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POLYAMINE VARIATION IN RAW GROUND PORK AND BEEF MEAT

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Abstract: *Samples of fresh ground beef and pork meat were studied for biogenic amine content. The initial amount of putrescine, cadaverine, spermidine and spermine was studied. The initial amount of cadaverine and putrescine were very low or not detected in both raw ground beef and pork meat. The initial amount of spermidine for ground pork meat was 5.56 ± 0.18 mg/kg dry weight and for ground beef meat was 4.32 ± 0.53 mg/kg dry weight. The initial amount of spermine was much higher than spermidine. The spermine in fresh ground pork meat was 26.33 ± 0.72 mg/kg dry weight and in fresh ground beef was 32.08 ± 0.17 mg/kg dry weight. At aerobically refrigeration storage for ten days, the amount of putrescine and cadaverine increased. The spermidine and spermine amounts slightly varied compared with putrescine and cadaverine along refrigeration storage of ground meats. Putrescine and cadaverine can be used as spoilage indicators for ground beef and pork meat stored in a refrigerated state for a longer time.*

Key words*: consumer health, shelf life, Romanian traditional dishes.*

1. Introduction

Biogenic amines can be produced by biosynthesis in the living organisms or by microbial activity. Putrescine, cadaverine, spermidine and spermine are polyamines that are found in eukaryote cells. Spermidine and spermine are biogenic amines that occur naturally in living organisms and are present after the organisms are dead. Because they are charged molecules, they bind to deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and proteins. Kusano [1] states that spermidine and spermine are essential regulators of growth, gene transcription, and ribosome-mediated translation. So, these two polyamines can be found in ground meat since they are located in cells and tissues. Usually, spermidine amount in fresh beef and pork meat is up to 5 mg/kg. Spermine amount in fresh beef and pork meat is higher compared with spermidine content, ranging between 20 and 40 mg/kg [2]. Putrescine and cadaverine are biogenic amines that are considered products of alteration by microbial activity. They derive from free amino acids by decarboxilation. Cadaverine is produced from lysine amino acid and putrescine from ornithine amino acid [3]. These two biogenic amines, in certain amount, influence negatively the sensorial characteristics of foods. Their names are associated with unpleasant odor and with meat alteration. The putrescine and cadaverine amount found in fresh meat is

low, usually not detected or around the limit of detection of the equipment. The increased levels of the biogenic amines are due to microbial activity. The microbial activity in meat is due to poor hygiene, possibly while slaughtering, cutting and mincing in case of ground meat.
Ground meat is used in Romanian dishes in combination with vegetables, pasta, cheese, eggs, or as meatballs. We mention some of the Romanian traditional dishes such as „*mici*", which are minced meat rolls, „*sarmale*" made from ground meat with rice wrapped in wine or pickled cabbage leaves, sausages, „*chiftele*" or meatballs, „*perisoare*" or meatballs for soup, all of them using ground meat. Therefore, the polyamine content of the main ingredient (ground meat) is very important in terms of food innocuousness and human health.
The research aims are:
- to assess the initial levels of putrescine (PUT), cadaverine (CAD), spermidine (SPD) and spermine (SPM) in fresh raw ground meat.
- to determine biogenic amine levels in refrigerated raw ground meat stored under aerobically conditions for ten days.

2. Materials and Methods

Sampling and refrigeration

Raw ground beef and pork meat were purchased directly from butcheries. All samples were put into an ice box for transportation to the laboratory. The samples were purchased from the same traders as ready to use fresh ground meat, on the production day. They were refrigerated at 4 ± 2 °C for ten days using the DBK386 WD (Beko, Turkey) refrigerator.
The samples were analyzed every two days. All the samples were stored aerobically, in plastic bags, packed since they were purchased from butcheries. The samples needed for analyses were taken aseptically from the original package.

Chemical analyses

The chemical determ
inations were made on the same day of the purchase. In total we analyzed 21 samples of ground pork meat and 19 samples of ground beef meat. The biogenic amine determinations were made in triplicates. Chemical analyses of meats were made on 12 samples, in triplicates.
Raw protein content was determined by digestion, distillation and titration by Kjeldahl method according to AOAC 984.13 method [4] using UDK 130 D distilling unit (Velp Scientifica, Italy).
Fat amounts were determined by Soxhlet extraction with solvent according to AOAC 945.16 method [4].
Ash contents were determined following AOAC 942.05 method [4] using FB 1300 furnace (Barnstead, USA).
Moisture levels were determined by air drying in the oven at 100 °C according to AOAC 950.46 method [4] using ULE 400 oven (Memmert, Germany).
All the reagents used for ground meat analysis were analytical grades.
The determination of biogenic amine amounts using high performance liquid chromatography was performed according to the method described in Baston [5]. The calibration curves for biogenic amines are linear, having r^2 as follows: putrescin r^2 = 0.9987; cadaverine r^2 = 0.9985; spermidine r^2 = 0.9981; spermine r^2 = 0.9983.
The concentration of each biogenic amine was expressed in mg/kg dry weight.
All the reagents were chromatographical grades.

Statistical data treatment

The statistic analysis was made using Microsoft Office Excel to determine the mean and standard deviations.

3. Results and Discussion

A very important indicator about the biogenic amine levels in raw ground beef and pork meat is the chemical structure of the products. Therefore, we analyzed the meats and the results are presented in table 1.

