INVESTIGATION OF THE CONSERVATION OF VITAMINS AND MICROELEMENTS DURING STORAGE IN BOILED-SMOKED SAUSAGES WITH ENRICHED LEGUMINOUS FLOUR

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Abstract

There has been studied the conservation of vitamins and microelements in boiled-smoked sausages, using enriched leguminous flour. The research object is boiled-smoked sausages, in which recipes there were used sprout flour of soya and nut that are carriers of vitamins A, E, C, B6, B9, B12 and microelements, including iodine and selenium, as an enriching ingredient. One of problems for today is an increase of the population with endocrine disorders. It is possible to prevent this problem by timely prophylaxis as consumption of products with iodine. Modern studies in molecular pharmacology have proved that for assimilating iodine by the organism, the “presence” of other nutrients, intensifying its assimilability and being its synergists is needed. The method of inversion voltamperometry and the one of high-effective liquid chromatography were used in the study.

It has been established, that sausage products contain in their composition after 30 days of storage vitamins: A – 0.4; E – 0.3; C – 17; B6 – 0.32; B9 – 0.4; B12 – 0.03, mg/100 g. And microelements: Fe – 5.0; mg – 340, Z – 8.5, Cu – 0.95; Se – 0,026; I – 0,025, mg/100 g. That satisfies: 50; 150; 30,9; 150; 200; 100 % of the daily need in vitamins A; Е; С; В6; В9; В12, respectively and 50; 97; 85; 95; 37; 37.5 % of the daily need in microelements Fe; mg; Z; Cu; Se; I, respectively. Comparing with a control recipe, enriched products have the increased content of nutrients – iodine synergists that provide essential advantages, “covering” deficiency conditions in other substances, needed for iodine assimilation. Let’s assume that it will be an effective prophylaxis for persons with iodine-deficiency diseases.

Keywords: vitamins, microelements, iodine, selenium, sausages, iodine deficiency, storage.

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1. Introduction

Realization of the European program “Health for all in XXI century” needs to provide the population of the planet with full-value nutrition. There appears a necessity to search innovative approaches to development of new food products that are carriers of vitamins and microelements. Iodine is an essential microelement, necessary for synthesis of thyroid hormones. Iodine deficiency is considered throughout the world as the most spread cause of fetus’ nervous system development disorders, endocrine ones that may be prevented by timely prophylaxis by food products, containing iodine [1, 2]. Consumption of enriched products doesn’t guarantee supply of the correspondent amount of the nutrient, which carrier is an enriching ingredient, to the human organism. Studies [3, 4] have demonstrated that at prophylaxis and treatment of iodine-deficiency conditions it is necessary to pay attention to the content and conservation of other micronutrients that are
synergists of iodine and intensify its assimilation. It is known [5, 6], that most vitamins and micro-
elements are rather unstable during storage.

In this connection it is topical in the scientific-practical aspect to determine the content of
vitamins and microelements during storage in food products, developed for consuming by the pop-
ulation under iodine-deficiency conditions.

2. Analysis of literary data and statement of the problem

Analyzing works of scientists, studying the use of sprouted leguminous grains in sausages
production, it has been established, that they sprout grain legumes in water solutions. Work [7]
present results of experiments, studying characteristics of forcemeats of semi-smoked sausages,
using flour with barley grains and malt of leguminous grains. The effectiveness of their use for
stabilizing autolytic processes and increasing the buffer capacity of meat-vegetable stuffing has
been proved. It has been determined, that the optimal amount of introducing sprouted barley flour
for producing semi-smoked sausages is 2...3 %.

Studies [8] have proved the expedience of replacing meat raw materials for flour of lentil
grains, sprouted in the water solution, at producing sausages. It has been established, that the
replacement of meat raw materials for lentil flour in amount 1.5 and 2 kg for 100 kg of meat
raw materials is expedient and raises the energetic value of new types of sausages by 10.5 and
16.3 kcal for 100 g of the product, comparing with a control sample. Sausages with sprouted
lentil flour contain more indispensable amino acids than ones with not sprouted lentil flour
and control.

[9] studies a possibility to produce flour of grains of the leguminous crop mash (*Phaseolus
aureus*). There has been established the change of the amino acid composition to the increase of
indispensable amino acids, namely, aminosuccinic, noted the high hydrophilicity of flour in force-
meats. There have been determined optimal concentrations (10 % of the meat raw material mass)
at producing boiled-smoked sausages.

But all offered technologies are not a carrier of microelements. Special attention must be
paid to iodine and selenium deficiency, which lack is observed in 17 % of the world population [10].
For enriching leguminous grains with microelements, the expedience of using mineral salts has
been scientifically substantiated [11].

