

GOAT MEAT – IMPORTANT FOOD OR VECTOR FOR ZOONOTIC MICROORGANISMS

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Goat meat is food but it can also be as other animals a carrier of bacteria that cause poisoning of people. Lately more and more bacteria of the genus *Campylobacter* and *Escherichia coli* have become very important causes of gastroenteritis and alimentary intoxications of humans. *Campylobacter* species are spread everywhere in nature in water, land, and particularly in the alimentary tract of animals. One of the important properties of these bacteria is to produce toxins. To humans they can be transmitted from animals, as sources of infection, in many ways, mostly by contaminated meat, milk and water. Many alimentary diseases in the world are caused by enterohemorrhagic *E. coli* O157:H7. Of the five known types of *E. coli*, that cause human diarrhea, the most pathogen is *E. coli* O157:H7, which, as well as some other types, produces a strong toxin. This pathogen causes hemorrhagic colitis in humans, hemolytic uremic syndrome and thrombocytopenic purpura. The goat intestinal tract can be a large reservoir of *E. coli* O157:H7. Most infections with *E. coli* O157:H7 have alimentary origin, although in some cases the horizontal infection is possible – from person to person. The research was done within the project TP 20005, "Improving of productive performances and quality of goat and kid meat in the ecological system of raising", funded by the Ministry of Science of the Republic of Serbia

Key words: goats; meat; *Campylobacter* spp.; *E. Coli* O157:H7; zoonotic infection

КОЗЈОТО МЕСО – ЗНАЧАЈНА ХРАНА ИЛИ ВЕКТОР ЗА ЗООНОТСКИ МИКРООРГАНИЗМИ

Козјото месо е храна, но може да биде и преносител на бактерии кои предизвикуваат труење кај луѓето. Во последно време бактериите од родот *Campylobacter* и *Escherichia coli* станаа многу важни причинители на гастроентеритис и алиментарни интоксикации кај луѓето. Видовите на *Campylobacter* се распространети насекаде во природата: во водата, во почвата и делумно во дигестивниот тракт на животните. Една од важните особини на овие бактерии е што продуцираат токсини. Тие можат да бидат пренесени на луѓето од животните како извори на инфекција на многу начини, а најмногу преку контаминирано месо, млеко и вода. Многу дигестивни болести во светот се предизвикани од ентерохеморагичната бактерија *E. coli* O157:H7. Од пет познати типови на *E. coli* причинители на дијареа кај луѓето, најмногу патогена е *E. coli* O157:H7 која како и некои други типови продуцира силен токсин. Овој патоген кај луѓето предизвикува хеморагичен колитис, хемолитичен уремичен синдром и тромбцитопенична пурпура. Козјиот интестинален тракт може да биде голем резервоар на *E. coli* O157:H7. Најголем дел од инфекциите со *E. coli* O157:H7 имаат алиментарно потекло, иако во некои случаи е можна хоризонтална инфекција – од човек на човек. Испитувањето беше извршено во рамките на проектот TP 20005, „Подобрување на продуктивните перформанси и квалитетот на козјото и јарешкото месо во еколошки систем на одгледување“, финансиран од Министерството за наука на Република Србија.

Клучни зборови: кози; месо; *Campylobacter* spp. *E. coli* O157:H7; зооноотска инфекција

INTRODUCTION

Goat meat is meat of high value and can have an important role in human nutrition, but in some cases it can be the source of pathogens. Meat of clinically healthy animals can be hygienically incorrect, which happens during production, technological operations or it can be healthy hygienically incorrect, which happens when it is contaminated during production, processing or sale, by pathogenic bacteria, parasites or the product of their metabolism.

For this reason, the monitoring program of zoonoses and zoonotic agents in the European Union includes microbiological pathogens that cause the majority of nowadays alimentary human diseases and they can be transmitted from animals to humans by contaminated meat and meat products. Among them, the largest number of human alimentary intoxications are caused by *Salmonella* and *Campylobacter* species, and then *E. coli* O157:H7, *Listeria monocytogenes* and *Yersinia enterocolitica*. The consequences of these infections are often epidemic diseases and often with lethal outcome.

