EFFECT OF GAMMA-RADIATION ON THE FATTY ACID COMPOSITION OF LAMB AND PORK PRODUCED FROM RADIATED ANIMALS

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SUMMARY: The effect of gamma-radiation on the fatty acid composition of meat obtained from in vivo radiated animals was studied. Pigs received radiation doses of 2.2 Gy and 3.3 Gy, and the tests of the fatty acids were made on the 30th day; the radiation dose for lambs was 3.3 Gy, and the tests were made on the 10th and 20th day after the radiation.

The results from the gas chromatographic analysis gave reason to conclude that, on the whole, despite certain deviation, the fatty acid spectrum of the radiated animals was typical of the studied types of meat and was similar to that of the controls. No significant differences were found out between the pigs radiated with both radiation doses and the control group. With radiated lambs there was a shift of the fatty acid spectrum towards the saturated and monoenic acids. The saturated: polyenic acid ratio was 5.0 for the control, and 12.5 and 10.0 for lambs radiated with 3.3 Gy on the 10th and 20th day after exposure, respectively. The saturated+monoenic:polyenic acid ratio was 7.7 for control samples, and 19.0 and 14.9, respectively, on the 10th and 20th day after the exposure.

INTRODUCTION: The changes in the fatty acid composition in test animals radiated with gamma-rays in vivo are of interest both from the point of view of radiobiology and utilization of meat for food. Formulating the theory of chain processes during radiation injury, Tarusov (1954, 1962) concluded that the basic substrate of the primary chain radiation reactions are biolipids (unsaturated fatty acids) that are mainly structural The studies of Ralleigh et al. (1977) supported his conclusion On the basis of all data familiar, Kudryashev et al. (1987) drew the general conclusion that lipids appeared to be the most sensitive component of meat under the action of ionizing radiation, and the most radiosensitive are the uncontrolled processes of free radical oxidation of the unsaturated fatty acids.

The above researches were considered as a reason good enough to carry out studies with the aim to establish the changes in the fatty acid composition in gamma-radiated test animals (lambs and pigs). The studies also aimed at assessing the biological value of meat from radiated animals, the possibilities for its technological processing, and its use as man's food.

MATERIALS AND METHODS: Two types of animals were used in this study - lambs and pigs. Test lambs were divided into two groups: one was subjected to single radiation with 3.3 Gy gamma-rays, and the other was kept as control. Samples were taken on the 10th and 20th day after the exposure. The samples were composed of equal parts of the following muscles: m. Semimembranosus, m. Supraspinatus, m. Longissimus dorsi, and were taken both from test and control animals. Pigs were grouped in three: one group was control, and the other two were gamma-radiated with 2.2 Gy and 3.3 Gy, respectively. Thirty days later the animals were slaughtered and samples were taken from the above-mentioned muscles, and their fatty acid spectra were analysed separately.

The fatty acid composition was determined by preliminary methylation of the fatty acids in 6% dry HCl in dehydrated methanol followed by identification in a Perkin Elmer SIGMA I gas chromatograph equipped with a flame ionization detector and SIGMA 10 microprocessor controlling the chromatographic process and giving qualitative/quantitative interpretations of the chromatograms.

The resultant data were processed by the method of external standard with data normalization, i.e. each fatty acid was calculated as a percentage of the sum total of the fatty acids

RESULTS AND DISCUSSION: The fatty acid composition of the fat from the analyzed pork samples is altogether typical of this type of meat. There are no significant differences between radiated and control animals (Table 1). It can be noticed a certain decrease in the saturated:polyenic, and the saturated+monoenic:polyenic fatty acids ratios in the samples from m. Supraspinatus as compared to the controls while the linolic:oleic acid ratio is slightly changed (Table 2). The level of the metabolically important arachidonic acid (C-20:4) is noticeably low while the essential C-18:2 (linolic) and C-18:3 (linolenic) acids are in sufficient levels from the point of their administration into the body. The saturated C-16:0 (palmitic) and the monoenic C-18:1 (oleic) acids are in approximately equal levels in all analyzed samples - test and control.

With the exception of C-20:4 whose level is low, the general fatty acid spectrum is balanced. All fatty acids that are important for the science of nutrition are available. Thus for example, the essential linolic acid (C-18:2, 6) as a precursor of the dihomo-gamma linolenic acid and the arachidonic acid is necessary to the hormones prostaglandines, prostacyclines, etc. C-18:2 together with the other polyunsaturated fatty acids has been proved to possess hypolipidemic and antitrombotic effect.

The linolenic acid (C-18:3, ω 3), the precursor of the long chain polyunsaturated fatty acids of the ω 3 family, possessing an important plastic role in the body, is also a precursor of the biologically active eicosanoids of series III and has antiaggregation effect, i.e. suppresses the trombogenicity by holding up the trombocyte aggregation.

In the tests with gamma-radiated lambs there are certain shifts of the fatty acid spectrum. The samples from the animals radiated with 3.3 Gy show shifts of the fatty acid spectrum on the 10th and 20th day after the exposure. The level of the arachidonic acid (C-20:4) has significantly decreased with unfavourable effect on the biological and nutritive value of meat (Table 3). On the other hand, however, its precursor, the linolenic acid (C-18:2, ω 3), has preserved its level and thus does not exclude the possibility for its obtaining by metabolism. The level of the essential C-18:3 (linolenic) acid is low in all samples - radiated and control.

