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Journal of Agroalimentary Processes and Technologies 2008, 14(2), 455-462

Journal of Agroalimentary Processes and Technologies

Researches concerning detection of irradiated food by physical-chemical methods

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Abstract

Meat, especially chicken and fish meat are considered an indispensable food for all ages, enshuring the human organism protein and esential aminoacid request. To prolong of the keep time for meat can use irradiation of it with gamma rays. In America this preserve method is usual for fruit and meat. In Europe, this technique has not industrial apliance, especially due to the human reticence on this subject. Consumers are gaining knowledge about the benefit of food irradiation and its potential to reduce the risk of foodborne disease, but the process is not a replacement for proper food handling practices. Irradiation, like other prevention methods, is only one of the methods used to prevent foodborne illness [1]. Our experiment was developped in 2006 and 2007 years. The aim of this paper was to achieve a comparison of sensorial and physical-chemical properties of some chichen and fish meat samples, which were treated by gamma radiation against samples without radiation treatment. After sensorial examination we determined the following parameters: easily hydrolysable nitrogen content, protein content, Kreiss reaction, H_2S reaction, acidity and pH of the samples. According to our results, we detected the samples which were irradiated one year ago finding the same carriage but the ESR (electron spin resonance) value signals were different. The sensorial examination were didn't discover differences between the control samples and the other samples; the non-iradiated and irradiated samples were in concordance whith the specific legislation. Reporting to the quality indicators, only the reaction which establish the fats oxidation stage was positive (we found the evidence of epihydrinic aldehyde presence), while the rest of determinations had no significant differences between analyzed samples and control samples. It was possible to detect irradiated samples after one year ago by ESR spectroscopy.

Keywords: sensorial examen, physical-chemical analyses, detection of irradiated food, bone, ESR (electron spin resonance)

1. Introduction

The irradiation of foods was the subject of many researches due to its benefits. Irradiation can kill fruit flies, weevils and other exotic pests that curently pose barriers to trade – as they can still pose infestation dangers. On the other hand, irradiation can mask the filth from factory – style production, sloughtering and processing, thus failing to encourage meat companies to improve conditions in their facilities [2,3,4].

Irradiation method for preservation of food is legal in about 60 countries for hundreds of types of food. In Romania, until now, this method is still avoided at food, but already used for pharmaceutical (e.g.: drugs, ointments, tea) or medical practices (e.g.: sterilisation of surgical instrumets). In Romania law in food irradiation field is the „Norme concerning food stuffs and food

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ingredients treated by ionizing radiation" [5].

It is estimated that in few years, many foods will be preserved by this method because strictly respecting the irradiated parameters this foods are not dangerous for the human, the foods being keept a longer time in safe conditions. Irradiation can double or triple shelflife, thus allowing to be shipped for longer distances before rotting – through depriving food of nutrition and taste [6].

Meat or fish have, generaly, a high microbiological load; therefore, it is necessary termic treatment, salting and smoking or irradiating to preserve these products.

FAO/IAEA/WHO Study Group in Geneva (1977) stated that food irradiation is a safe and effective process which doesn't affect nutritional characteristics and good manufacturing practices [7]. The aims of irradiation treatment are disinfestation; the prolongation of shelflife; improving the technological properties of different food products; prevention of germination and sprouting [4].

The compulsory condition for this food is the labeling, which must contain the mention „irradiated food" or „preserved by irradiation".

For detecting irradiated foods in IRASM Bucharest there is used ESR spectroscopy method for food containing: bone [8], cellulose [9] and crystalline sugar [10].

2. Materials and method

In this study we examinated chicken and fish meat samples after irradiation treatment by ionising radiations and compared these samples with similary meat sample without irradiation.

We irradiated these samples in IRASM (Irradiation Technological Center for Multiple Aims) Bucharest, using a special equipment IRASM - SVST Co-60/B irradiator, with Co-60 sources. We kept also reserve samples without irradiation treatment. IRASM's work is authorised by National Commission for Control of Nuclear Activities concerning the radiation processing; the National Drug Agency for microbiology tests and certificated by DQS Germany for conformity with ISO 9001, DIN EN ISO 13485 and EN 552.

