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Selected physicochemical, technological, and hygienic characteristics of artisanal and sausages produced with functional starter culture

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Abstract. Fast acidification is one of the main factors of microbial stability of dry fermented sausages. Development of functional starter cultures for improving safety of sausages without altering their quality is under way. This study compared aspects of physicochemical, technological, hygienic and instrumental quality of sausages produced with or without functional starter culture. Finished sausages with starter had lower water activity and lower levels of enterobacteria and lactic acid bacteria, compared to artisanal ones. During most of the ripening, pH was lower in sausages with starter, but in the final products, the same pH was observed in both groups of sausages. In sausages with starter lower redness was determined than in artisanal sausages, while other parameters, colour and chewiness, did not differ significantly. Use of starter culture improved physicochemical, technological and hygienic characteristics of the final products.

1. Introduction

The antimicrobial factors acting in dry fermented sausages (DFS) can prevent growth and reduce the counts of unwanted microbiota. Fast acidification induced by starter cultures and drying in air-conditioned rooms are the two most important of many factors in the hurdle concept on which is based safety of industrially produced dry fermented sausages. Rapid growth of technologically useful bacteria and their main metabolic activity in the presence of sugar induce reduction of pH and at the same time, they are competitive to undesirable microorganisms. Development of a third generation of functional starter cultures is under way and presents the use of well adapted strains that occur in traditional artisanal foods and which do not negatively affect technological or sensory properties of sausages [1]. As another main safety factor, low water activity (a_w) suppresses growth of all microbiota and values of $a_w \leq 0.9$ defines the microbial stability of finished DFS [2]. So, the main aims of this study were to assess dynamics of physicochemical factors (pH, a_w) during ripening, as well as levels of undesirable (enterobacteria) and technologically useful microorganisms (lactic acid bacteria) in sausages produced with (S) or without (A) functional starter culture. The final DFS were also evaluated in terms of colour and texture quality. These preliminary results should provide the basis for further investigation of



technological and hygienic improvement of dry fermented sausages by use of selected starter culture of the third generation.

2. Material and Methods

Chorizo sausages were produced in a local meat plant from pork meat. A traditional recipe was used without nitrite as an additive. Half of each batter was produced with the starter Flora Italia from Christian Hansen Company (*Pediococcus acidilactici*, *Lactobacillus sakei*, *Staphylococcus carnosus*) and another half as artisanal DFS (without starter). The production process for both subgroups of sausages lasted 5 weeks at 12°C - 14°C.

Microbiological analysis: enterobacteria count (EBC) was determined on *Enterobacteriaceae* Count Plate Petrifilms incubated at 37 °C for 24h, lactic acid bacteria (LAB) on Lactic Acid Bacteria Count Plates Petrifilms at 30 °C for 48h.

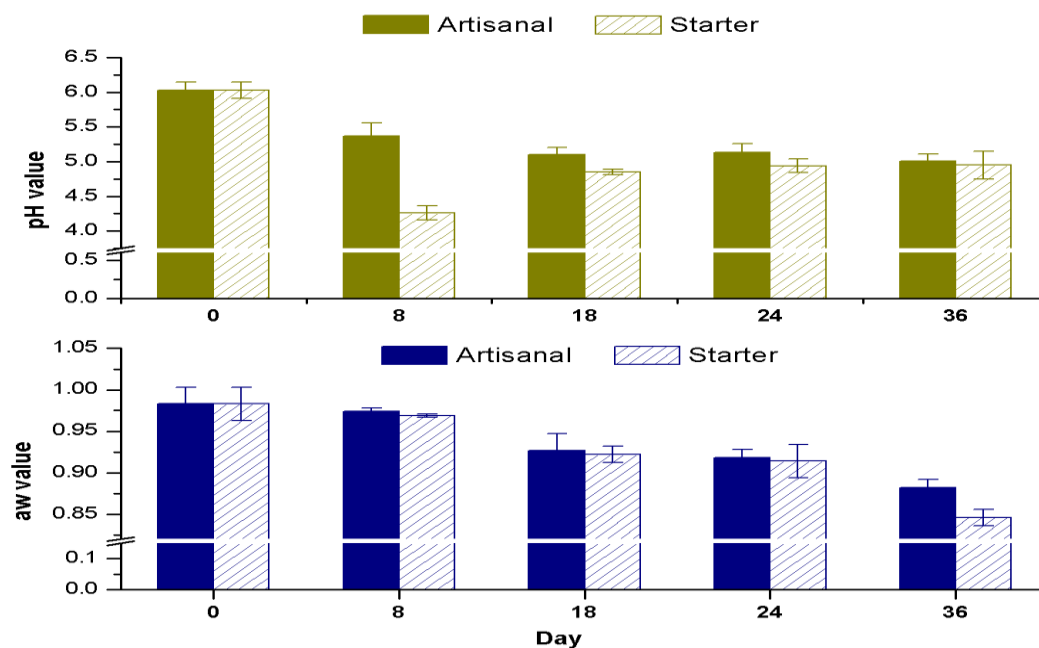
Physico-chemical analysis: examination of physico-chemical parameters in sausages comprised of determination of a_w and pH using LABswift- a_w set equipment and pH meter, respectively.

