

THE BIOLOGICAL VALUE OF MEAT LOAVES PRODUCED BY MEANS OF SUPER-HIGH FREQUENCY HEATING

At present great attention is given to the application of physical methods of food processing, which allow to improve a number of technological processes /5, 8, 10/.

Of considerable interest is studying the possibility of SHF-heating in the manufacture of emulsion products, like meat loaves.

As the initial model, sausage emulsion was taken containing 70% 1st grade cured beef and 30% semi-fat cured pork. Such raw materials are relatively homogeneous in composition and properties and are less affected with selective warm-up which is determined by differences in absorption coefficients of individual components and which is inherent in SHF-heating.

Test samples were prepared in a SHF-unit. The heating time proper was estimated by the degree of product doneness.

Control samples were prepared by conventional heating which corresponds to the conditions of rotating ovens in meat loaves production.

Thermally-processed control and test samples were analyzed for their physico-chemical properties, the effect of digestive enzymes, bacteriological characteristics and toxicity (on test animals).

Studying physico-chemical properties indicated that the water content of the test samples was somewhat lower as compared to the controls (64.5 and 67%, respectively); water extract pH was slightly acid both in the test and the control samples (6.1-6.2); a test for peroxidase and phosphatase in all the samples studied proved to be negative this evidencing the culinary doneness of the product; analyses for the contents of protein, fat, carbohydrates and mineral salts did not show any significant differences between the test and the control samples (protein content was 15.5 and 15.3%; fat content - 14.6 and 14.5%, respectively; starch 2.5%; ash - 1.6%).

There were also no great differences in the amino acid composition of both test and control samples. Analyses showed that for

the test samples fat acid and peroxide numbers were slightly lower than for the controls (the average of six series was lower by 0.27 mg KOH/1 g fat and by 0.0416% iodine), this, probably, being explained by a reduction in thermal processing time when using SHF-energy.

The extinction after the reaction with thiobarbituric acid showed that SHF-heating contributes to a greater accumulation of carbonyls as compared to the conventional method (the average of 3 series - by 0.698).

Analysis for vitamins B₁ and B₂ indicated a higher retention of thiamine in the test samples than in the controls (1.61 and 0.79 mg%, respectively), whereas riboflavin content was similar in both (0.05 and 0.04 mg%).

Testing the residual microflora showed that in the test samples saprophyte load was higher than in the controls. Simultaneously, the bactericidal effect of the SHF-field was noted by some conditionally pathogenic microorganisms pre-introduced into the raw materials (salmonellae, intestinal bacterium of the pathogenic serotype O 111).

The results obtained indicated that SHF-heated meat loaves, by their physico-chemical and bacteriological properties, are not inferior to those produced conventionally, and in vitamin B₁ content and biological value, they are even superior.

The nutritive value of food proteins is known to be determined both with their amino acid composition and, to a great extent, with their digestibility and assimilation by the body /3/.

To study the effect of digestive enzymes upon the proteins of the test samples, the method in vitro was used /9/. Taking into account that the amount of digestible protein is proportional to the tyrosine contained in the filtrate, the optical density values derived were converted by means of the standard curve plotted for pure tyrosine. To plot calibration curves, crystalline L-tyrosine and bovine albumin were used.

In the process of meat proteins digestion with pepsin, the tendency in hydrolysis products accumulation was similar for both the test and the control samples of meat loaves. The most pronounced accumulation of amino acids was observed an hour after digestion. During the 2nd hour the intensity of this process was same-

what slowed down, within three hours it reached the maximum in both samples. At the same time, significant differences were noted in the amount of hydrolysis products in pepsin digestion of the test samples as compared to the control. Thus, after one-hour digestion hydrolysis products content in the test samples turned out to exceed that of the controls by 19%: 25.5 mg ($0.001 < P < 0.01$) against 21.5 mg ($0.01 < P < 0.02$); within 2 hours it was 32% higher: 33 mg ($P < 0.001$) against 24.9 mg ($0.01 < P < 0.02$); within 3 hours it was 38.2 mg ($P < 0.001$) against 31.2 mg ($0.02 < P < 0.05$), i.e. the total level of hydrolysis products after digestion of the test samples was 22.5% higher than for the controls.

When subsequently trypsin was added to the system, no significant differences in the increase of hydrolysis products were observed in the control and test samples.

A similar regularity in the accumulation of hydrolysis product was found, when using the albumin calibration curve.

Thus, the data obtained in model experiments in vitro prove that SHF-energy application in meat loaf production increases meat proteins digestibility by proteolytic enzymes, mainly, pepsin by 22%, on the average, as compared to the conventional thermal processing.

According to E.P.Kozmina et A.F.Malyutin /6/, an increased digestion of foods by proteolytic enzymes after SHF-heating is, obviously, related to less deep denaturation and post-denaturation changes in protein molecules, effected with SHF-energy, as compared to the conventional thermal processing.

V.M.Efimov et al. /11/ showed that meat tissue histostructural changes at SHF-processing are much more pronounced than at the conventional one. It may suggest that a higher effect on meat proteins after SHF-processing is due both to protein specific biochemical changes and to considerable loosening of meat stroma, at which the protein molecule becomes more available to the enzyme.

