RADURIZATION OF POULTRY MEAT

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INTRODUCTION

Poultry carcasses of high water activity are the food products exceptionally tractable to deterotation process. This feature as well as the possibility of Salmonelae occurrence in surface contamination have played the decisive role in undertaking the scientific research in the field of practical application of ionizing radiation as the way of extensioning the shelf-life of poultry meat as early as the late fifties /9,16/.

The results of these investigations have become particularly important since 1976, when thanks to FAO/IAEA/WHO Experts Committee radurized poultry carcasses were unconditionally accepted, and the extension method was reckoned as physical /16/.

It was the detailed analysis of some aspects referring to radiation extension of poultry meat freshness described by Kahan and Howker /5/ as well as the intensive increase in poultry meat production in Poland that made the authors undertake the research in the field of radurization of broiler chicken meat.

MATERIALS AND METHODS

The broiler chicken carcasses of weight 0.9-1.2 kg were divided into 3 groups according to pH-15 breast muscles: below 5.8 - PSE meat; 5.8 - 6.2; above 6.2 - DFD meat. The carcasses were wrapped into the foil bags under vacuum and irradiated in Co-60 device with the doses of 2.5 and 5.0 kGy determined according to Frick's procedure /13/. Irradiated samples and nonirradiated controls were stored at the temperature 4±1 °C. The changes of sensoric features were defined according to Polish norms /6/ within 5 point scale and according to IAEA advices, within 9 point hedonic scale /12/.

Microbiological analyses were conducted according to the methods presented in /2,8,13/. Radiosensitivity estimation according to Brynjolfson's procedure /1/. Peroxide value and FFA value and malonic aldehyde content were indicated by standard methods. Fatty acids composition was evaluated by gas chromatography method in Varian-Aerograph 2740-30 device.

Processing utility was identified with the help of analysis of sensoric parameters of roasted carcasses as well as of poultry-pork sausages Vienna-type, produced of boneless poultry meat irradiated by 5.0 kGy dose and stored for 14 days.

RESULTS

The results of sensoric estimation of basic parameters characterizing the permanence of poultry carcasses in practice is shown at Fig. 1 and 2. Analysis of these data shows that the range of estimation variability of PSE caecasses indicates their sensoric disqualification between 14-th and 21-st day of storage. This phenomenon cannot be explained by more intensive development of recovering microflora. Fig. 3 indicates that TPC per square cm of poultry surface was deliberately lower than 10^7 value per square cm as defined by Coleby /4/, for beginning of spoilage process. All raw material groups reducing factor of surface microflora after gamma irradiation amounts to 10^3 - 10^4, what is confirmed by Thornley's results /14/ as well as Kahan and Howker's /5/. Therefore the thesis that the permanence of radurized poultry carcasses is limited by their enzymatic instability seems to be logical and confirmed by both suggestions of Kahan and Howker /5/. This hypothesis is additionally backed up by Niewiarowicz et all. /7/ who proved that higher speed of post-mortem glicogenolysis of PSE meat results in different biochemical features of this raw material group.

Two groups of bacteria of Pseudomonas type and Bacillus one were isolated from poultry carcasses. The first one was taken from carcass spoiled in temperature + 4°C, and the later one from the carcasses spoiled in temperature + 30°C. The samples of crumbled poultry meat were poisoned by suspensions of these bacteria, and next they were irradiated by different doses from 11.6 to 42.2 Gy /Pseudomonas sp.group I/; 59.3 to 294 Gy /Pseudomonas sp.group II/, and 0.99 to 7.3 kGy /Bacillus sp./. Quantative designation of cells surviving the irradiation was conducted according to TPC method /8/.