Thus, we treated samples from all kinds of meat, fish and chicken meat. These samples were kept in refrigeration during the transport. After sensorial examination in laborator we determined the following physical-chemical parameters [11]:

- easily hydrolysable nitrogen content by indirect titration with sodium hydroxide 0.1 N;
- protein content by Kjeldahl method;
- fats oxidation degree - Kreiss by color reaction with floroglucine (1,3,5-trihydroxibenzol);
- H_2S identification by reaction with lead acetate 10%;
- acidity by titration with sodium hydroxide 0.1 N;
- pH by potentiometric method;
- the irradiation degree by ESR spectroscopy (detection of irradiated food containing bone).

Next to these determinations we tryed to detect some bone of fish and chichen samples which were irradiated 1 year ago at 0, 2, 5 or 7 kGy and preserve in IRASM data base. Food irradiation detection was made by ESR spectroscopy. The fresh fish and chicken samples are irradiated at 5,8 kGy.

The ESR signal of irradiated bones is an asimetrical axial wide singlet with the values g=2.002 and 1.998; the non-irradiated samples give a wide, weak, simetrical ESR signal with the value g=2.005 [12]. Two paramagnetical species are responsible for the signal of irradiated bone tissue: one resulted from the bone collagen and the other coming from the structure faults in the crystalline fraction of the mineral component in bones – hydroxyapatite [12].

3. Results and discussion

Through sensorial exam of fish and chicken meat we appreciated: the extern appearance, inside appearance, consistence, colour and smell. After this examination we couldn't observe any differences between irradiated or non-irradiated samples. Physical-chemical parameters of analyzed samples are presented in table 1.

Table 1. Mean values of physical-chemical parameters of fish and chicken meat which were analyzed in laboratory

Crt. no.	Physical-chemical index	Mean values			
		Non-irradiated fish meat	**Irradiated fish meat**	**Non-irradiated chicken meat**	**Irradiated chicken meat**
1.	Easily hydrolysable nitrogen (mg/100g)	24.01	23.7	23.78	18.4
2.	Protein (%)	28.9	28.56	28.64	27.4
3.	Kriess reaction	negative	negative	negative	**pozitive**
4.	H_2S identification	negative	negative	negative	negative
5.	pH	6.91	6.32	6.76	6.71
6.	Acidity	0.9	1.3	0.2	0.3

The easily hydrolysable nitrogen was framed in legal limits, in irradiated samples and in non-irradiated samples. This fact shows in figure1. The protein content of the analysed samples was higher in non-irradiated samples. Since in the fish samples the differences of protein content between the samples weren't significant, in the chicken meat samples the differences were significant. This fact suggests that irradiation process may cause light damages to proteins; it appears that the chicken proteins were more sensitive at this treatment with gamma rays.

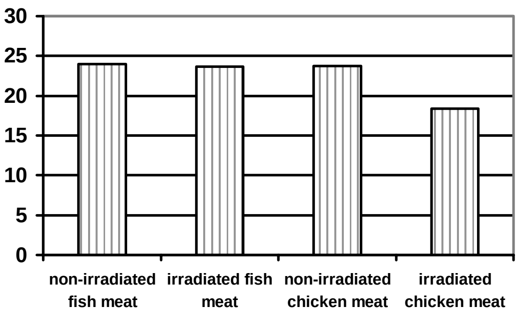

Figure 1. Easily hydrolysale nitrogen (mg/100 g product)

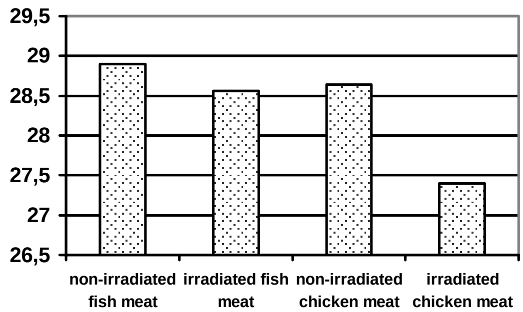

Figure 2. Protein content from analyzed samples (%).

The Kreiss reaction quantificates the oxidation stage of fats. In our experiment, this reaction was positive at chicken irradiated samples. The presence of the epidydrinic aldehide means that the oxidative processes of fats has already started and this product cannot be given to human consumption.

