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Current Opinion in Food Science

# Role of autochthonous starter cultures in the reduction of biogenic amines in traditional meat products

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The transformation of raw meat in highly appreciated traditional fermented meat products is a topic of great importance for researches and consumers. At first, we describe the importance and feelings about traditional food to local and foreign consumers. Then the role of autochthonous microflora in the reduction of biogenic amine accumulation without changes in the expected general quality of traditional meat products is discussed. Both *in vitro* and re-inoculation studies were included in this review.

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**Current Opinion in Food Science** 2017, **14**:61–65

This review comes from a themed issue on **Food microbiology**

Edited by **Ursula Gonzales-Barron**

For a complete overview see the Issue and the Editorial

Available online 4th February 2017

http://dx.doi.org/10.1016/j.cofs.2017.01.009



## Introduction

The denomination of traditional food, in particular for meat products, comes from the combination of timely factors as local traditions, gastronomic habits and heritage which sustain their identity and consumption, originated from a distant past, until today. Traditional meat products in Europe are believed to be originated in Mediterranean countries and then spread to other countries. This expansion led to an exponential increase in the number of products due to differences in local ingredients, environmental microbiota, climate conditions, local traditions and processing conditions [1]. In technical terms, meat fermentation in traditional meat products occurs as a consequence of increasing microbial development during fermentation and maturation from natural and environmental microbial contamination. The major effects are the development of flavour, colour and texture on the final product which are highly appreciated [2].

The dependency of natural and environmental microbial contamination on the processing of traditional meat products is a topic of major public health concern, since pathogenic microorganisms can proliferate compromising the quality and safety of final product. Apart from the safety concern, the final characteristics of the traditional meat products can also vary according to the contaminant microbiota and the meat processor's skill leading to a poor standardization in a technological perspective. Nevertheless, consumers perceive products manufactured by traditional processing (with artisanal claim) as food with higher quality compared to a similar industrial product, even with the increased risk of consuming a spoiled or contaminated product with pathogenic microorganisms and toxic compounds. In this sense, providing safe meat products and ensuring their peculiar sensory traits represent a major challenge in the production of traditional meat products [3].

The prevention of spoilage and pathogenic microflora development by improvements in processing and formulation is a difficult challenge due to the possible impact in microbiota (both unwanted and desirable) and sensory attributes: thermal treatment destroys desirable microorganisms and enzymes; modified atmosphere packaging can induce changes in aroma and addition of chemical preservatives may compromise the perception of 'traditional' claim by consumers. Improving both safety and standardization of the final characteristics of traditional meat products without impairing their sensory attributes is a great challenge, due to the importance that consumers place on the flavour, taste, aroma and texture of these foodstuffs [4]. However, traditional processing and innovative approaches should not be considered as opposite concepts [2].

Biogenic amines (BAs) are anti-nutritional compounds generated due to microbial decarboxylase activity from free amino acids. Formation of BAs is dependent on crucial factors, such as: availability of specific amino acid, presence of bacteria with genes encoding decarboxylases and favourable conditions for bacteria growth and enzymatic activity. The main BAs in fermented meat products are histamine, tyramine, putrescine and cadaverine that are normally detoxified by amine oxidase produced by intestinal mucosa. However, when BAs are ingested in elevated proportions, some symptoms have been associated as nausea, sweating, vomiting, diarrhoea and tachycardia. In severe intoxication cases, irreversible damage to heart and central nervous system can occur [5••,6]. In this

short review, we consider the aspects related to the reduction of biogenic amine content in traditional meat products through the selection of appropriate autochthonous starter cultures.

## Importance of traditional food and meat products for consumers

The feeling associated with traditional food consumption differs between local population and tourists, but in both cases positive experiences were reported in literature. The preservation of such feeling is an important aspect to keep the consumption of traditional meat products [7]. Consumers tend to rate the quality of traditional products with high scores and consider themselves satisfied with general quality of such products [8]. In a recent study, Croatians and Austrians were questioned about the meaning of traditional food. Words as 'freshness' and 'better taste' were the most cited words among Austrians whereas 'enjoyment' and 'safety' were more frequently remembered by Croatians [9]. It is worth noting that Croatians also associated traditional foods, in particular for meat products, with their childhood memories. In both cases, technological or sensory aspects were involved in the context of consumption of traditional food [10].

