oxidative processes are also important. Bacteria of the family *Micrococcaceae*, present in starter cultures, have the greatest impact on the development and color stability of the product. If starter cultures contain *Staphylococcus xylosus*, which has strong nitrate reductase activity, the color will develop faster. Also, this starter culture affects the prevention of oxidation processes. Jessen (1995) points out that the activity of reductase in lactic acid bacteria is much lower, as well as the ability to form catalase, which occurs only under special conditions.

Figure 1. Overview of the biochemical activities of certain strains of bacteria (Franciosa et al., 2018)



Smole Možina and Raspor (1994) point out that the present natural proteolytic enzymes mostly contribute to the development of the textural properties of the finished product.They are naturally occurring enzymes, and the bacterial proteinase from the bacteria *Lactobacillus casei* and *Lactobacillus plantarum* which participate in the proteolytic activities is present in smaller quantities. Fadda et al. (2002) suggest that starter cultures participate in the degradation of sarcoplasmic and myofibrillar meat proteins during fermentation, because proteolytic enzymes have higher affinity for sarcoplasmic proteins. The activities of proteolytic enzymes are higher at higher temperatures, so for these reasons, their maturation is faster. In addition to the proteolytic action, lactic acid bacteria also affect the development of texture, with the formation of lactic acid. A drop in pH affects the solubility of proteins. In

fermented sausages, it contributes to the development of better textural properties and shorter production time (Varnam and Sutherland, 1995).

For the development of aroma in fermented products, Hammes and Hertel (1998) state that several factors are important, such as: raw material used, additives and spices, choice of technological processes, chemical changes that occur during glycolysis, proteolysis, lipolysis and oxidation of fat, which is caused by endogenous or bacterial enzymes. Leroy et al. (2006) point out that the development of aroma is influenced by temperature, production time, smoking and the choice of starter culture.

Table 1. Action of starter culture in dry susages (Lücke and Hechelmann 1987)

Quality characteristics	Mode of action	Lactic acid bacteria	Catalase positive cocci
Colour	Nitrate reduction	-	+++
	Decrease of pH value	+++	-
	O_2 consumption in sausage core (Eh)	-	++
	H_2O_2 degradation	-	++
Aroma	Acid production	+++	-
	Proteolysis	-	+
	Lipolysis	-	++
	Delaying rancidity (antioxidative)	-	++
Firmness (consistency)	Decrease of pH value	+++	-
Preservation	Decrease of pH value	+++	-
	Nitrate reduction	-	++
	Suppression of undesirable microbes	++	-
Low residue content	Nitrite degradation	+	++

+++ decisively important, ++ important, + noticeable effect, - no effect

Enzymatic processes in the adipose tissue are more significant than the processes of proteolytic enzymes for the formation and development of aroma and characteristic odor of a mature product. The lipolytic and proteolytic activity of lactic acid bacteria is limited and does not significantly contribute to the development of the taste of the mature product, but is much higher in starter cultures of the family *Micrococcaceae*. Fat breakdown occurs under the influence of adipose tissue lipases and bacterial lipases. Lipolysis is only the first stage in the process of breaking down fat. It is followed by further oxidative degradation of free fatty acids into alkanes, alkenes, alcohols, aldehydes, ketones and furans. To some extent, lipolysis has a positive effect. Otherwise, it contributes to the appearance of shine and other unpleasant odors. The amount of peroxides increases at the beginning of the maturation, as the first product of auto-oxidation. In the presence of metal ion catalysts, decomposition into carbonyls, aldehydes and ketones follows, which are carriers of luster and other additional flavors in large quantities. Most lactobacilli are catalase- negative and do not break down peroxides formed by the oxidation of unsaturated fatty acids. The presence of peroxides is resolved by the use of combined starter cultures with catalase activity (some *S. carnosus*). These starter cultures as well as the moulds, reduce the possibility of oxidation product formation through the consumption of oxygen in their metabolism.

The degree of influence of microbial and non-microbial enzymes in proteolysis has not yet been fully elucidated. During the maturation of the sausages, a large part of the protein undergoes enzymatic hydrolysis. Some amino acids

are later decarboxylated, deaminated, or even further metabolized. The share of protein nitrogen, α-amino nitrogen, peptides, free amino acids, ammonia and amines is increased. The resulting products contribute to the taste of the mature products. The increase in ammonia has an effect on the increase of the pH value and on the sensory properties of the products that mature for a longer period of time.

Staphylococci are important participants in the process of shaping the smell and taste of products. They participate in lipolytic and proteolytic processes. Staphylococci (primarily *S. xylosus* and *S. carnosus*) significantly affect aroma by breaking down amino acids (primarily leucine, isoleucine, and valine) and free fatty acids (Hammes and Hertel, 1998; Leroy et al., 2006). With the addition of *S. carnosus*, sausages ripen faster. Stahnke et al., (2002) point out that Milanese salami, which ripens for at least two weeks, contains several aromatic components. With longer maturation times and / or starter culture activities, the aroma of the product is more complete. The bacterium *S. xylosus* is often used in products from southern Europe. Its use is recommended for products with a characteristic, full, rounded aroma with less sour taste. (Leroy et al., 2006).

Also, mould and yeast significantly affect flavour. The contribution of these organisms to the formation of a typical aroma is based on their proteolytic and lipolytic activity. In the presence of oxygen, moulds and yeasts not only form aromatic components but also oxidize lactic acid, whose pH also rises above 7.0. Such products have a different, spicy taste. The mould on the product surface also affects the taste by preventing access to oxygen and allows a microclimate , which will contribute to proper drying of the product.

3. CONCLUSION

Starter cultures can be used in acidic environments, environments with high salt concentration, low water activity, low temperature activity; they grow in anaerobic conditions and nitrites do not inhibit their metabolism. They contribute to microbiologically safe finished products with superior sensory characteristics, standard and consistent quality. Meat producers should use a starter cultures in their production.

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