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Goat meat products

S Stajic¹ and B Pisinov²

¹ University of Belgrade, Faculty of Agriculture, Department of Animal Source Food Technology, Nemanjina 6, Belgrade, Republic of Serbia

² Institute of Veterinary Medicine of Serbia, Department of Food Safety, Autoput 3, Belgrade, Republic of Serbia

E-mail: stajic@agrif.bg.ac.rs

Abstract. In general, goat meat is not inferior to other meat types regarding nutritional and biological value – it has a high protein content (up to 29%), and it is a good source of minerals, vitamin B-complex, and essential amino acids. However, the meat of older and culled goats is less juicy, less tender, has a characteristically different odour and taste compared to kids' goat meat (and meat of other animals), and thus tends to be less desirable. Different meat products could be produced using goat meat (including culled goat meat): dry-fermented sausages (e.g. sucuk), dry-cured meats (Violino di capra – goat prosciutto), frankfurters, mortadella, etc. without adverse effects on products' technological properties. The negative impact of goat meat on the properties of meat products is mainly associated with the use of goat fatty tissue. However, this could be overcome by using fatty tissue of other animals (e.g. pork back fat or beef fatty tissue).

1. Introduction

Goats are small ruminants that live in small or large herds in different areas and environments across the world, with the exception of extremely cold areas. According to Devendra [1], there are 1156 different breeds of goats. The total number of goats in the world is over 1,000 billion, whereby around 95% are bred in Africa and Asia [2] and are considered suitable for meat production [3]. Contrary to this, in Europe, especially in the Mediterranean countries (where the highest goat population is located), goats are kept primarily for milk production.

From the 2000s, the global number of goats has increased by 30% while goat meat production has risen by almost 50% [2]. In Serbia, about 200,000 goats are kept primarily for milk production [2].

Goat meat consumption is not limited by religious restrictions and cultural habits. Despite that, goat meat consumption is lower compared to beef [4]. However, in developing countries goat meat is the main source of red meat [5].

Kids' goat meat is gladly consumed and is used for the preparation of different traditional dishes in the Mediterranean countries, while meat of older and culled goats is less acceptable and has low commercial value [6, 7]. However, the meat of such animals has been used for centuries for the production of salted/cured and dried meat products, e.g. *cecina de cabra* [6]. Moreover, some recent research indicates that goat meat, including culled goat meat, can be used in the production of some well-known industrial meat products such as mortadella [8], frankfurters [9, 10] etc.

In general, numerous studies indicate that goat meat (including culled goat meat), in addition to being used for the production of traditional products, is also used in the production of industrially processed



non-heat treated (including non-heat treated for heat processing) and heat-treated meat products, as well as for the production of meat products with improved functional/nutritional properties within all groups [8-11].

The aim of this paper is to give an overview of goat meat usage in the production of different meat products.

2. Goat meat characteristics

Goat meat is consumed as kids' meat and goat meat. As mentioned above, kids' goat meat is very acceptable and appreciated, so that kids bred in the Mediterranean EU countries are recognized as brands with protected designation of origin and protected geographical indications [7]. However, the meat of older and culled goats is less juicy, less tender, has a characteristically different odour and taste compared to kids goat meat (and meat of other animals) and, thus, tends to be less desirable [4, 12, 13].

On the other hand, goat meat generally has a high protein content (up to 29%) and is a good source of minerals (iron and potassium), vitamin B-complex, and essential amino acids, e.g. lysine, threonine and tryptophan [12, 14]. Moreover, goat meat generally has a low fat content and could have a more desirable unsaturated/saturated fatty acid ratio compared to beef and pork [14, 15]. All in all, goat meat is not inferior to other meat types regarding nutritional and biological value.

Regarding technological properties, goat meat can be successfully used in different types of meat products. Dry-fermented sausages and dry-cured meat can be produced using goat meat without an adverse effect on the technological properties of products [15, 16]. Because of the similar content of salt-soluble proteins compared to beef, goat meat can be used in the formulation of emulsified meat products [4].