Identification reaction for H_2S was negative in all cases.

The mean values of pH and acidity are presented in figure 3 respective in figure 4; there may be noticed that irradiated samples registered smaller values that non-irradiated samples in all cases. Acidity was higher in non-irradiated samples that in the rest of samples.

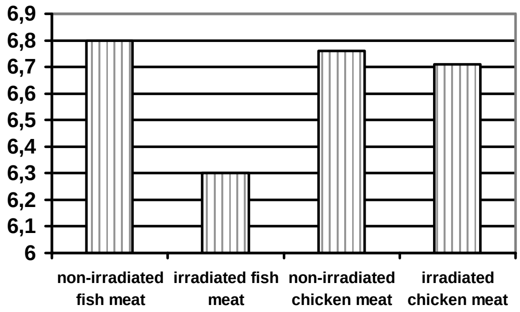

Figure 3 - Values of pH

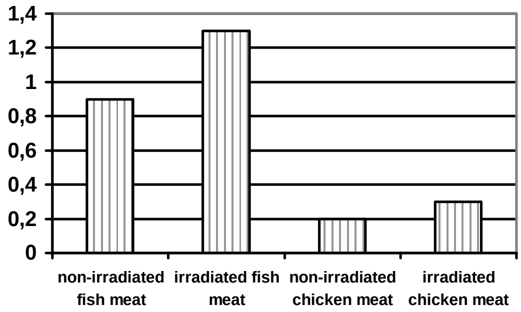

Figure 4 - Acidity of analyzed samples.

Regarding hunt out of irradiated samples we remarked the specifical signals of free radicals in bones caused by ionising radiations. More than that, the signals of the irradiated samples 1 year ago preserved their look, but with reduced signal intensity. This signal detection was possible after 1 year by ESR spectroscopy method (standardizating in IRASM Bucharest) because these bone samples can be preserved for a long time. In fact, we detected the signal of hydroxiapatite component from bones.

In all fish samples may be observed the same look of the ESR signals, which confirms free radicals presence.

For chicken irradiated samples, the specific signals are presented in the graphics from Figs. 12-15.

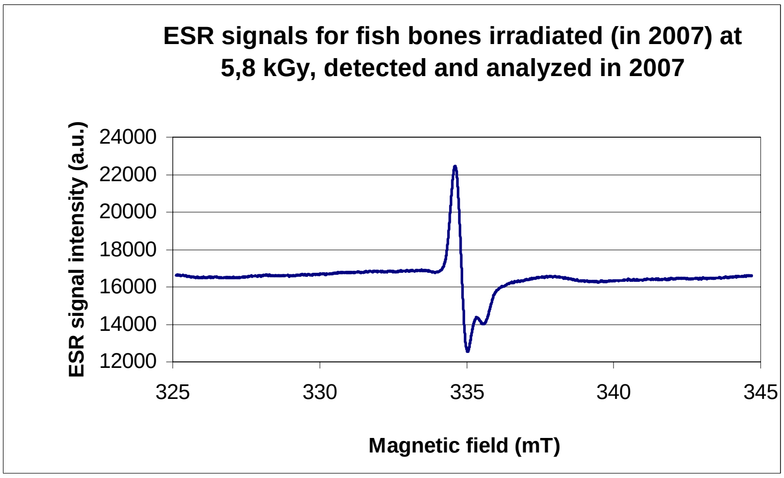

Figure 5 - ESR signal of analyzed fish samples irradiated at 5,8 kGy .

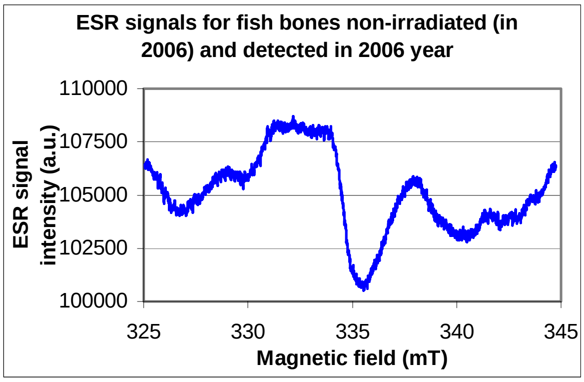

Figure 6 – ESR signal of non-irradiated fish samples from 2006 and detected in same year.

