

BIOGENIC AMINES VARIATION FROM REFRIGERATED WHITE AND RED CHICKEN MEAT

Octavian BASTON¹, Octavian BARNA¹

¹ “Dunarea de Jos” University of Galați

Abstract

Our aim were to determine the initial content of biogenic amines from raw chicken meat (red and white) and their evolution along refrigerated storage for seven days. By red meat we understand the meat from thigh and drumstick and by white meat we refer to breast meat. For biogenic amines determination we used HPLC (high performance liquid chromatography) method and we determined nine biogenic amines from chicken meat: tryptamine, phenylethylamine, putrescine, cadaverine, histamine, serotonin, tyramine, spermidine and spermine. After one day of slaughtering and carcasses cutting for obtaining the breast and legs (thigh and drumstick) we detected high levels of polyamines: spermine and spermidine. Spermine had the highest content of all biogenic amines studied. Also, in the first day we do not detected any amount of cadaverine and putrescin. After the meat was stored at refrigeration temperature at 4°C, we observed a decrease of spermine and spermidine content. Tryptamine, phenylethylamine, putrescin, cadaverine, histamine, serotonin and tyramine content increased in time in red and white chicken meat. Our study were conducted for seven days of refrigerated chicken cuts storage, and we did a comparison between biogenic amines profiles of red and white meat. Histamine was present in the first day of storage in both types of meat, in small quantities. Putrescin were detected first in red meat. Cadaverine were detected for both types of meat at shelf life and. We also calculated for the red and white chicken meat a biogenic amines index proposed by Mietz and Karmas and it also be as freshness index by researchers from Barcelona University.

Keywords: quality, freshness, chicken thigh, chicken breast

The refrigerated chicken meat spoilage when stored for a long period is due to the microorganism action and the biochemical transformations inside the product. After chicken slaughter, the muscular tissue suffers irreversible physical, chemical and biochemical transformations that determine the muscle to convert in meat. The microbial spoilage processes occurs later. Using refrigeration temperatures for meat conservation purpose reduces microorganism activity.

The difference between white and dark meat or white and red meat is a consequence of the different muscle cell types. Muscle cells are commonly called muscle fibers. White muscle fibers are also known as "fast-twitch" muscle fibers, and are geared towards (as their name implies) quick, sudden movements like a short burst of flight. Red or, "slow-twitch" muscle fibers, by contrast, dominate in muscles that require prolonged constant effort, such as the legs of most animals. Their primary source of energy is fat stores by way of cellular respiration. Birds such as chickens or turkeys fly rarely, and only for short periods, so their breast muscles are mostly white

fibers, while their legs are a combination of white and red.

Initially, chicken meat quality was evaluated by determination of microbiological and sensorial attributes. For the identification of the early signs of meat alteration, some chemical indices were proposed: volatile nitrogen basis, composites resulted after breaking the nucleotides, volatile acidity and the biogenic amine content (Halsz *et.al*, 1994). The biogenic amine occurrence is a consequence of the enzymatic decarboxylation of the precursor amino acids because of the microorganism activities. Polyamines: spermine and spermidine are natural amines produced by the body. The biogenic amines: putrescin, cadaverine, histamine, tyramine, tryptamine, β -phenylethylamine can be formed when storing the chicken meat due to microorganism action. The biogenic amine determination is important not only because of their toxicity but also their potential use as freshness indicators (Balamatsia *et. al*, 2006). Different authors' studies regarding the refrigerated chicken meat showed that some of the previously mentioned biogenic amine concentrations are increasing in time, while others are decreasing during storage (Vinci et Antonelli,

2002, Apostolos *et.al*, Sarinen *et.al*, 2002, Balamatsia *et.al*, 2006, 2007). The occurrence of these amines is dependant on different factors that vary in time. The microbial population influences the profile of biogenic amines. Spoilage responsible microorganisms might not have the capacity of amine forming. From a practical point of view, the relative simplicity and quickness identification and quantification of the biogenic amines (compared to the micro-biological measurement) besides the economical advantages (for example the quick test for determining the diamines described by Hall *et.al*, 1999), are reasons for using these substances as chemical indices for animal origin product freshness. The purpose of the study is evaluation of refrigerated white and red chicken meat quality using biogenic amines and to calculate the freshness index for chicken breast and thigh and drumstick.