The negative impact of goat meat on meat product properties is mainly associated with the use of goat fatty tissue. Goat fatty tissue decreases emulsion stability and reduces the palatability of meat products [17], while in dry-fermented sausages, the use of goat fatty tissue decreases taste acceptability [16]. This unwanted influence of goat fatty tissue could be overcome during the production process by using the fatty tissue of other animals with better technological properties (e.g. pork backfat, beef tail fat etc.) and/or by using nonmeat ingredients (e.g. spices).

3. Dry and cured goat meat products

Dry and cured meat products are prepared from whole meat pieces (bone-in or deboned) or ground meat and fatty tissue (sausages), which are salted/cured, sometimes smoked and air-dried.

3.1. Dry-cured meats

Dry-cured meats have been traditionally prepared for centuries by salting (or curing) different parts of animal carcasses (or even the whole carcass). Many of them are considered national products and are protected as quality brands.

Cecina de cabra and *Cecina de castron* are dry-cured meat products made from goat legs, and are traditionally produced in Spain; they are also called goat ham [6]. The whole process (3–8 months) is done in six stages [18]: shaping, salting with coarse salt (0.3–0.6 day/g at 2–5 °C and RH 80–90%), washing with warm water, post-salting (30–45 days at 3–5 °C and RH 85–90%), smoking and ripening (at 12–20 °C and RH 65–80%).

Violino di capra, called “goat prosciutto”, also a dry-cured meat, is produced in Alpine valleys of Northern Italy from the legs of female goats from dairy herds, and is flavoured with garlic and different herbs [4, 6]. The whole production process lasts several months and the final product has a violin-like shape, hence its name. This “goat prosciutto” is characterized by specific sensory properties and is high in mono- and polyunsaturated fatty acids with a very favourable n-6/n-3 ratio of 1.7 [19].

In Serbia, Ivanovic *et al.* [15] examined the characteristics of dry-cured and smoked goat ham from the Balkan breed, reared in three regions: mountain, hilly and plain. The results indicated that diet had a significant impact on the quality of dry-cured goat ham. The products from goats reared in the mountainous region had the lowest fat and saturated fatty acid contents, while the content of

polyunsaturated fatty acids was the highest and indicated a more favourable fatty acid profile in those hams. Moreover, the results of sensory evaluation pointed to the ham from goats reared in the mountainous region as the most acceptable.

3.2. *Dry-fermented sausages*

Fermented sausages are meat products that have been manufactured for centuries and are highly valued for their sensory characteristics. Almost every region in the world is known for some typical type of sausage classified into this group.

Among them, sucuk is one of the most popular fermented sausages prepared without using pork meat. Sucuk formulations differ regionally, but in general, beef and beef fat and/or sheep tail fat is mostly used [16]. In research by Stajić *et al.* [16], the use of goat meat (and goat fatty tissue) was examined and compared with all-beef and all-mutton sucuks. Moreover, the influence of the addition of commercial starter cultures in production conditions similar to traditional production was examined. Technological properties (weight loss, basic chemical composition, pH changes and instrumental colour) were very similar between treatments made from the different meats. The use of starter cultures could shorten the production process and could enhance safety (faster pH drop). However, all-goat sucuk received poorer grades in terms of the sensory evaluation of taste and texture, which could be explained by the specific properties of goat fatty tissue. The authors suggested recipe modifications and use of beef fatty tissue to overcome this negative influence of goat fat.

Regarding the implementation of goat meat in the formulation of salami-type products, a combination of 25% goat meat with 75% pork can provide products with desirable properties. Also, very good consumer acceptance of fermented products was achieved by using 80% adult goat meat and 20% pork meat [4].

4. Non-heat treated goat meat products for heat processing

Minced meat products, e.g. burgers, patties, fresh sausages, are non-heat treated products which are intended for heat processing before consumption.