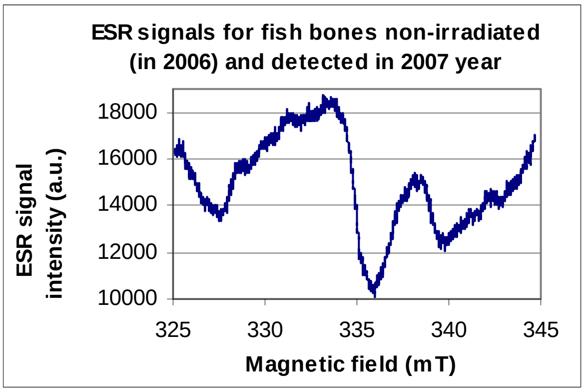

Figure 7 - ESR signal of non-irradiated fish samples from 2006 and detected in 2007 year.

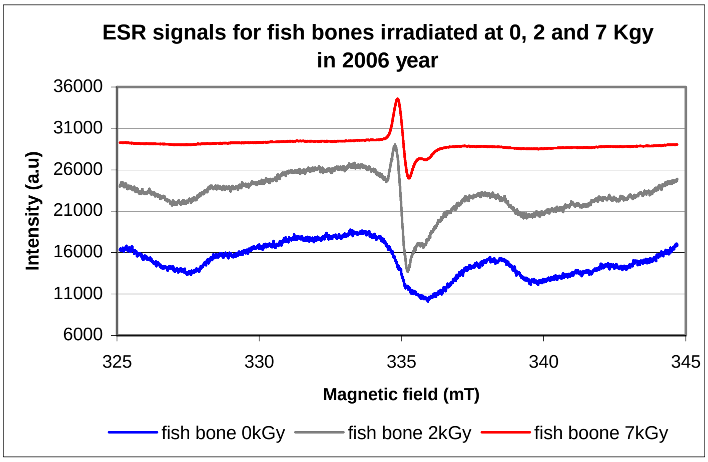

Figure 8 – ESR signals of fish samples irradiated at 0 (bottom), 2 (middle) and 7 (top) kGy in 2006 year.

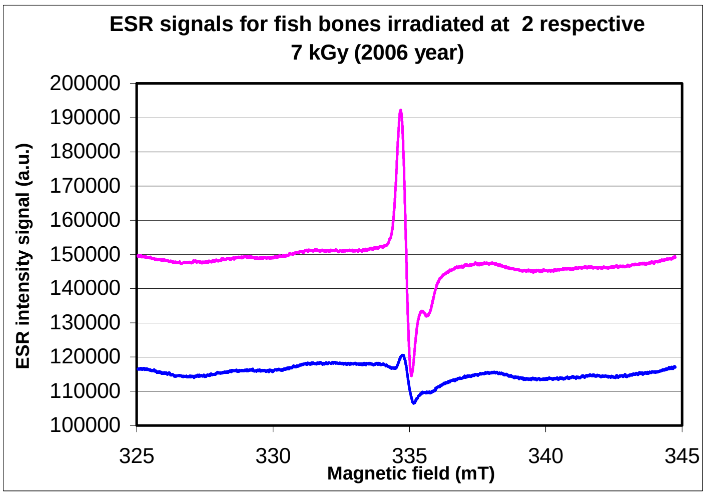

Figure 9 – ESR signals of fish samples irradiated at 2 (middle) and 7 (top) kGy in 2006 year.