MATERIAL AND METHOD

The chicken carcasses were purchased from the Agricola International Bacau company slaughterhouse. The meat was analyzed after cooling, packaging and transportation from the plant the first day after slaughter. The carcasses were stored aerobically for 20 days at a temperature of $4\pm 1^{\circ}\text{C}$ in the refrigerator. The refrigerator used is Electrolux ENB43691S. The carcasses weight varied between $1.2\div 1.5$ kg. Sampling was done as per Romanian Recommendation Norm 24/01/2005 (***, 2005).

The samples were analyzed the first day when the meat was received, recorded as day 1, then the 3rd, 5th, and 7th day. The dry matter determination was done according to STAS 9065/3-73. The measurement of biogenic amines content using high performance liquid chromatography, was performed according to the method proposed by Food Research Institute from Helsinki, Finland (Eerola *et.al*, 2001). All the reagents used were analytic pure, for HPLC use. The water used was deionised. The necessary reagents were purchased from the Merck and Sigma-Aldrich companies.

Installations and equipment used for biogenic amine determination: Philips 7768 food processor, homogenization device 7011S, Kern 770-60 analytical balance, Silent CrusherM homogenization device, centrifuge EBA 21, filter paper for quick filtering with 55 mm diameter, syringe filters with porosity of $0.45\ \mu\text{m}$ and 13 mm diameter, Heidolph REAX control agitator, ultrasonic water tank Aquawave TM, incubator BMT INCUCCELL 55, water deionising system EASY pure RoDi, filtering assembly with vacuum pump. The device for the HPLC determination was a liquid chromatograph model SURVEYOR produced by Thermo Electron company,

configured with detector model PDA PLUS DETECTOR, auto-sampler model AUTOSAMPLER PLUS, pump model LC PUMP PLUS and detector UV-VIS. Chromatography column is type BDS Hipersyl C18. The biogenic amines quantification: quantitative measurement was performed depending on the internal standard using peaks for each biogenic amine. The 254nm wavelength absorbance was measured and the resulted peaks were integrated with CromQuest software. The concentration of each biogenic amine was expressed in mg/kg. The statistical analysis of the obtained data was done using SPSS 13 software for 10 samples in each of the storage days. The results obtained are presented as the mean \pm standard deviation (SD). The standard deviation is a measure of the dispersion of outcomes around the mean. The differences among means were determined using the method of the smallest squares and the significance level was $p < 0.05$.

RESULTS AND DISCUSSIONS

Our determinations of biogenic amines from chicken breast, as can be seen in figure 1, can be discussed as follow:

-spermine (SPM) had the highest content from all nine biogenic amines. In the first three days spermine had an increase followed by a decrease until the seventh day at 20mg/kg dry weight. The increase is due to enzymatic activity of possible spermidine interconversion to spermine and the decrease is possible due to microbial activity that use spermine as nitrogen source;

-serotonin (SER) and β - phenylethylamine (FEN) had a very little increase, about $<1\text{mg/kg}$ d.w., for one week of breast storage at refrigeration;

-spermidine (SPD) had a little decrease, as a value of $<1\text{mg/kg}$ d.w., for one week of refrigerated breast storage, its initial and final value being around 5 mg/kg;

-tryptamine (TRIP) had a continuous increase during the all seven weeks of storage, but under 1 mg/kg. This is due to enzymatic action on amino acid tryptophan by muscular enzymes and possible microorganisms enzymes;

-tyramine (TIR) had a continuous increase in time of slightly more than 1 mg/kg for one week of breast storage at refrigeration temperature of 4°C . This increase is due to decarboxilating action of microbial enzymes;

-histamine (HIS) had a little increase, this biogenic amine had also a small initial content, in the seventh day being at a value of 4 mg/kg, also due to microbial activity;

-putrescin (PUT) were not detected for the first three days. Its increase is slow, being at seventh day of 2.5 mg/kg;

-cadaverine (CAD) like putrescine were not detected for three days the increase of cadaverine for seventh day being of 2mg/kg. Surely, the increase of cadaverine and putrescin content in chicken breast was due to microbial activity.