On the other hand, gastronomic experiences have become an important aspect of tourism during the immersion in local culture and history due to the synergistic growth between cultural and gastronomic tourism. A recent study with tourists in Córdoba (Spain) revealed that local gastronomy, which includes traditional meat products, was the second most cited reason to visit this city. The recognition of quality and uniqueness of local cuisine improved the experience leading to positive evaluation of visit [11•]. In a similar way, Chen and Huang [12] assessed the importance of food on tourism in its three stages (pre-travel, during-travel and post-travel stage) for tourists in Chongqing (China). Authors indicated that in pre-travel stage, food was considered as a factor of minor importance but during-travel and post-travel stages, food played a central role to improve tourism experience. In addition, tourists rated food and food-related activities as the second largest expenditure in during-travel stage.

## Microbiota of fermented meat products

The transformation of meat and fat in to fermented meat products involves the activities of microorganisms in a complex ecosystem. The identification of well adapted microorganisms reveals, at genera and strain (with molecular techniques) level, which microorganisms are involved in fermentation and their technological potential. The co-existence of such microorganisms during fermentation and ripening can contribute to safety and stability of fermented meat products [13]. Lactic acid bacteria produce lactic acid and bacteriocins which promote the pH reduction, conferring the acidic flavour and inhibiting pathogenic bacteria. Coagulase negative cocci produce lipolytic and nitrate reductase enzymes contributing to sensory characteristics, characteristic colour formation and increasing safety and stability [14]. Yeats and moulds are consider as secondary microbiota and can contribute in the protection against variations in humidity and formation of aroma due lipolytic and proteolytic activity and consumption of lactic acid [15].

In the typical Bosnian sausage Suduk, the main lactic acid bacteria were identified: *Lactococcus* sp., *Enterococcus* sp., *Leuconostoc* sp., *Lactobacillus* sp., *Pediococcus* sp. and *Weissella* sp. [16]. In the chouriço produced in Alentejo region (Portugal) *Staphylococcus xylosus*, *S. equorum*, *S. saprophyticus* and *S. carnosus* were the predominant coagulase negative cocci [17]. The dominant microbiota of Slavonski kulen, a traditional Croatian fermented sausage, was composed by *Leuconostoc mesenteroides*, *Lactobacillus acidophilus*, *S. xylosus* and *S. warneri* [18]. In Botillo, a traditional sausage produced in Galicia (Northwest of Spain), *Lactobacillus sakei*, *L. alimentarius*, *L. curvatus*, *L. plantarum* and *L. farciminis* predominated among the lactic acid bacteria while *S. saprophyticus*, *S. xylosus*, *S. lentus*, *S. cohnii cohnii*, *S. epidermidis*, *S. sciuri* and *S. capitis* were the major CNC bacteria [19]. In the traditional salchichón (produced in Spain), *Debaryomyces spp.* was the main yeast followed by *Rhodotorula mucilaginosa* and *Yarrowia lipolitica* [20].

However, pathogenic microorganisms can also develop in fermented meat products as reported for *Escherichia coli* in Spanish [21] and Chinese [22] fermented sausages and *Staphylococcus aureus* in raw fermented sausages [23•]. In addition, the health risk may increase by the accumulation of toxic compounds such as biogenic amines [24].

## Occurrence of BAs in fermented meat products and health importance

The production and accumulation of BAs is a result of microbiological development associated to specific strains with specific genes for decarboxylase enzymes. These genes can also be transmitted between bacteria sharing a common environment by horizontal transfer, thus increasing the risk of intoxication [25]. A recent study evaluated the BA content of sausages sold in Belgian markets. Although this study revealed that almost all samples displayed satisfactory results, the large range of values in the same class of products is a major concern, particularly for tyramine (0–411 mg/kg), putrescine (0.3–316 mg/kg), cadaverine (0–641 mg/kg) and histamine (0–131 mg/kg) that are the main BAs in fermented food. In addition, a critical BA content of 1000 mg/kg was reported for one sample [26].

A similar study was performed in European dry ripened sausages produced with horse, beef or turkey meat. Thin slices of each sample were kept at 4°C for up to 28 days.