Under estimation of D_{10} value - its level and sterilization doses 12D examined kinds of bacteria - relation between the bacteria surviving capacity and used doses was established /1/. Surviving curves showed on Fig. 4 can be described by the following equations: for Pseudomonas sp.group I : $\log /N_D:N_O/ = 0.0105 - 0.0437\ D$; for Pseudomonas sp.group II: $\log /N_D:N_O/ = - 1.37 - 0.006\ D$; and for Bacillus sp. $\log /N_D:N_O/ = - 0.754 - 0.444\ D$. The surviving curve and dose D_{10} /23 Gy/ for Pseudomonas sp.group I is typical for this kind of bacterium /12/. The surviving curves of Pseudomonas sp.group II and Bacillus sp. are characteristic for mixtures of cells of different radiosensitivity. D_{10} value = 2.3 kGy for Bacillus sp. is consistent with literature data /12/. Exceptionally high D_{10} value of Pseudomonas sp. group II /170 Gy/ seems to indicate the fact that isolated bacteria could

be the mixture often defined as Pseudomonas-Achromobacter group. Within this group Achromobacter characterizes itself by higher radioresistance than Pseudomonas. Nevertheless, some scientific data show that D_{10} value for Pseudomonas can reach even 120 Gy /15/.

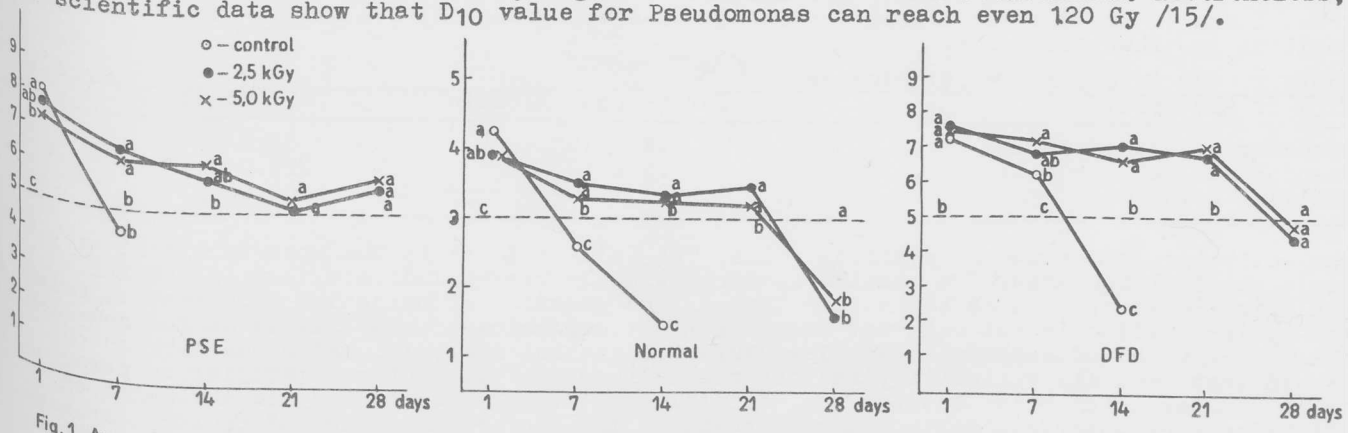

Fig.1. Average score of colour changes. The doded line – neither like nor dislike. The same letters within columns indicate no significant difference.

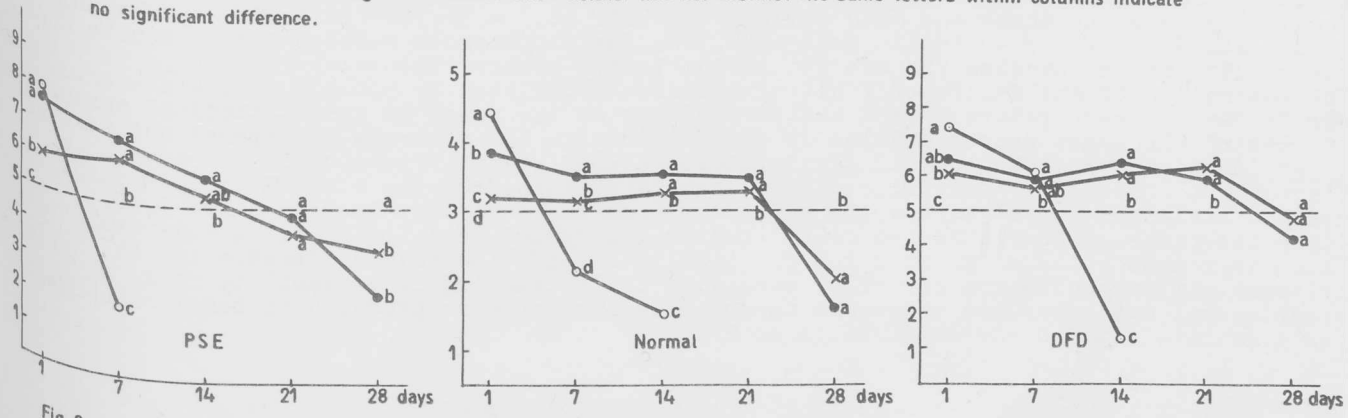

Fig.2. Average score of odour changes of raw broiler chicken carcasses.