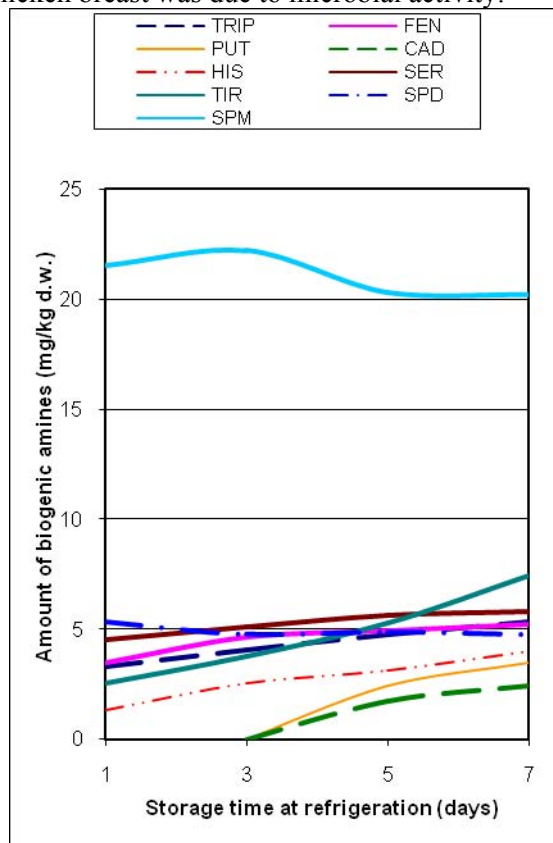


Figure 1 Chicken breast biogenic amines variation in time

In figure 2 we can say that:

- spermine was steadily decreasing and it has the biggest initial value between all the biogenic amines studied;
- spermidine also decreased in time with approximate 1 mg/kg for one week;
- serotonin and β -phenylethylamine increased, but very slow;
- tryptamine increased very slow, in one week under 1 mg/kg;
- -tyramine increased good, with more than 5 mg/kg for one week;
- histamine increased very slow under 1 mg/kg for one week of chicken leg refrigeration;
- putrescin had the most spectacular increase (over 10mg/kg) from the first day due to powerful microbial activity;
- cadaverine had also an increase but not as spectacular as putrescin because in the first three days it was not detected.

Making a comparison between biogenic amines content of the chicken white and red meat, we can say that in the red muscles, the microbial decarboxylation activity is bigger than in white muscles due to myoglobin content that can be a nutritive medium for spoilage microorganisms that produce putrescin and cadaverine. The contamination of red met is possible due to the contaminated knives and a bigger surface of contact between the meat and the knife comparing with the contact surface of breast and the knife.