Table 1
Chemical parameters of raw ground beef and pork meat

Product	Protein (g %)	Total fat (g %)	Ash (g %)	Water (g %)
Raw ground pork meat	15.83 ± 1.22	20.88 ± 2.62	1.04 ± 0.86	62.25 ± 7.77
Raw ground beef meat	17.60 ± 3.40	17.34 ± 4.10	0.91 ± 0.73	64.22 ± 5.05

The results represent means ± standard deviation

The chemical analysis of ground meats cannot be compared with the chemical composition of pork or beef meats because it depends on the fattening state of the animal, age, anatomical area used for mincing and the fat amount added to the ground meat composition.
It has been acknowledged that ground meats have a higher amount of fat and a smaller amount of protein.
Generally, our average values for chemical parameters can be compared with the ones of a fat top round of beef and fat ham for pork [6].
Protein amount is the only important parameter for our study because the proteins have amino acids that can be broken to biogenic amines by spoilage microbiota.
In our case, cadaverine and putrescine are the biogenic amines.
Figure 1 presents the putrescine variation in raw ground meats.
Initially, the putrescine content of ground beef is below the detection limit. Ground pork meat has an amount of 0.10 ± 0.09 mg/kg.
On the second day of refrigerated storage, the putrescine amount of ground beef is still under the detection limit, while in pork ground meat it increased to 0.69 ± 0.61 mg/kg.
Beginning with the fourth day of storage, the putrescine in ground pork and beef meats is increasing.
This increase is due to microbial decarboxilation of free ornithine.

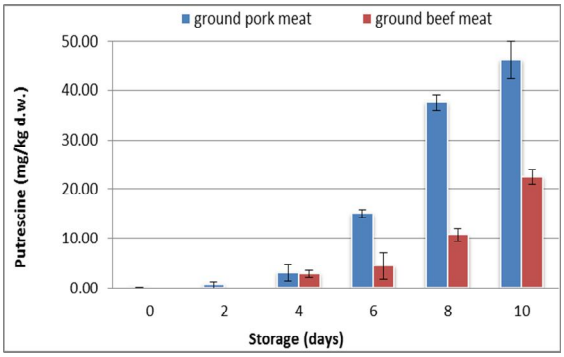

Fig. 1 Putrescine variation in ground meats.

As can be seen in figure 2 the cadaverine amount of raw ground beef meat in the first four days of determination is below the detection limit.
Cadaverine was found in pork meat on the second day of refrigeration to be under 1 mg/kg. After the second day of refrigeration, the cadaverine amount has increased in both types of meats studied.

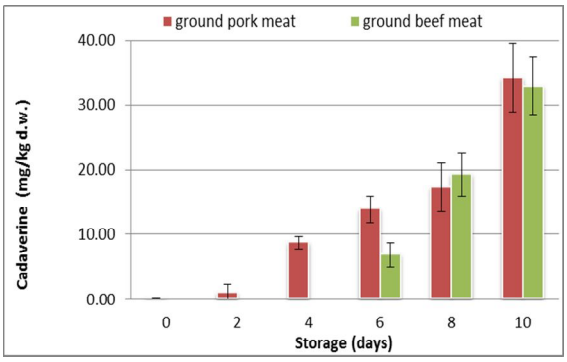

Fig. 2 Cadaverine variation in ground meats.

The highest amount of biogenic amines was registered on the tenth day of storage in ground pork meat.
Spermidine was found in small amounts in both types of ground meats.

Fig. 3 Spermidine variation in ground meats.

The initially registered spermidine values were of 5.56 ± 0.18 mg/kg in ground pork meat and of 4.32 ± 0.53 mg/kg in ground beef meat. Since spermidine is an amine produced by the body, it is found in tiny amount in pork and beef meat, as other researchers stated in their works [4,7]. After ten day-storage the spermidine in ground pork meat varied between 4.5 and 6 mg/kg.

The amount of spermidine in ground beef meat was smaller than that determined in ground pork meat and it varied depending on refrigerated storage from 4.12 to 4.9 mg/kg (as mean values). The variation of spermidine is due to its production from spermine and its use as carbon and nitrogen source by spoilage bacteria [7,8]. High amount of spermine was found initially in ground pork and beef meats as compared with spermidine. The following spermine values were obtained: 26.33 ± 0.73 mg/kg in ground pork meat and 32.08 ± 0.17 mg/kg in ground beef meat respectively.
The spermine variation after ten day-refrigeration storage is low, values between 25.01 ± 2.47 and 26.33 ± 0.73 mg/kg being registered in ground pork meat and 31.0 ± 0.84 to 32.19 ± 0.68 mg/kg in ground beef meat respectively. The spermine variation in beef and pork meats is due to its production from putrescine and its transformation to spermidine [9,7]. In beef and pork meats spermine can be found in a large range, from 13.3 to 47.5 mg/kg in beef and from 14.5 to 70.3 mg/kg in pork meat [2].

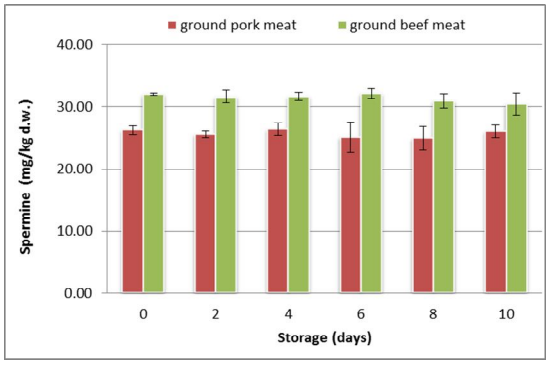

Fig. 4 Spermine variation in ground meats.

4. Conclusion

The polyamine values registered by our research comply with the limits established in the literature.
The smaller amounts of some polyamines found in ground meats are due to many factors of influence. One of them is the chemical composition of ground meats with reference to protein amount. And if this is low, then the polyamines that can be produced by microorganisms will be low, too. Meat hygiene is also very important because the initial contamination and the type of microorganism influence the polyamine type and amount. Moreover, polyamine amounts in ground meats are influenced by the age of the animal, fat addition or contained by the meat, and the anatomical area used.

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