Table 1. Fatty acid composition of meat from in vivo single gamma-radiated pigs, 30 days after the exposure (%).

Fatty Acids	Control			Gamma-radiated 2.2 Gy			3.3 Gy		
	Types of studied muscles								
	A	B	C	A	B	C	A	B	C
12:0	-	-	-	-	-	-	-	-	-
14:0	4.5	5.0	4.8	5.6	4.6	5.1	4.5	4.5	4.5
14:1	-	-	-	-	0.7	-	-	-	-
15:0	0.7	-	-	-	-	-	-	-	-
16:0	32.6	36.2	36.9	34.1	32.0	34.6	32.6	36.2	33.7
16:1	8.3	8.8	9.0	11.6	10.6	12.0	10.3	10.3	9.6
17:0	1.1	1.4	1.0	1.3	1.2	1.6	1.0	-	1.3
17:1	0.5	0.8	0.7	0.6	0.7	1.0	0.7	-	0.8
18:0	8.1	7.6	7.0	4.9	5.3	5.4	6.1	6.0	6.2
18:1	33.6	31.6	32.1	31.3	34.5	31.6	35.0	31.9	34.3
18:2	9.8	8.0	7.9	9.5	9.6	7.8	8.9	8.9	9.0
18:3	0.7	0.6	0.6	0.8	0.8	0.8	0.8	0.9	0.7
20:4	traces	traces	-	traces	traces	-	-	1.2	traces

A: m. Semimembranosus; B: m. Supraspinatus; C: m. Longissimus dorsi.

Table 2. Some ratios between individual fatty acids in pork fat from in vivo single gamma-radiated pigs, 30 days after the exposure.

Type of Sample	Saturated / Polyenic	Saturated+Monoenic / Polyenic	Linolic / Oleic
m. Semimembranosus			
Control	4.4	8.4	0.3
2.2 Gy	4.4	8.6	0.3
3.3 Gy	4.5	9.2	0.25
m. Supraspinatus			
Control	5.8	10.6	0.25
2.2 Gy	4.1	8.5	0.28
3.3 Gy	4.2	8.2	0.28
m. Longissimus dorsi			
Control	5.8	10.8	0.25
2.2 Gy	5.4	10.6	0.25
3.3 Gy	4.7	9.7	0.26

Some ratios between the fatty acids given in Table 4 illustrate a certain shift of the fatty acid spectrum (compared to the control) towards the saturated and monoenic fatty acids while the dienic:monoenic ratiohas been kept stable. Impressive is the significant increase of the myristic acid (C-14:0) compared to the control (Table 3). Slightly lower is the increase of the oleic (C-18:1) and palmitic (C-16:0) fatty acids (Table 3).

Table 3. Changes in the fatty acid composition of lamb fat (mixed sample)[a] from animals in vivo radiated with 3.3 Gy gamma-rays, in the post exposure period (%)

Fatty Acids	Control	Gamma-radiated	
		Post exposure period, 3.3 Gy	
		10 days	20 days
12:1	11.0	4.8	6.0
14:0	13.4	21.9	21.0
14:1	3.6	2.5	-
15:1	-	-	-
16:0	24.4	28.1	27.4
16:1	5.5	3.2	3.8
17:0	2.5	1.3	1.4
17:1	traces	traces	traces
18:0	5.8	6.5	7.7
18:1	22.2	26.6	26.4
18:2	3.2	2.7	3.0
18:3	traces	traces	0.6
20:4	8.3	2.3	2.7

[a]Each meat sample is mean and is composed of equal parts of m. Semimembranosus, m. Supraspinatus and m. Longissimus dorsi.

Table 4. Some ratios between fatty acids in mixed sample[a] fat from in vivo single gamma-radiated (3.3 Gy) lambs, in the post exposure period.

Type of Sample	Saturated / Polyenic	Saturated+Monoenic / Polyenic	Linolic / Oleic
Control	5.0	7.7	0.1
Radiated:			
- after 10 days	12.5	19.0	0.1
- after 20 days	10.0	14.9	0.1

[a]Meat samples are as in Table 3.

CONCLUSIONS: The laboratory tests on the effect of in vivo single gamma-radiation of animals on the fatty acid composition of meat allow to make the following conclusions: 1. In the radiation of pigs with 2.2 Gy and 3.3 Gy, on the 30th day after the exposure, there were insignificant deviations in the fat composition of the studied muscles, and on the whole the fatty acid spectrum of the radiated animals is typical of this kind of meat, and is close to that of the control. 2. In the radiation of lambs with 3.3 Gy, the results obtained on the

10th and 20th day after the exposure show a shift of the fatty acid spectrum towards the saturated and monoenic acids and concomitant considerable decrease of the relative percentage of the arachidonic acid. 3. Finally, it can be said that the results on the fatty acid spectrum of the gamma-radiated animals do not show such deviations so as to significantly lower the biological value of meat, and the possibility to use it as man's food.

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