An off-flavour was noticed in burgers prepared with goat meat compared to beef burgers, which could be overcome by using 25% of beef/pork or using liquid smoke after moulding to improve flavour and colour [4].

Goat meat was successfully used as the only meat source in patty formulation [17]. However, the dispersion of goat fat globules was not uniform in patties, unlike chicken fat and vegetable oil which were used in other treatments. Moreover, patties with goat fat had significantly lower sensory scores for flavour and overall acceptability, which the authors correlate with a smeary and greasy mouth-coating sensation that panelists felt when evaluating patties containing goat fatty tissue. Patties with chicken fat and vegetable oil received the highest scores regarding all examined sensory properties.

Culled goat meat was used in fresh sausage production, and compared to the sausages made of sheep meat, they were defined as harder and more fibrous, though they were generally very well accepted by consumers [20]. Also, Leite *et al.* [7] reported that fresh sausages prepared with culled goat meat and 30% of pork fat had good acceptability.

5. Heat treated goat meat products

Among heat-treated meat products, emulsion-type sausages (e.g. frankfurters, mortadella) are popular worldwide and gladly consumed. As mentioned above, goat meat has a similar content of salt-soluble proteins as beef and could be used in the formulation of emulsion-type sausages. However, due to bad emulsion properties and a negative impact on taste and texture properties, goat fatty tissue should be avoided.

In the research by Stajić *et al.* [10], culled goat meat was used for partial and complete replacement of beef in all-beef frankfurters (beef and beef fat). Cooking loss, purge loss during storage, basic chemical composition and instrumental texture parameters were not affected by the amount of goat meat used in frankfurter formulation, while pH values were progressively higher with the increase in the

amount of goat meat, but were within the values for emulsion-type sausages. A progressive decrease of saturated fatty acid content and a progressive increase of polyunsaturated fatty acids (PUFA), especially long chain PUFA, was observed with the increase of culled goat meat content in frankfurter formulation. This led to a more favourable n-6/n-3 ratio in frankfurters with the higher amount of culled goat meat, reaching 6.63 in frankfurters with 100% goat meat. On the other hand, the main effect was observed regarding instrumental colour parameters – with the increase of culled goat meat content (and decreased beef content), frankfurters were lighter and less red, which led to higher values of total colour difference values. Since the colour of meat products is of great importance regarding consumer preferences [21], it would be expected that these observed differences are noticed by consumers. The check-all-that-apply (CATA) analysis confirmed that hypothesis, since the frequency of consumers that marked light surface and light pink surface as present progressively increased in goat frankfurters. However, this was not negatively perceived, because more than 80% of consumers marked pleasant colour as present in both beef frankfurter and in goat frankfurters. Panellists also perceived goat frankfurters as lighter than beef frankfurters and pointed to the frankfurter with 50% of beef and 50% of culled goat meat as the most preferred.

Guerra *et al.* [8] used goat meat from culled animals to produce mortadella with different pork fat levels (10–30%). All treatments showed good emulsion stability and water holding capacity, whereby mortadella with 30% of pork fat showed the highest values of these parameters. On the other hand, consumers gave the highest scores to mortadella with 10% of pork fat in all examined sensory properties except for texture. Moreover, about 70% of consumers said they would purchase goat mortadella.

6. Conclusions

Numerous research studies indicated that goat meat, including meat from culled animals, could be used in the formulation of different types of meat products. Some of them, such as *Violino di capra*, could be of importance as traditional meat products, while some, such as goat frankfurters, goat mortadella, etc., could be included in industrial manufacturing. Moreover, some value could be added to culled goat meat by using it in the formulation of these products. On the other hand, goat fatty tissue is marked as the main influence on the sensory properties of goat meat products, especially the ones made of culled goat meat. This could be overcome by using the fatty tissue of other animals (e.g. pork backfat or beef fatty tissue).

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