The data obtained prove higher nutritive value, from the viewpoint of protein digestibility, of the test meat loaf samples as compared to the controls.

The absence of toxic factors in meat loaves was established in test-tube assays on a tissue culture and on experimental animals, i.e. in acute tests on white mice and chicken embryos and in chro-

nic tests when feeding white rats with test foods for a long time.

In the first series of experiments, the cytotoxic effect of product filtrate was studied on a two-day-old monolayered digestible culture of the human embryonic plumule cells, which was coated with 0.2 ml filtrate in question. As the controls served filtrates of the conventionally[^]-processed meat loaf and Henks solution. The cytotoxic effect was registered 4 hours later and afterwards every 24 hrs for 6 days.

No degenerative changes were found both in the test and the control test tubes. In all of them a good monolayer of cells was observed up to the 6th day.

In the 2nd series of experiments product filtrates were tested on experimental animals (in acute tests) - on white mice and chicken embryos.

The white mice were injected with the filtrates, being studied, intravenously according to the universally accepted procedure /2/, as well as intraperitoneally and intracerebrally /4/.

Eight test and corresponding control samples were used in the experiments.

120 mice, injected by different methods, did not reveal toxic properties of the products under study. All the animals, watched for 7 days, were alive, behaved normally and gained weight.

To study possible embryotoxic effect, the filtrates of test meat loaves were injected to 7-day-old chicken embryos /7/ through the yolk sacs and the allantois cavities of the eggs. In the experiments on 200 chicken embryos, no toxic effect of the test filtrates was detected, which would prevent the development of embryos and batched chickens, as compared to the filtrates prepared from the control products.

In the 3rd series of experiments the health safety of the test meat loaves was studied in chronic tests on white rats. The indices of product nutritive value were the growth and the development of the rats and their immuno-biological reactivity /1/ during prolonged feeding with test meat loaves.

As the basis served the experimental ration, suggested by the Institute of Nutrition of the AMS USSR. In our studies the protein component and the fats of the ration were represented by the test samples. The average caloric value of a daily ration of the rats was 85.5 kcal. As the controls served similar rations with

the control samples added, as well an isocaloric ordinary laboratory ration for white rats.

In the experiments 180 white male rats were used, weighing initially 50-60 or 120-140 g (depending on the experimental purpose).

During the experimental period the appearance of the rats, their behaviour and weight were registered. According to the purpose of the experiments, all the animals were divided into two groups (90 rats each).

On the rats of group I, maintained on the experimental ration for three months, the non-specific resistance of the organism was studied /1, 2, 4/.

On the 60th, 75th and 90th days, the lysozyme activity of the blood serum was studied by the nephelometric method suggested by V.G.Dorofeitchouk, that of the internal organs - by the dish method in agar; the phagocytic activity of the leucocytes was studied by the three characteristics: by their activity (the number of phagocytic leucocytes), by intensity (the number of microbes absorbed by every phagocyte) - by the accepted procedure; and by the completeness of phagocytosis - by the V.N.Berman and E.S.Slavskaya method. Special attention was given to phagocytosis completeness as a most delicate index of the non-specific immunity of the cells. Besides, the total protein of the blood serum was tested refractometrically and the protein formula of the blood serum - by the electrophoretic separation of the protein fraction.

The comparison of the immunobiological reactivity indices of the test and the control animals did not reveal significant differences.

Group II was used to study the indices of the specific anti-typhoid immunity at prolonged feeding the rats with the meat loaves dielectrically-heated in the SHF-field.

From the 60th day of rats maintenance on the above-indicated rations the animals were twice immunised with a heated typhoid vaccine (strain T1-29) with a 10-day interval.

On the 10th day after each of the two vaccinations the agglutinin titres in the blood serum were studied by the reaction of hemagglutination. Simultaneously, the indices of the non-specific immunobiological reactivity: serum lysozyme activity and leucocytes phagocytic activity, as well the total protein of the blood

serum and of the protein fraction, were investigated.

Agglutinin titres (for the same experimental periods) are the same for the test and the control animals; on the 10th day after the second immunisation they were 1:320.

Similar were also the total protein in the blood serum, lysozyme activity and phagocytosis indices.

The comparison of the indices of the non-specific resistance of the immunised animals with those of non-immunised but maintained under the same test conditions indicates that in the process of immunisation there occur certain changes in the intensity of non-specific immunity, which agreed with the published data on the regularities of organism immunobiological re-orientation in response to an antigenic irritant.

It was also established that the number of antibody-producing cells in the spleen (by the Erne method) on the 5th day of animal immunisation did not depend either on the experimental ration or on the control one, and averaged $2.3-3.5 \times 10^3$ at equal agglutinin titres.

The obtained results show that the synthesis of specific antimicrobial antibodies, studied by us by the accumulation of antityphoid agglutinins in blood serum and by the number of antibody-producing cells in the spleen of the white rat, is not disturbed during rat prolonged feeding with the test samples, this evidencing that these products are free from the toxic factors which inhibit organism protective properties.

The results of the sanitary-hygienic and biological evaluation of the test meat loaves indicated that SHF-heating of emulsion meat products did not reduce the nutritive value of the mentioned products, as compared to the traditional method of processing; and by some characteristics, e.g. digestibility by enzymes, the vitamin contents, it improves foods nutritive value.

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