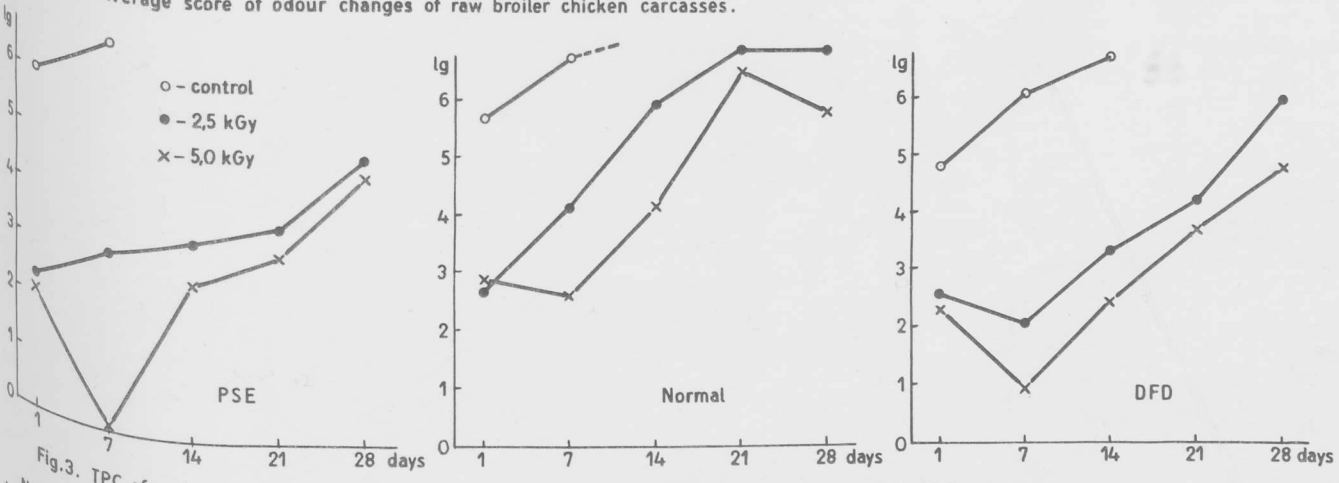

Fig.3. TPC of radurized broiler chicken carcasses. Log surviving fraction vs. storage period. TPC per sq.cm.