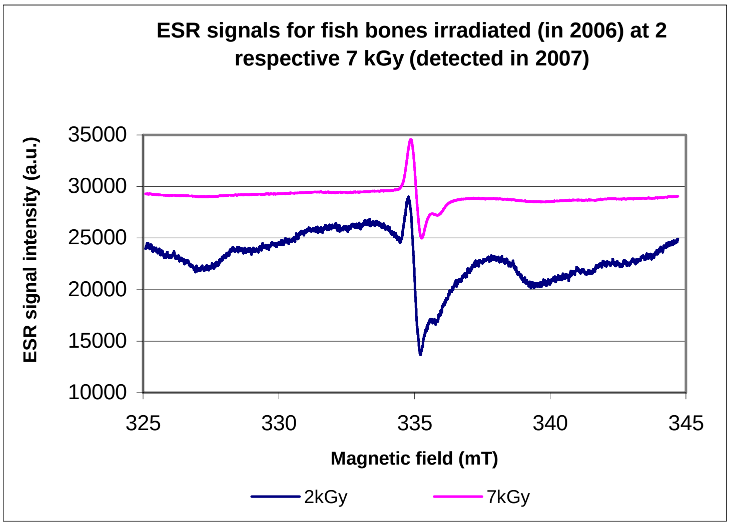

Figure 10 – ESR signals of fish samples irradiated at 2 (middle) and 7 (top) kGy in 2006 year and detected in 2007 year.

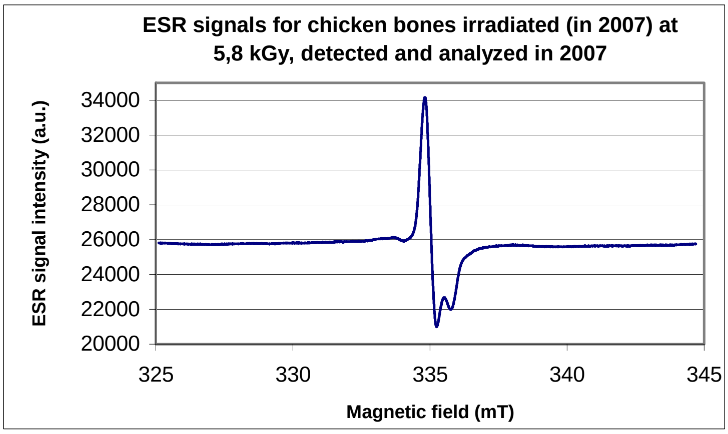

Figure 11 – ESR signals of chicken samples irradiated at 5,8 kGy.

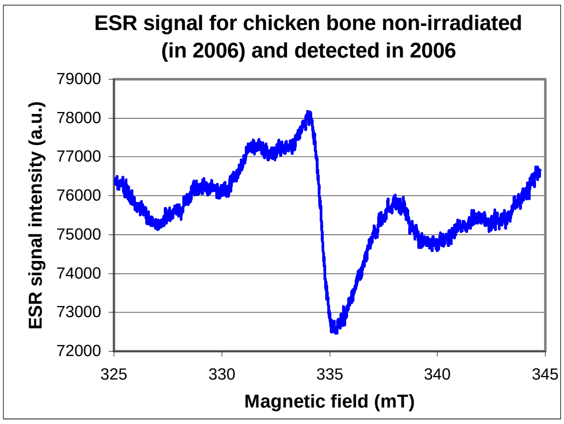

Figure 12 - ESR signal for non-irradiated chicken bones from 2006 year.

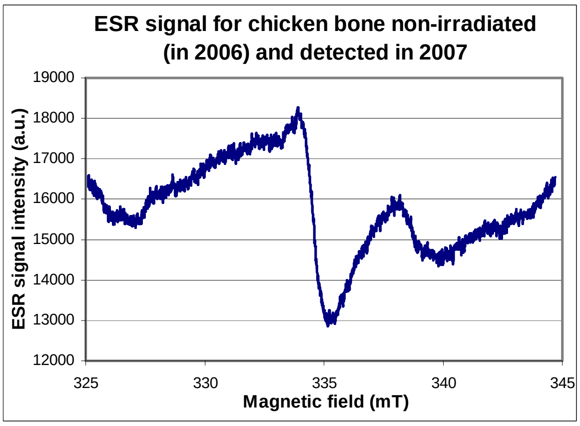

Figure 13 - ESR signal for non-irradiated chicken bones from 2006 year detected in 2007 year.

