

# EXAMINATION OF COOKED SAUSAGES ENRICHED WITH POLYUNSATURATED FATTY ACIDS

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**Abstract** –The aim of this study was to examine an effect of cooked sausages enriched with LCPUFAs on the development, training process and cognitive functions of the progeny of the laboratory animals. The control cooked sausage sample, the samples of finished cooked sausages with  $\omega$ 3 PUFAs and laboratory animals were the subjects of research. Fatty acid composition was determined by gas chromatography. The medico-biological assessment and clinical blood analysis were conducted. Investigations on the substantiation of the possibility to use a food additive (deodorized oil on the basis of fish oil) as a source of  $\omega$ 3 PUFAs for cooked sausage enrichment were performed. The level of oil addition was calculated with consideration of the oil fatty acid composition and the product formulation in order to obtain the optimum  $\omega$ 6  $\omega$ 3 fatty acids ratio without organoleptic properties deterioration. The selected oil dose 0.78% was sufficient to provide an optimal fatty acid ratio in the product. The results of the testing of the progeny of the rats consumed the analyzed samples throughout pregnancy and feeding showed that the rats fed the cooked sausages enriched with  $\omega$ 3 PUFAs learned faster and their learned skills persisted longer compared to the control group.

**Key Words** – cooked sausages, long-chain polyunsaturated fatty acids, laboratory animals.

## I. INTRODUCTION

An important factor determining the health condition of a future mother and a newborn baby is the balanced nutrition during pregnancy and breastfeeding. When a mother's nutrition is rational, a child obtains with her milk all necessary nutrients including minerals, vitamins, trace elements, LCPUFAs and the protective factors against many diseases.

LCPUFAs play an important role during pregnancy and in formation of practically all organs and systems of a newborn baby. During pregnancy the growth of the tissues of a mother's

body, placenta and embryo occurs; therefore, the demand for LCPUFAs in a pregnant woman and a developing fetus is increased. A provision of PUFAs to the fetus significantly depends on a maternal PUFAs intake and metabolism as well as the placental transfer of fatty acids. A woman's organism gives 2.5 g of  $\omega$ 3 fatty acids daily for ensuring normal fetal development. This is especially important in the last trimester of pregnancy because of the rapid growth of the brains tissue. In this connection, a diet of a pregnant woman should contain sufficient amounts of essential fatty acids and LCPUFAs in order to meet not only the requirements of a woman but also the requirements of a child. According to the data of WHO (1994), the optimal ratio of  $\omega$ 6 and  $\omega$ 3 fatty acids for pregnant and nursing women is  $\omega$ 6: $\omega$ 3 = 5:1.

## II. MATERIALS AND METHODS

The control cooked sausage sample, the samples of finished cooked sausages with  $\omega$ 3 PUFAs and laboratory animals were the subjects of research. Fatty acid composition was analyzed on the gas chromatograph HP 6890. Medico-biological assessment (determination of animals cognitive abilities using tests such as the classic maze, "test with sunflower seeds", Morris water maze) and clinical blood analysis were performed.

## III. RESULTS AND DISCUSSION

The study on the substantiation of the possibility to use a food additive as a source of  $\omega$ 3 PUFAs for cooked sausage enrichment was carried out.

The additive presents a pale-green deodorized oil on the basis of fish oil.

The level of the addition of the oil was calculated with consideration for fatty acid composition of oil and product formulation in order to obtain the

optimal  $\omega 6:\omega 3$  fatty acid ratio in the finished product without organoleptic characteristics deterioration. The selected dose of oil 0.78% was sufficient for ensuring the optimal fatty acid ratio in the product (Table 1).