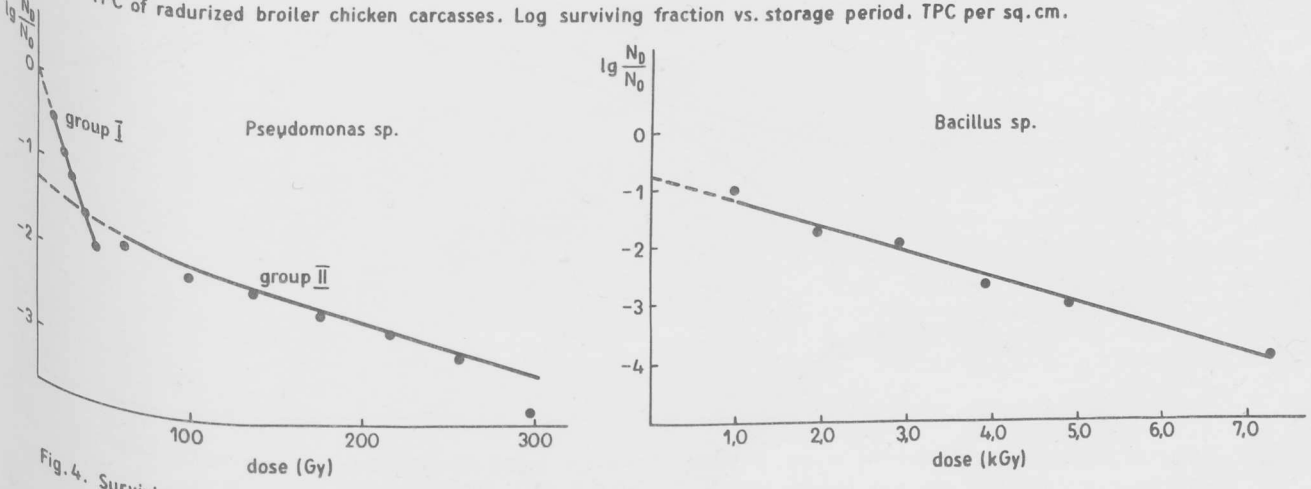

Fig.4. Surviving curves of Pseudomonas sp. and Bacillus sp.

The estimated doses of 12D value mentioned in Table 1 indicate that irradiation doses of poultry carcasses 2.5 and 5.0 kGy are adequately 33 and 67 times higher for Pseudomonas sp. group I and 12 to 22 times higher for Pseudomonas sp. group II; 2.6 and 1.3 times lower for Bacillus sp. than 12D value.

Table 1. 12D values for model studies.

Kind of bacterium	Inital contamination	12D doses
Pseudomonas sp. group I	7.4×10^8	75.0 Gy
Pseudomonas sp. group II	1.9×10^9	226.0 Gy
Bacillus sp.	2.4×10^8	6500.0 Gy

The estimation of changable peroxide value, TBA value and FFA is the most important of basic chemical features. The results of denotation on Fig. 5 indicate that in natural biological system, such as the muscle tissue, the question of oxidation processes stimulated by irradiation is not relevant from the practical point of view. It is at the same time the confirmation of Schubert's studies /10/. Statistical analysis, which was carried out, showed that from all variability factors the influence of kind of raw material on peroxide value and the interaction between the material and time of storage and its influence on TBA value were observed. Fatty acids composition in chloroform extract of poultry carcasses muscle tissue irradiated by 5.0 kGy dose was not significantly different from the controls. Judging by quantity there was much C /18:1/ - oleic acid - 34.76%; C /16:0/ - palmitynic acid - 26.7%; C /18:2/ - linolic acid - 22.54%. The differences between these results and the results of Rao studies /9/ are within the limits of experimental error.
The estimation of shelf-life of poultry carcasses irradiated by 5.0 kGy dose and stored for 14 days at temperature 4 ± 1^{0}C was carried out on the basis of the statistical analysis of roasted carcasses sensoric value in comparison with the controls not stored but roasted in an identical way. The lack of statistically significant differences in appearance and flavour was observed. The radurized caecasses taste gained medium score 7.15 in 9 point hedonic scale and was significantly different from the controls - medium score 7.80. Since the range of scores in two cases equated the verbal description "like moderately" - "like very much", therefore from the practical point of view this difference is not relevant. It was quite the different case with the estimation of variability range of experimental meat products taste and odour. These latter were produced of boneless carcasses irradiated by 5.0 kGy dose /Table no 2/.