To protect the health of people modern management systems for microbiological risks in the meat have been introduced, which are based on risk assessment and integrated and a longitudinal approach to meat the production chain. These systems use a variety of microbiological criteria in the context of goals to be achieved regarding the global food hygiene in the context of the production process and verification of HACCP (for example, the EU process hygiene criteria) and in the context of medical propriety of food placed on the market (for example: EU criteria of processing hygiene); and in the context of safety of food in the markets (for example: EU criteria of food safety) (Bunčić, 2007). The aim of our paper is to give the view of two pathogens that are the most important bacterial pathogens that can be transferred to humans by meat.

CAMPYLOBACTER SPP.

Campylobacter is a zoonotic microorganism, widely distributed in the nature. It naturally settled the intestinal tract of domestic and wild animals, especially birds, but not people. In the external environment it comes through excretion and secre-

tion of animals and after slaughter via waste water (Ivanović, 2009a). The most pathogenic of *Campylobacter* spp. is *Campylobacter jejuni*. As the main source for this bacteria the poultry is marked, although it is isolated from healthy pigs, sheep and goats (Ivanović, 2007a; Ivanović, 2008a; Ivanović, 2009b). Since it is conditionally pathogen, spreading of this organism rarely exceeds 50% of animals in a flock, and it usually occurs in young specimens or in groups of animals that are densely populated (AIFST, 2003).

According to Bergey 'Manual, the genus *Campylobacter* spp. contains sixteen species and six subspecies. It is proposed to add two more species (Vandamm, 2000). Members of this genus are typical Gram-negative, not sporulating forms, the form of S or spiral bacteria (0.2 – 0.8 μm wide and 0.5 – 5 μm long), with one polar flagella that gives characteristic movement. One of the most important features is to produce toxins. These bacteria require microaerophilic conditions, but only some types can grow under aerobic or anaerobic conditions. They are not able to neither ferment nor oxidize carbohydrates. Some species, especially *C. jejuni*, *C. coli* and *C. lares* are thermophilic, optimal growth temperature is 42°C. They may colonize the mucosa, especially of intestines, mostly in mammals and particularly in poultry.

Type *C. jejuni* contains two subspecies (*C. jejuni* subsp. *jejuni* and *C. jejuni* subsp. *doylei*) defined according to some phenotypic characteristics (nitrate reduction, selenite reduction and reduction of sodium fluoride and safranin). Subspecies *jejuni* is more frequent than subspecies *doylei*.

In the goat meat production, especially in the slaughter line, there are great opportunities for the contamination of goat carcasses by this pathogen (Ivanović, 2007a). Evisceration is a phase that most contributes to the finding of bacteria on the surface of carcasses, especially because after removing the skin there is no phase that can decrease the number of bacteria. Therefore, it is important that hygienic principles are met in each part of the slaughter line, such as accessories for evisceration, accessories for cutting and veterinary inspection, carriages for intestines and organs, since in any case they can determine the final load of carcasses and edible parts by enterobacteria (Ivanović, 2007c).

The influence of physical factors on the survival and multiplication of *Campylobacter* spp. in the areas where the products of animal origin are

manufactured has main importance, because in these areas these products can be contaminated and in this way *Campylobacter* can be transmitted to humans.

Besides the temperature and atmosphere for the growth of *Campylobacter* spp., optimal pH of 6.5 – 7.5 is necessary, but the range can be 4.9 – 9.5, water activity of 0.997. It can be quickly inactivated from the meat surface by heating at 55 – 60°C for one minute (ICMSF, 1996). Freezing causes the reduction of the number of *C. jejuni* during storage. The level of reduction depends on the type of food and of temperature in the storage place (AIFST 2003). The freezing temperature of at least –12°C, leads to the destruction of cells, which cannot recover after unfreezing.

Campylobacter is very sensitive to drying, especially at the room temperature. This bacterium can survive one hour on hands that are not well dried.

Acid environment also negatively affects the multiplication of *Campylobacter* spp. Meat industry use sodium chloride, various spices, additives etc. *Campylobacter* spp. can tolerate sodium chloride in the concentration of 0.5%. Spices, particularly black pepper, muscat walnut and allspice in the concentration of 0.14% at pH of 5.0 influence as bactericides and at pH of 5.6 and 7.0 decrease the growth (Ivanović, 2007b). It is sensitive to γ radiation. Dose of 2 to 3 kGy is sufficient to decontaminate meat or to destroy *Campylobacter* in meat.