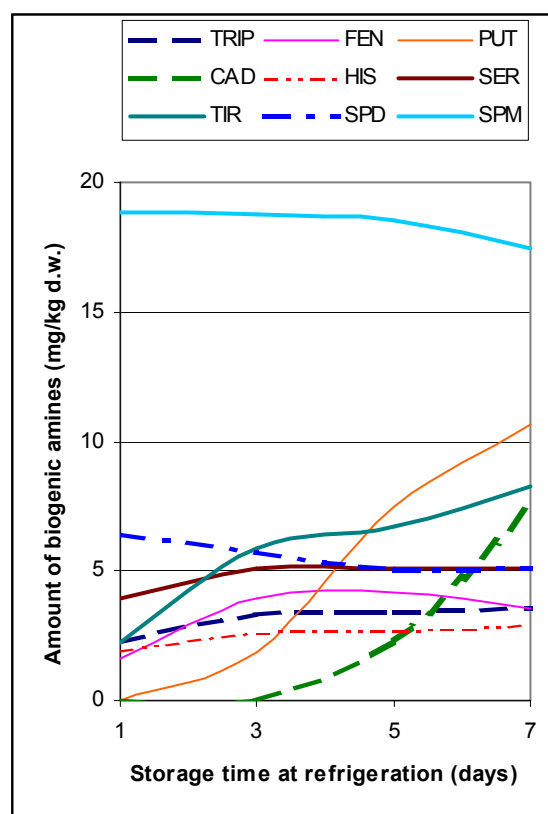


Figure 2 Chicken thigh and drumstick biogenic amines variation in time

Freshness index that we used for white and red chicken meat was calculated with the Mietz and Karmas relation proposed initially for canned fish:

$$\frac{\text{histamine} + \text{cadaverine} + \text{putrescin}}{1 + \text{spermine} + \text{spermidine}}$$

The variation of freshness index for white meat shows, as can be seen in figure 3, for first five days a slow increasing, having a maximum value of 0.35. After the fifth day the increase became more accelerated, attaining at a value of 1. Between day five and day seven we can observe an increasing spoilage of the white chicken.

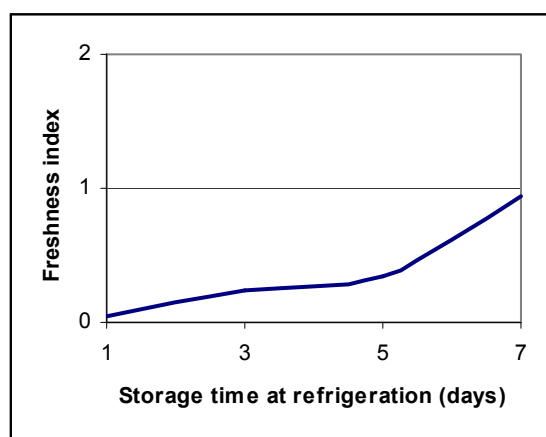


Figure 3 Freshness index variation of chicken breast

Figure 4 show us the freshness index variation of red meat. We can see that the index increase steadily from day one, reaching at a value of 1.9 after one week of leg refrigeration storage. The value of 1, in this case, is achieved after 4.5 days of breast storage.

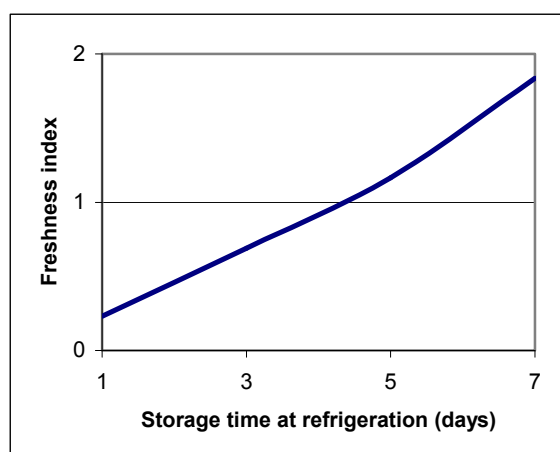


Figure 4 Freshness index variation of chicken thigh and drumstick

Making a comparison between the two freshness indexes from figure 3 and 4, we can say that the relation proposed by Mietz and Karmas can be used for chicken meat and it highlight the difference between the spoilage speed of the two types of meat.

CONCLUSIONS

Our determinations showed a difference of biogenic amines content between refrigerated chicken white and red meat. Spermine had the biggest content of all biogenic amines, in both white and red chicken meat. All the studied amines had an increased value, exception for spermine and spermidine. The mathematical relation of Mietz and Karmas for freshness index reveals us the advanced spoilage of red chicken meat comparing with white chicken meat.

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