Colour analysis was described in detail in [3].

For texture analysis (chewiness) the procedure of Marcos et al. was adopted, with small modifications [4].

3. Results

Figure 1 pH and a_w in sausages without or with starter during ripening



Sausages with starter had significantly lower pH during ripening ($p < 0.05$), compared to artisanal sausages while in the final products values became approximately the same.

Lowering of water activity during the production process was similar for both groups of sausages. However, in the final stage sausages with starter had significantly lower a_w ($p < 0.05$) compared to artisanal ones.

Table 1 Levels of *Enterobacteriaceae* and lactic acid bacteria in sausages without and with starter during ripening

Day	<i>Enterobacteriaceae</i> count log10 cfu/g $\pm$ SD		Lactic acid bacteria count log10 cfu/g $\pm$ SD	
	A	S	A	S
0	3.2 $\pm$ 0.4	3.2 $\pm$ 0.4	4.1 $\pm$ 0.2	4.1 $\pm$ 0.2 + starter (6 log 10 cfu/g)
8	6.5 $\pm$ 0.2 ^a	4.3 $\pm$ 0.2 ^b	8.9 $\pm$ 0.2 ^c	9.5 $\pm$ 0.2 ^d
18	5.5 $\pm$ 0.4 ^a	1.5 $\pm$ 1.4 ^b	9.3 $\pm$ 0.3 ^c	9.2 $\pm$ 0.2 ^c
36	2.6 $\pm$ 0.5 ^a	< 1.0 ^b	9.4 $\pm$ 0.3 ^c	8.7 $\pm$ 0.4 ^d

A – Artisanal sausages (without starter); S – sausages with starter; SD – standard deviation
Averages with different letters (for EBC - a or b; for LAB – c or d) in the same row differs significantly ($p < 0.05$)

Table 2 Colour and texture parameters of sausages without and with starter at the end of ripening

Colour parameters	A	S
Lightness	33.85 $\pm$ 4.37	33.82 $\pm$ 5.12
Redness	19.63 $\pm$ 2.29 ^a	17.86 $\pm$ 2.96 ^b
Yellowness	16.47 $\pm$ 3.7	15.76 $\pm$ 3.55
Texture parameter (Chewiness)	9.39 $\pm$ 2.81	9.62 $\pm$ 3.7

Averages with different letters in the same row differs significantly ($p < 0.05$)
A – artisanal sausages (without starter); S – sausages with starter; SD – standard deviation

4. Discussion

The pH of artisanal sausages were within the frame considered as common for this type of DFS [5,6]. In sausages produced with starter culture, pH first dramatically dropped, probably due to the high metabolic activity of starter microorganisms, but then increased and reached the same level as in the artisanal sausages in the final stage of production.

Levels and changes of a_w in artisanal and sausages produced with starter culture were also within the frame considered common for this type of DFS [6,7]. Compared to artisanal, sausages with starter culture had similar or slightly lower a_w during most of the ripening, but reached significantly lower values in the final stage of production.

Patterns and levels of LAB during the production process were generally similar to those reported for this type of DFS [8,9]. Lactic acid bacteria in sausages with starter showed somewhat higher values at the beginning of production, but in the final products, LAB levels were considerably lower than in artisanal DFS. Higher susceptibility of starter culture strains to lowering of a_w and other stress factors may cause such results.

In artisanal sausages initial *Enterobacteriaceae* loads increased during the first part of the ripening, but then decreased to moderate numbers in the final products, mainly as a consequence of lowering of a_w . In sausages with starter culture levels of this group of bacteria were lower during the whole ripening process, compared to levels in artisanal sausages and reduced to under the detection limit in final products. Faster acidification of sausages with starter culture probably inhibits growth of *Enterobacteriaceae* during the first part of ripening and consequently is responsible for their lower number in the final products .

Regarding lightness, yellowness and chewiness no differences between artisanal DFS and sausages with starter were observed. However, significantly lower redness value in sausages with starter culture is probably because of faster acidification which intensifies partial or total denaturation of myoglobin.

5. Conclusion

Selected starter culture improved physicochemical and hygienic characteristics of the chorizo sausages. Moreover, in sausages with starter culture there are no changes of instrumental color and texture parameters, with the exception of redness.

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