In works [12] lupine grains were sprouted in the potassium iodate solution (KIO₃). The
production technology includes washing of grains, their turn-by-turn air-water soaking, sprouting,
drying, grinding. Flour, obtained by the developed technology, is an iodine carrier (30 mcg/100 g)
and has the increased content of protein. Scientists have proved [13] the expedience of using sodium
hydroselenite (NaHSeO₃) at sprouting soya grains. The method includes washing of grains, their
turn-by-turn air-water soaking, sprouting and drying, and differs by the fact that grains are soaked
in the selenium solution with a concentration from 1.7 to 3.2 mcg/ml of the selenium content. The
content of selenium in flour reaches 15–28 mcg/100 g.

The use of sprouted flour at producing sau-
sages is regulated at the SSU level and must be no more 10 % of the product mass [14]. That is why
the use of aforementioned technologies is not expedient because of unessential % of satisfying the
daily need in the enriching microelement.

Studies [15, 16] on the development of flour of soya beans, sprouted in the potassium iodide
solution (KIO₃) and flour of nut beans, sprouted in the sodium hydroselenite solution (NaHSeO₃)
that are carriers of 50 and 52 mcg/100 g of iodine and selenium, respectively are being conducted.
Sprouted leguminous grains are also carriers of vitamins A, E, C, B6, B9, B12. Work [17] considers
the expedience of using developed leguminous flour at producing boiled-smoked sausages. But
unsolved questions are connected with the conservation of microelements and vitamins during
storage of ready products. As far as there are no enough data about solving these questions, it is
necessary to deepen and widen studies in this direction.

3. Research aim and task

The research aim is to study the conservation of vitamins and microelements during storage
in sausages with enriched leguminous flour.
The following tasks were set for attaining this aim:
– to determine the conservation of vitamins in sausages during storage;
– to determine the conservation of microelements in sausages during storage.

4. Materials and methods for studying production of sausages, enriched with leguminous flour

Raw materials, used for producing enriched sausages: “Soya flour, enriched with iodine” TC U 10.6-02071205-001:2019 is a carrier of 50 mcg of iodine in 100 g of flour. “Nut flour, enriched with selenium” TC U 10.6-02071205-002:2019” is a carrier of 52 mcg of selenium in 100 grams of flour.

A control sample of boiled-smoked sausage was produced by classic recipe [18] according to SSU 4591: 2006 “Boiled-smoked sausages”.

An experimental sample of boiled-smoked sausage was produced, using 10 % of enriched leguminous flour in ratio (1:1) at the expanse of decreasing meat raw materials in equal shares, namely beef, pork and lard.

All samples of sausage products were packed in clean dry, without side smells, boxes of cardboard and stored at the relative humidity from 75 % to 78 %.

A storage term was determined, based on SSU 4591:2006 “Boiled-smoked sausages” (point 10.2.3 “Shelf life of sausages”) at temperature 4°C during 30 days.

There was used a viscous-reinforced barrier protective film with lamination (produced by LTD “MNS” group, Kharkiv, Ukraine) [19], that must provide an unessential loss level of moisture and enriching substances [20]. Research results were statistically processed by Exel.

4.1. Methods, used at studying the vitamins content

Vitamins were determined by the method of high-effective liquid chromatography, using the chromatograph “Lumachrom” (Russia, Saint-Petersburg) and detectors: spectrophotometric – 3220; fluorometric – 2410. The content of vitamin A was determined by the number of pigments of carotenoids. The studies were conducted at the base of the research institution “Biotech” (Ukraine, Kyiv).

4.2. Methods, used at studying the microelements content

The mass share content of microelements was determined by the method of “Inversion vol- amerometry” by the voltamperometric analyzer “AVA”, completed by indicator electrodes for determining mass shares of different microelements [18].

5. Results of studying the content of vitamins and microelements at storage in sausages, enriched with leguminous flour

Table 1 presents the results of studying the conservation of vitamins and microelements at storage in sausages, enriched with leguminous flour.