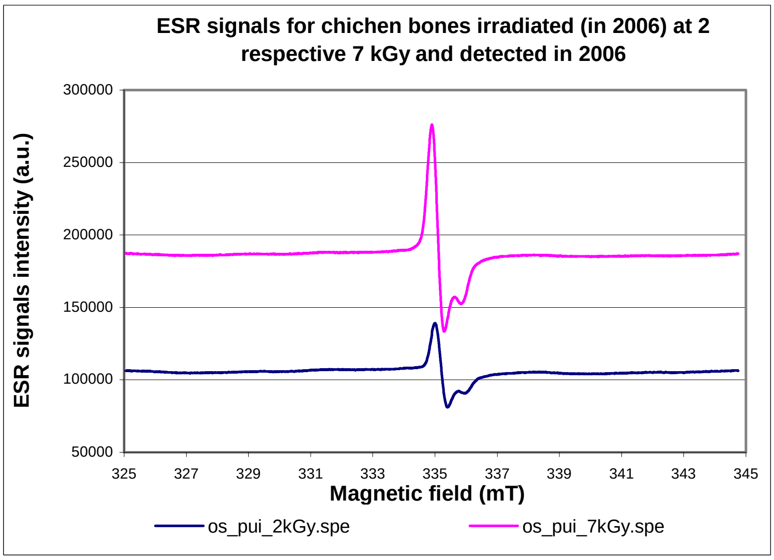

Figure 14 - ESR signal for irradiated chicken bones from 2006 year and detected in 2006 year.

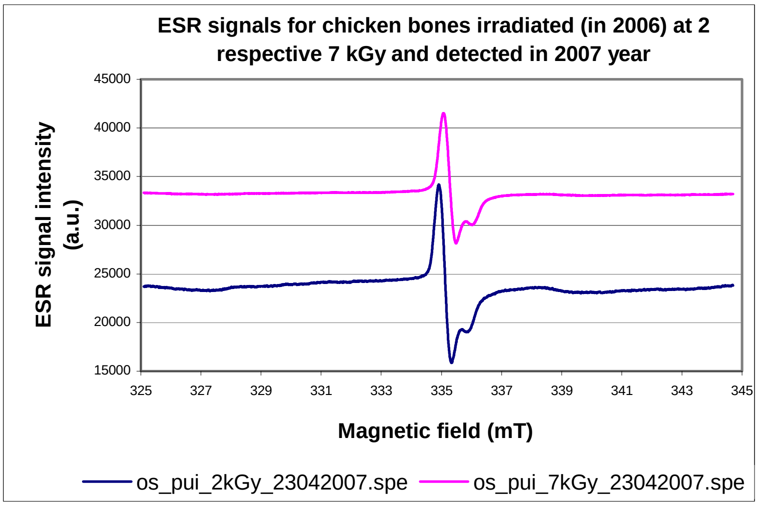

Figure 15 - ESR signal for irradiated chicken bones from 2006 year and detected in 2007 year.

4. Conclusions

After the quality control of irradiated fish and chicken meat, the comparison with non-irradiated meat brought the following conclusions:

- by sensorial point of view, non-irradiated samples concorded to imposed requsets, while the irradiated samples couldn't detected through this method;
- the value of easily hydrolysable nytrogen framed in the maximum admited limits at irradiated and non-irradiated samples as well;
- non-irradiated samples had the highest protein content, the differences being significant at chicken meat (non-irradiated 28.64% and for irradiated meat 27.4% proteins); this fact suggested that irradiation may little destroy the proteins; at fish the differences of pretein content weren't significant (28.9% proteins for non-irradiated fish; 28.56% proteins for irradiated fish meat);
- pH values at chicken and fish irradiated samples prooved to be higher than pH values at non-irradiated samples;

- acidity values at chicken and fish irradiated samples prooved to be lower than acidity values at non-irradiated samples;
- at chicken irradiated samples, we put in evidence, after the positive Kreiss reaction, the presence of epyhydrinic aldehyde;
- the reaction for H_2S presence was negative for all samples;
- between all the analyzes and laboratory determinations achieved, only Kreiss reaction was positive, for irradiated chicken samples; the single effective method to certainly establish the irradiation of samples was electron spin resonance spectroscopy, a method standardised at IRASM Bucharest;
- by ERS method was possible to detect the specific signals for irradiated bone samples even one year after the treatment with radiations; this fact has a great importance for irradiated food detection with large shelflife.

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