Campylobacter coli showed the resistance to tetracycline and it is sensitive to erythromycin and ampicillin (Ivanović, 2007a) and some kinds of probiotics (Ivanović, 2003). In animals some kinds of *Campylobacter* cause enteritis but the mechanism of these bacteria is not well known yet.

Animals in which *Campylobacter* spp. persists as a facultative pathogen, for the second host have the role of source of infection. The way for the human infection is the consumption of meat of these animals. The main source of *C. jejuni/coli* for people is handling and consumption of contaminated meat, particularly poultry meat. The risk factors are also the consumption of contaminated water or raw milk and traveling in areas where the *Campylobacter* species are spread (Friedman, 2000). The newest investigations point out that goat meat has epidemiologic importance, because *Campylobacter* spp. were isolated from goat intestines (Ivanović, 2009c) without the contamination of carcasses. In Etiopy where the goat meat is one of the most important food of animal origin, authors examined 92 samples of goat meat of which seven (7.6%) were contaminated with *Campylobacter jejuni* (Dadi, 2008).

Campylobacter is an important cause of human bacterial intestinal disease, especially in developed countries. More than 80% of cases are caused by *C. jejuni* and about 10% by *C. coli*. In humans, infections by *C. jejuni/coli* cause acute enteritis with abdominal pain that lasts seven or more days. Anyway, each infection can be complicated with bacteremia, Guillan-Baré syndrome, reactive arthritis and abortion (Skirrow, 2000; Ivanović, 2008b). The infective dose, according to Heisick (1984) can be less than 500 cells in one milliliter or one milligram of food.

ESCHERICHIA COLI O157:H7

Escherichia coli is a normal inhabitant of the gastrointestinal tract of animals and people. It has an important role in maintaining the normal physiological function of the digestive tract of animals and humans. Over the last 60 years, about 60 out of 176 identified serotypes, are proven the pathogenic action and role in the development of diseases of humans and animals (Bunčić, 2007).

It is widespread in about 30 states. It is isolated from samples originated from animals in Canada, USA, Japan and Great Britain. By serological identification it is found that the species *Escherichia coli* has somatic O, flagellar H and capsular K antigen. Serotypes are in the correlation with clinical symptoms. The identification of virulent characteristics determines pathogenic kinds of normal flora. During 1977 there were identified diarrheic kinds of *E. coli* that produced toxin which had irreversible cytopathogenic effect on the culture of Vero cells (Konwalchuk) that was similar to the toxin produced by Shigella (Shiga-toxin) (O'Brien). The role of toxins in colon disease, causing hemolytic urinary syndrome (HUS) and neurological disease is not completely explained. The opinion is that the toxin directly damages endothelium cells in some organs and in that way disarrange, cell homeostasis. *E. coli* O157:H7 species isolated from animals and humans which had blood diarrhea, commonly produce the toxin V1 and V2 or only V2. These verotoxic *E. coli* can

consist of the 100 various serotypes (Johnson, 1996). *E. coli* O157:H7 is the most virulent serotype of pathogenic subset of verotoxic *E. coli* and it is signed as enterohemorrhagic *E. coli* (EHEC). They have characteristic long plasmid (Netaro, 1998). It has the possibility to ferment sorbitol for 24 hours, it is not able to produce β glucuronidase, it is able to link and remove gene (AE gene). Many *E. coli* O157:H7 are tolerant to acid medium. Minimal pH for the growth of *E. coli* O157:H7 is 4.0 – 4.5. If they are in large number, it can survive the fermentation, drying the stored fermented sausages for two months at 4°C. *E. coli* O157:H7 has three systems that give it the tolerance to acid medium: acid induced the oxidative system, acid induced arginin depended system and glutamate depended system. One made acid a tolerant form that can survive more than 28 days at the refrigerator temperature and this form, what is more important, increases the tolerance microorganisms to other stresses as heating for example. *E. coli* O157:H7 strains isolated from humans, animals and food have developed resistance to antibiotics as streptomycin-sulfisoxazole-tetracycline.