It has been studied, that the use of enriched leguminous flour at producing boiled-smoked sausages increases the content of vitamins, namely vitamin А from 0.2 to 0.4 mg/100 g, and vitamin Е from 2.75 to 0.4 mg/100 g of the product. There is also observed the increase of B group vitamins: В6 (from 0.1 to 0.32 mg/100 g); В9 (from 0.15 to 0.4 mg/100 g); В12 (from 0.01 to 0.03 mg/100 g). The content of mineral substances in the produced boiled-smoked sausages by such microelements as Fe, mg, Z, Cu remained almost stable and correspondent to the control sample. The changes were observed by selenium (from 0,005 to 0,026 mcg/100 g) and iodine (in the control sample it was 0,025 mg/100 g). The increase of these indices is explained by their content in the enriched four. Analyzing the content of vitamins in the sausages during storage, it has been established, that at storage during 30 days losses of vitamins A, E, C by 20….70 % of the initial content are fixed in both experimental and control samples. The content of B group vitamins В (В6; В9; and В12) during storage in the experimental samples didn’t undergo essential changes, and at the end of the studied term it was 030; 0.4 and 0.03 mg/100 g, respectively. It is known, that the enrichment of products with vitamins В6, В9, В12 together with vitamin Е allows to minimize losses of B group vitamins with vitamin Е loss up to 20 % [20]. Studying
the content of microelements in the sausages during storage, it has been established, that during 30 days iron losses are observed by 1 mg in 100 g of the product – in the control sample, and by 2 mg/100 g – in the experimental one. Storage of the boiled-smoked sausages during 30 days didn’t decrease the content of iodine, selenium, magnesium, zinc, cooper in the studied samples essentially, so let’s assume that the studied microelements are organically connected with vegetable proteins, amino acids of leguminous grains.

Table 1
The study of the content of vitamins and microelements at storage in sausages, enriched with leguminous flour

| Parameter                                      | Vitamins, mg | Microelements, mg |
|-----------------------------------------------|--------------|-------------------|
|                                               | A | E | C | B6 | B9 | B12 | Fe | Mg | Z | Cu | Se | I |
| Daily need                                    | 0.8| 2.0| 55.0| 0.2| 0.2| 0.03| 10.0| 350| 10| 0.1| 0.07| 0.15 |
| Content of vitamins and microelements in soya flour, enriched by iodine | in 50 g | 0.2| 2.1| 8.0| 0.15| 0.2| 0.015| 4.5| 195| 4.0| 0.45| 0.005| 0.025 |
| Content of vitamins and microelements in nut flour, enriched by selenium | in 50 g | 0.2| 1.9| 9.0| 0.17| 0.2| 0.015| 3.5| 160| 4.5| 0.5| 0.026| 0.010 |
| Boiled-smoked sausage                         |               |                 |
| Control                                       | 0.2| 2.75| 17.5| 0.01| 0.15| 0.01| 8.0| 350| 4.0| 0.45| 0.005| traces |
| Experiment                                    | 0.4| 4.0| 17| 0.32| 0.4| 0.03| 8.0| 350| 8.5| 0.95| 0.026| 0.025 |
| At storage of the ready product (at 5th day)   |               |                 |
| Control                                       | 0.2| 2.3| 10.1| 0.01| 0.15| 0.01| 6.0| 345| 4.0| 0.45| 0.005| traces |
| Experiment                                    | 0.4| 3.9| 12.5| 0.32| 0.4| 0.03| 7.0| 345| 8.5| 0.95| 0.026| 0.025 |
| At storage of the ready product (at 15th day)  |               |                 |
| Control                                       | 0.15| 1.9| 17.5| 0.01| 0.15| 0.01| 6.0| 340| 4.0| 0.45| 0.005| traces |
| Experiment                                    | 0.38| 3.2| 17| 0.32| 0.4| 0.03| 6.0| 345| 8.5| 0.95| 0.026| 0.025 |
| At storage of the ready product (at 30th day)  |               |                 |
| Control                                       | 0.2| 1.2| 17.5| 0.01| 0.15| 0.01| 5.0| 335| 4.0| 0.45| 0.005| traces |
| Experiment                                    | 0.4| 3.0| 17| 0.30| 0.4| 0.03| 5.0| 340| 8.5| 0.95| 0.026| 0.025 |

Note: Indices are given for a healthy adult with a middle labor intensity [19]

6. Conclusions
The content of vitamins in the sausages during storage has been determined. It has been established, that sausage products contain in their composition after 30 days of storage vitamins: A – 0.4; E – 0.3; C – 17; B6 – 0.32; B9 – 0.4; B12 – 0.03, mg/100 g. That satisfies: 50; 150; 30.9; 150; 200; 100 % of the daily need in vitamins A; E; C; B6; B9; B12, respectively.

The content of microelements in the sausages during storage has been determined. It has been established, that the new sausage products contain in their composition after 30 days of storage: Fe – 5.0; mg – 340, Z – 8.5, Cu – 0.95; Se – 0.026; I – 0.025, mg/100 g. That satisfies: 50; 97; 85; 95; 37; 37.5 % of the daily need in microelements Fe; mg; Z; Cu; Se; I, respectively.

Comparing with a control recipe, enriched products have the increased content of nutrients – iodine synergests that provide essential advantages, “covering” deficiency conditions in other substances, needed for iodine assimilation. Let’s assume that the developed recipe will be an effective prophylaxis for persons with iodine-deficiency diseases.
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