

COMPARATIVE INVESTIGATION OF RADIOSENSITIVITY OF *Listeria monocytogenes* and *Salmonella* sp. IN POULTRY MEAT

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Key words: radiosensitivity, *Salmonella* sp., *Listeria* sp.

Background:

Poultry meat is very important source of protein in human diet. Due to enormous industrial poultry production the infection of poultry is possible. As a consequence of this, the infection of meat and products increases too. Poultry meat is an ideal media for the growth and breeding of microorganisms. At the same time, it is susceptible to contamination with different ubiquitous and pathogenic microflora, as well as by microorganisms which are indicators of non adequate hygiene in the production line, processing, storage, distribution and preparation (Molins, Motarjemi, 1997).

The investigation connected with application of radiation technologies in food preservation are intensified. Two factors are important for such movements in the development of radiation technology. The first is the efficiency of ionizing radiation as the antimicrobial Agnes and the second is that the mentioned process combined with other physical preservation methods cause insignificant chemical change without any harmful effects on the quality of the treated food (Robins, 1991, Thayer *et al.* 1996, Loaharanu, 1996).

Objective

The objective of this work was to represent the difference in radiosensitivity of tested pathogenic species of microorganisms, which are could lately appear as the source of the disease by people consuming contaminated meat.

Material and methods

Experiments were carried out on samples of frozen poultry meat artificially contaminated with:

- a) *Salmonella infantis* at concentration 7,7 log. No., b) *Salmonella enteritidis* at concentration 7,3 log. No c) *Salmonella agona* at concentration 8,3 log. No., d) *Salmonella typhimurium* at concentration 8,3 log. No., e) *Listeria monocytogenes* at concentration 7,7 log. No., f) *Listeria innocua* at concentration 7,5 log. No

Chunks of red, frozen poultry meat, of low initial spontaneous contamination with saprophytic microflora, were artificially contaminated with afford cited microorganisms. The contamination was carried out 24 hours post mortem by submerging the frozen samples into 24 hours old culture suspension of tested afforded cited microorganisms. The frozen and contaminated samples were than packed into plastic bags and subjected to ionizing radiation at doses of 2 and 3 kGy.

After the irradiation, the frozen samples were transported to the microbiological laboratory, Department of Meat Technology, the Faculty of Technology in Novi Sad, for the determination off cells surviving irradiation of chosen doses.

Results and discussion

The results of those investigations were presented in Table 1.

Table 1 – Effect of irradiation doses of 2 and 3 kGy on investigated microorganisms

type of microorganisms	initial contamination(log.No)	contamination after 2 kGy(log.No)	contamination after 3 kGy(log.No)
<i>Salmonella infantis</i>	7,7	2,69	0,01
<i>Salmonella enetritidis</i>	7,3	5,61	3,65
<i>Salmonella agona</i>	8,3	4,77	2,85
<i>Salmonella typhimurium</i>	8,3	3,84	1,48
<i>Listeria monocytogenes</i>	7,7	4,74	3,85
<i>Listeria innocua</i>	7,5	4,58	3,51

Tab. 1. Illustrates effect of applied ionizing treatment with two different doses on six different bacterial contaminant. From this table it can be seen that different doses are different in their efficiency to eliminate the tested microorganisms.

Immediately after the applied doses of 2 kGy evident is the decrease of vital cells of *Listeria monocytogenes* for 2,958 log.No. For *Listeria innocua* this value was decreased for 2,92 log.No. From the genus *Salmonella* the most radiosensitivity was observe in the *Salmonella infantis*, were the vital cells after the applying treatment of 2 kGy was only 2,69 log.No., i.e. the vital number was smaller for the 5,0 log.No. Similar trends were occurred with the level of *S.thypimirium* and *S. agona*. Immediately after treatment of 2 kGy caused a decrease of vital cells for 5,46 log.No., while *Salmonella infantis* caused a decrease for 5 log. No. and *Salmonella agona* were decrease by 3,53 log. No.

Applying doses of 3 kGy vital cells of *Salmonella infantis* are not determinate. Vital cells of *Salmonella enteritidis* are present in concentration of 3,65 log.No., i.e. the vital cells of *Salmonella agona* and *Salmonella enetritidis* are present at 2,85 log.No., i.e. 3,6 log. No. After treatment with doses of 3 kGy vital cells of *Listeria monocytogenes* was 3,85 log No, and for *Listeria innocua* was similar (3,51 log No.).

Dickson (1991) investigated the effect of external factors on the binding of cells of *Salmonella* and *Listeria* on the surface of poultry meat. The author established that the binding level of cells is in direct dependence of following parameters: initial inoculum level, temperature and age of bacterial culture i.e. inoculum. Having in mind the mentioned parameters, we decided to use 24 hour old culture, high initial inoculum level and freezing temperature.

The observed radioresistance of *Listeria monocytogenes* was also reported by Lewis and Corry (1991). Lebepe and all.(1990) presented the results of the work in which they are investigated radiation influence in the doses of 3 kGy on mesophilic aerobic bacteria in fresh pork stake. They pointed out that the investigated dose of 3 kGy was sufficient for the elimination for every pathogenically microorganisms with exception of *Yersinia enterocolitica*, *Aeromonas hydrophilla* and *Listeria monocytogenes*, which survive in a small number.