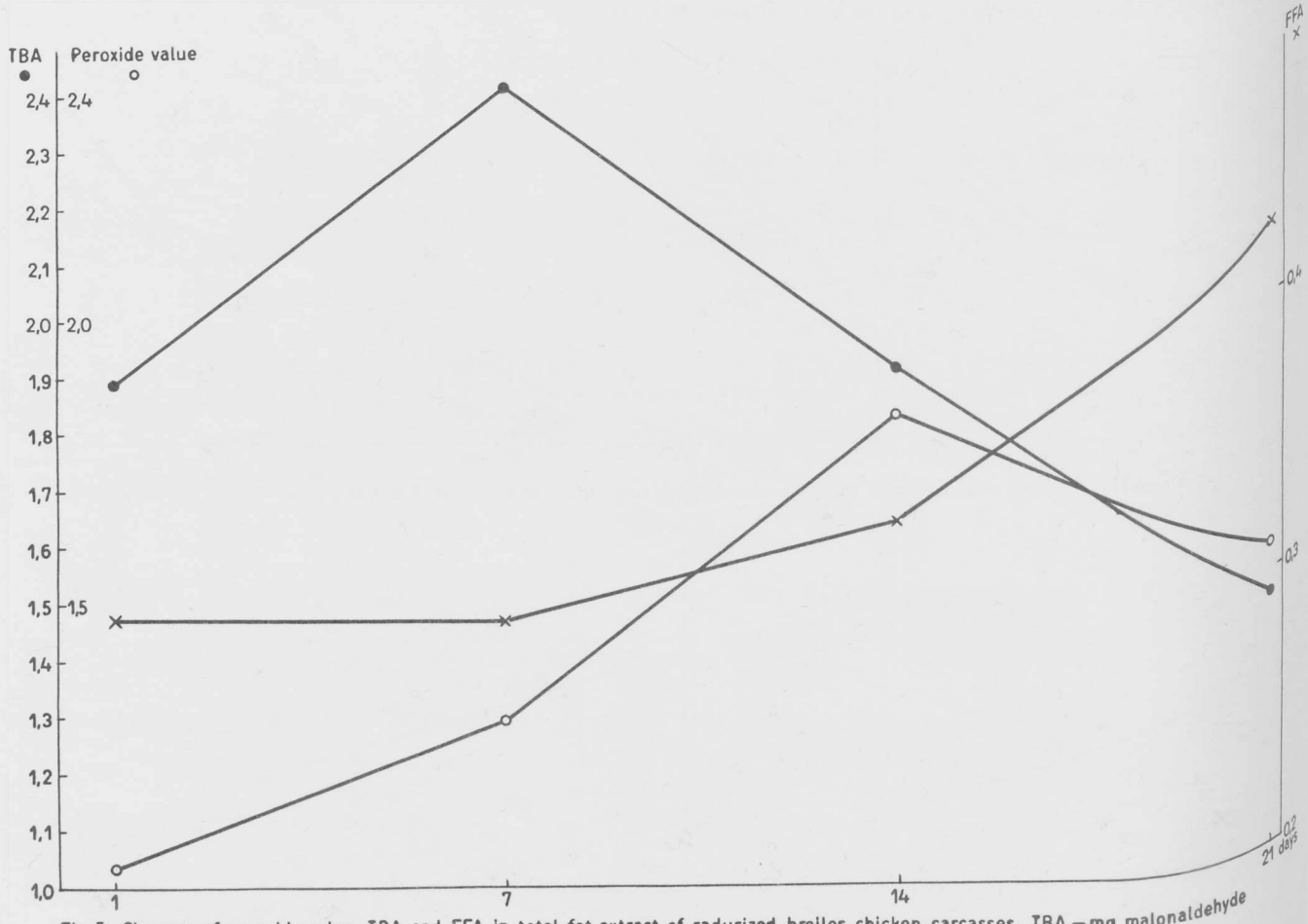

Fig. 5. Changes of peroxide value, TBA and FFA in total fat extract of radurized broiler chicken carcasses. TBA – mg malonaldehyde per 100 g of fat, FFA – % of oleic acid, peroxide value – ml 0,002 N $Na_2S_2O_3$ per 1 g of fat.

Table 2. The range of taste and odour in the experimental Vienna - type sausage.

Parameter	Mean ± standard error α = 0,05	Mean ± standard error α = 0,01
Odour	4.53 - 7.28	3.90 - 7.90
Taste	5.15 - 6.85	4.76 - 7.24

Quantative increase of poultry meat in material composition from 12,5% up to 25% has caused the fact that apart from odour and taste also the estimation of cross-section's colour shows the possibility of sensoric disqualification. Therefore the possibility of using radurized boneless broiler chicken meat in the production of poultry - pork sausages is doubtful.

GENERAL REMARKS

The presented results are only the part of studies devoted to radurization process as the way of extensioning poultry carcasses freshness. At the moment Laboratory of Nuclear Methods in Agriculture is interested in the studies of the changes in basic protein parameters and technological features. The results of these studies would contribute to better description of the changes undergoing in poultry meat under the influence of gamma irradiation.

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