Probiotics decrease the possibility of link of *E. coli* O157:H7 and *E. coli* O127:H6 for epithelial cells. If lactic acid bacteria are ingested they will prevent the influence on epithelial cells decreasing transepithelial electric resistance (Sherman, 2005).

E. coli O157:H7 is sensitive to heating as other pathogens. There are some components in the food that can protect microorganisms as the fat. Temperature of cooking of at least 63°C for several seconds can inactivate *E. coli* O157:H7 and it is the most important critical control point.

Many countries have approved use of irradiation for the elimination of pathogens from food. The dose of 1.5 kGy can be enough to eliminate *E. coli* O157:H7 from minced beef.

Although cows are the main source of enterohemorrhagic *E. coli* (EHEC) in the food chain, EHEC strains are also isolated from other domestic and wild animals as sheep, goats, dogs, horses, pigs, cats and deer.

In Greece, from many farms, 351 samples of feces from goats, sheep and cows have been collected. From all samples *E. coli* O157:H7 is isolated that did not ferment sorbitol it produced only VT2 and showed β glucuronidase positive activity. This finding shows that goats can be a potential source of *E. coli* O157:H7 and this pathogen can

be transmitted by milk, milk products and meat to humans (Dontrou, 2004).

Most infections with *E. coli* O157:H7 are alimentary, although in some cases horizontal infection – from human to human, is possible. The largest number of epidemic caused by *E. coli* O157:H7 are linked with minced beef, inadequate thermal treated hamburgers, blood beefsteak, cooked meat and game meat. The use of water for irrigation, contaminated with feces, contributes that vegetables can be a source of infection but with less possibility (Steinhart, 1996).

In Ethiopia, authors investigated during seven months (October to April) totally 738 meat samples: 250 beef samples, 243 sheep meat samples and 245 goat meat samples. *E. coli* O157:H7 is isolated from 31 samples (4.2%). Positive samples were 8% of beef, 2.5% of sheep and lamb meat and 2% of goat meat. Isolates were 100% sensitive to amikacyn, chloramphenicol, gentamicine, kanamycin, nalidixic acid, norfloxacin, polymyxin B and trimethoprim-sulphamethoxazole (Hiko, 2008).

All strains of *E. coli* O157:H7 can grow at 10–43°C, but after three days at 12°C the number of live cells in minced beef decreases 1000 times (pH 5.7). Principally, *E. coli* O157:H7 survive in food at refrigerator temperature (3 – 7°C) with reduction of 0.5 – 2.0 logarithmic units during 1 – 5 weeks of storage. The survival is more efficient at 5°C than at 20°C (due to thermoresistancy) and during 9 months of storage of minced beef at –20°C it is proved that there are almost no changes in the population of *E. coli* O157:H7. Literature data showed that microorganisms that survived cooling or freezing become more thermoresistant. These facts have importance for the meat industry (Ivanović, 2007c).

Salt concentration can also influence the inactivation of this pathogen. Glass et al. (1992) proved that *E. coli* O157:H7 can be multiply in the medium with 6.5% NaCl while it survives in milk, but cannot multiply at salt concentration of 6.5%, pH 5.0 and 5.4 and at temperature of 12°C. A set of these factors results with the inhibition increasing of *E. coli* O157:H7.

E. coli O157:H7 causes different human diseases as diarrhea, blood diarrhea (hemorrhagic colitis), kidney disease (hemolytic urinary syndrome – HUS) and thrombocytopenic purpura (TTP). Hemorrhagic colitis is disease of all ages and it is characterized by strong abdominal

cramps, water feces that can become blood diarrhea, vomiting and a slightly fever. Hemolytic urinary syndrome (HUS) is characterized by acute damages of kidneys and microangiopathic hemolytic anemia. Trombocytopenic purpura is the second manifestation of infection with *E. coli* O157:H7 mostly in elderly persons. Pathogenesis of HUS and TTP become as consequence of acting of verocytotoxin. The infective dose for *E. coli* O157:H7 is extremely low and can be lower than 100 cells. Age, immunological status and healthy condition can individually or together influence the appearance of disease.

Other non-O157 serotypes (O26:H11, O104:H21, O111:H) as linked can sometimes influence disease of humans (Johnson, 1996).

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