Such finding leads to the conclusion that it is not possible to determine an exact dose of ionizing radiation which would guarantee absence of tested bacterial species from the surface of poultry meat. They are many reasons such as the:

- primary reason is that different bacterial culture exhibit different sensitivity to this kind of conservation procedure
- another reason is the different initial level of contamination
- chemical composition e.g. quality of substrate used to investigated the sensitivity of micro-organisms to irradiation process

Different ionizing radiation doses are cited in literature as efficient for elimination of pathogenic bacteria. Some literature data will be mentioned, with the aim of discussion the obtained results. The dose of 2 kGy is not sufficient to cause a radication effect tested species of *Salmonella*. Thayer et all. (1991) has also observed similar radiosensitivity of tested *Salmonella* species to the applied irradiation doses in comaparation to the other *Salmonella* sp. They established that *Salmonella enteritidis* show the highest resistance to the applied doses, and show the similar radioresistance just like *Listeria monocytogenes*. This finding was also reported by Patterson (1989) and Gaze et. all.(1989).

Survival of small number of vital cells of tested microorganisms after irradiation with 3 kGy was achieved because the initial contamination was high. In our work, extremely high initial contamination was investigated, which is rear during the production process. This, investigated initial contamination, was near to the one stated by Urbain (1986) as indicator for meat spoilage.

According to our experience (Bulatović, Todorović, 1992, Bulatović et all, 1995, Bulatović, 1998) it is not correct to determine in advance a dose of ionizing irradiation aimed to the reduction or elimination of a tested bacterial species. The value of such a dose always depends on the initial inoculum level, the nature of substrate and a type of tested microorganisms..

Conclusions

On the basis of the investigation carried in this work it is possible to draw following conclusions:

1. Immediately after applying dose of 2 kGy the vital cells: a) *Listeria monocytogenes* are present in the concentration of 4,74 log. No, b) *Listeria innocua* are present in the concentration of 4,58 log. No, c) *Salmonella enteritidis* are present in the concentration of 5,61 log. No, d) *Salmonella infantis* are present in concentration of 2,69 log. No., e) *Salmonella typhimurium* are present in concentration of 3,84 log. No., f) *Salmonella agona* are present in concentration of 4,77 log. No.
2. Immediately after applying dose of 3 kGy the vital cells of: a) *Listeria monocytogenes* are present in the concentration of 3,85 log. No., b) *Listeria innocua* are present in the concentration of 3,51 log. No., c) *Salmonella enteritidis* at 3,6 log. No., d) *Salmonella infantis* at 0,01 log. No., e) *Salmonella agona* 2,85 log. No., f) *Salmonella typhimurium* 1,48 log. No.
3. The most sensitive species was *Salmonella infantis*, which is not found after the treatment with ionizing radiation in 3 kGy dose.
4. From genus *Listeria* was determinated similar radiosensitivity between tested species.
5. From the results it can be concluded that it is not possible to determine an exact dose of ionizing irradiation which guaranty the absence of tested bacterial species.
6. The doses which will be applied should represent a compromise between the need of meat hygiene and health safety on the one hand, and the preservation of nutritive values and sensorial characteristics of the substrate, on the other hand.

References:

1. Bulatović V., (1998): A study of radiosensitivity of *Listeria monocytogenes* 4b in poultry meat, Acta Microbiol., 35, 1, p. 45.
2. Bulatović V., M.Todorović (1992): Ispitivanje mogućnosti primene jonizujućeg zračenja pri dekontaminaciji kozijeg mesa zagađenog odabranim sojevima *Listeria* sp., Tehnologija mesa, 33, 6, p.292.
3. Bulatović V., M.Todorović, A.Terzić (1995): A study of radioresistance of different pathogenic *Salmonella* species in chicken meat, Acta Microbiol., 32,2, p.217.
4. Dickson J.S. (1991): Attachment of *Salmonella typhimurium* and *Listeria monocytogenes* to Beef Tissue: effect of inoculum level, growth temperature and bacterial culture age, Food Microbiol., 8, p.143.
5. Gaze J.E., G.D.Brown, D.E.Gaskell, J.G.Banks (1989): Heat resistance of *Listeria monocytogenes* in Homogenates of Chicken, Beef Steak and Carrot, Food Microbiol., 6, p. 251.
6. Lewis J.S., J.E.L. Corry (1991): Survey of the incidence of *Listeria monocytogenes* and other *Listeria* sp. in experimentally irradiated and matched unirradiated raw chicken, Int. J. Food Microbiol., 12, 2/3, p.257.
7. Lebepe S., R.A.Molins, S.P. Charoen, H. Farrar, R.P.Skowronski (1990): Changes in Microflora and Other Characteristics of Vacuum-Packaged Pork Loins Irradiated at 3 kGy, J. Food Sci., 55, 4, p.918.
8. Loaharanu P.(1996): Vet. Parasitol., 64,4, p. 188.
9. Molins R.A., Y. Motarjemi (1997): A Critical control point in ensuring the microbiological safety of foods, World Congress of Food Hygiene, Hague, p.19-24.
10. Patterson M. (1989): Sensitivity of *Listeria monocytogenes* to irradiation on poultry meat and in phosphate-buffered saline, Lett. Appl. Microbiol., 8, 5, p. 181.
11. Robins D. (1991): The Preservation of Food by Irradiation, London Press, p. 53.
12. Thayer D.W., E. S. Josephson, A. Brynjolfsson, G.G.Giddings (1996): Issue Paper No 7, CAST, Ames, IOWA.
13. Thayer D.W., G. Boyd, W.S. Muller, C.A.Lipson, W.C.Hayne, S.H. Baer (1991): Radiation Resistance of *Salmonella*, J.Industrial Microbiol., 5, p.383.
14. Urbain W.M. (1986): Food Irradiation, Vol. III, Academic Press, New York.