Table 1 Fatty acid composition of cooked sausages

Name of fatty acid, code	Compositions including fat-containing ingredients		Standard g/100 g lipids
	Beef, semifat pork, dry milk, melange, $\omega 3$ PUFAs	Turkey meat, turkey liver, fat pork, $\omega 3$ PUFAs	
Saturated fatty acids (SFAs), % / 100 g lipids			
$\Sigma$ SFAs	42.9 $\pm$ 2.24	35.3 $\pm$ 2.19	41.78
Monounsaturated fatty acids (MUFAs), % / 100 g lipids			
$\Sigma$ MUFAs	45.8 $\pm$ 2.28	38.3 $\pm$ 2.26	43.03
Polyunsaturated fatty acids (PUFAs), % / 100 g lipids			
$\Sigma$ PUFA s	11.65 $\pm$ 0.25	14.5 $\pm$ 0.23	12.42
Linoleic acid C18:2	8.3 $\pm$ 0.2	10.7 $\pm$ 0.21	10.85
Linolenic acid C18:3	0.66 $\pm$ 0.02	0.5 $\pm$ 0.019	0.62
Arachidonic acid C20:4	0.08 $\pm$ 0.001	0.32 $\pm$ 0.02	1.95
$\gamma$ linolenic acid C 18:3	0.25 $\pm$ 0.01	0.3 $\pm$ 0.022	
$\alpha$ linolenic acid C 18:3	0.45 $\pm$ 0.02	0.6 $\pm$ 0.03	
Eicosatrienoic acid C 20:3	0.4 $\pm$ 0.019	0.5 $\pm$ 0.02	
Docosapenta-enoic acid C 22:5	0.06 $\pm$ 0.002	0.07 $\pm$ 0.001	
Docosahexa-enoic acid C22:6	0.1 $\pm$ 0.001	0.1 $\pm$ 0.001	
Eicosapenta-enoic acid C20:5	1.3 $\pm$ 0.2	1.4 $\pm$ 0.1	
$\omega 6: \omega 3$ fatty acids ratio	4.7:1	5.4:1	

This conclusion is confirmed by the results of the investigation showing the influence of the cooked sausage products enriched with PUFA on the development, training process and cognitive functions of the progeny of the laboratory animals. The progeny of white outbred rats (n=25) at the age of 50-60 days was used in the experiment. The experimental group consisted of the progeny of the

rats from the first group, which diet contained enriched cooked sausage products throughout pregnancy and infant feeding. The control group consisted of the progeny of the rats from the 2<sup>nd</sup> group, which were fed the control samples using the same scheme. The grown litter of the ordinary vivarium rats comprised the group of the intact animals.

During the investigation, rats were kept in groups before and after the experiment. After the experiment, all rats were fed in a feeding compartment during 40 min. irrespective of the success in learning. Testing was carried out during 13 min., food deprivation was 22 hours.

Three types of tests were performed: the classic maze [1,2], "test with sunflower seeds" [3,4] and Morris water maze [3]. Based on the results of the testing, rats could be divided irrespective of the group into three subgroups differed by the learning character, namely: quickly learning rats (type A), slowly learning rats (type B) and rats refused to learn (type C).

The highest number of type B and C animals was found in the process of testing the control (40% and 60%) and intact (20% and 80%) groups, respectively. At the final stage of the training, the skill of these animals was unstable; a small number of individuals were able to reduce the time of "the right answer" by 28.9%. In the experimental group, the type A animals dominated (70%); the animals refusing to learn were not revealed. In a condition of a free choice, the rats of this group were twice as successful in solving a set task as those from the control and intact groups and demonstrated high stability of the formed skill. At the end of the experiment on the 7<sup>th</sup> day, all animals from the experimental group managed to get a food reward and reduced the time needed to reach it (37.8%, respectively).

Testing the cognitive abilities of the animals from all groups in the Morris water maze showed that the rats of the control group learned poorly, their time of finding the platform was twice as much as the time of the intact and experimental animals; they also demonstrated low swimming speeds.

The animals from the experimental group demonstrated better results compared to the intact animals. The swimming speeds and the time during which they were in the central area of the swimming arena exceeded those of the animals from the control and intact groups.

Thus, the results of the experiments on the progeny of rats consumed the tested samples throughout pregnancy and infant feeding showed that the rats from the experimental group learned more quickly and the learned skill persisted during the whole testing period.

#### IV. CONCLUSION

The cooked sausages for pregnant and nursing women nutrition were developed with the optimal  $\omega 3/\omega 6$  LCPUFAs ratio. In the experiments on animals the effect of PUFAs in the composition of the cooked sausages on the intellectual abilities of the newborn rats was proved.

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