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QUANTITATIVE DETERMINATION OF THE CONTENT OF OMEGA-3 AND OMEGA-6 FATTY ACIDS IN THE COMPOSITION OF DRY MILK MIXTURES BY THE METHOD OF GAS CHROMOTOGRAPHY

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Abstract
The aim of the study is to determine the quantitative composition of fatty acids in the composition of oils in dry milk porridges. Several methods have been explored for determining the composition of the extracted oil. By comparing the relevance and availability of methods, a gas chromatographic test method was chosen. In conclusion, all the results and data obtained are summarized.

Keywords: omega-3, omega-6, gas-liquid chromatography, baby food, dry cereals, iodine number.

INTRODUCTION

Modern manufacturers of baby food produce their products taking into account the requirements and norms for a full and balanced complementary feeding of infants, even if it is necessary to completely transfer the child to baby dry mixes, then such dry milk porridges should contain a sufficient amount of the necessary protein, vitamins, carbohydrates, minerals and additional nutrients that fill all

the needs of a growing organism at the most early stages of human life. Special attention should be paid to healthy fats – omega-3 and omega-6, which are included in the group of unsaturated fatty acids [1].

As part of human cell membranes and blood vessels, omega-3s play a significant role in connective tissues and their balance can be disrupted by insufficient synthesis of these fatty acids in the human body. A valuable source of omega-3 in food can be fish and fish products included in the healthy diet of most dietary recommendations [2].

The natural barrier of cells and their strengthening, as well as protection from external damage, underlies the functions of omega-6 fatty acid, which supports many processes of the human body in a normal state. Blood pressure is normalized with the direct help of this fatty acid, and the overall effect on the cardiovascular system is favorable with sufficient omega-6. Anti-inflammatory and anti-allergic effects should be considered a useful property of fatty acid, from which substances that contribute to these processes are synthesized. However, our body is not able to produce omega-6 independently and it is possible to obtain fatty acid only from food [3].

$CH_3(CH_2)_3$-$(CH_2CH=CH)_2(CH_2)_7COOH$ – linoleic acid belongs to omega-6 and is a monobasic carboxylic acid containing two isolated double bonds. According to its physical properties, linoleic acid is an oily liquid having a light yellow color, insoluble in water, but dissolves well in many organic solvents. Linoleic acid, as a geometric cis isomer, is found in natural fats and has non-conjugated double bonds, which are located after the 9th and 12th carbon atom on an unbranched chain of carbon atoms (9,12-unoctadiene acid). Such an acid is included in the family of ω-6 acids by the position of the double bond. The oxidation of linoleic acid by air oxygen takes place faster with such a structure than with oleic acid [4].

Omega-3 is manifested in the acids docosahexaenoic (DHA), eicosapantaenoic (EPA) and alpha-linolenic (ALA). The conversion of short-chain ALA in the human body can occur from long chains of EPA and DHA, but it is not able to synthesize these acids from simple substances.

Omega-3 and omega-6 are cis-isomers of fatty acids, they pass into transisomers in animal and human organisms and belong to the fat-soluble group of vitamins F [5]. Alpha-linolenic acid will be an example of considering omega-3, and linoleic acid is omega-6. The physico-chemical properties of acids are presented in Table 1.

Table 1. Physic-chemical properties of unsaturated fatty acids

Title	Melting point, °C	Boiling point, °C (533 Па)	Density (at 20° C)
Linoleic Acid (Omega-6)	-11	182	0,903
Linolenic Acid (Omega-3)	-11,3	184	0,906

There are many methods and methods for determining the presence of omega-3 and omega-6 fatty acids. The main methods for determining the content of omega-3 and omega-6 are the determination of the iodine number and the method of chromatographic analysis. There is also a method for determining unsaturated compounds in grams of iodine equivalent to homeland, but this method is not relevant for this period for a number of reasons.

MATERIALS AND METHODS

Determination of the content of fatty acids is provided only by some of the methods, and the qualitative composition of oils due to the rupture or addition of a double bond in reactions does not allow determination. However, the qualitative and quantitative composition can be measured in dry substances by determining unsaturated fatty acids by gas-liquid chromatography and iodine number according to Kaufman or Wijs.

Determination by the iodine number is characterized by the content of unsaturated compounds in 100 grams of vegetable oil, which is attached to the oil due to a reagent equivalent to halogens, expressed in grams of iodine and is a conditional value.

The Wijs iodine number is determined by titration of the sample with iodine chloride and potassium iodide made immediately before analysis. If the amount of iodine in the titration process has become excessive, it is necessary to titrate with sodium thiosulfate, then discolor with the addition of starch and use the formula to determine the iodine number.

According to Kaufman, the iodine number is determined using a bromide solution. The suspension is titrated when dissolved in chloroform and bromine is added, a part of sodium bromide will precipitate. Potassium iodide is gradually added to the solution and titrated with sodium thiosulfate in the presence of starch. Next, the iodine number is determined by the formula.

Environmental objects are currently being studied with the most widely used chromatography method, the accuracy of which reaches 0.01% combined with ease of use. Due to the variety of stationary phases, in practice gas-liquid chromatography is used more often, according to the principle of running the test substance through a column and determining peaks on the graph [6].

The object of the study is dry rice baby milk porridge with apples for children from four months of age by Nestle Russia LLC under the Nestle trademark, using a gas-liquid analysis method.

Dry substances should be examined using gas-liquid chromatography with the extraction of fats from substances. Extraction is carried out in an ammonia-alcohol solution of a milk-containing product with petroleum and diethyl esters, then the solvents are evaporated, after which the extracted substances are calculated by weight in petroleum ether and the mass fraction of fat is calculated. The resulting

solution of dry substances is subjected to gas-liquid chromatography according to the conditions given in Table 2.

Table 2. Chromatographic conditions of the analysis

Injector temperature	220°C
Detector temperature	250°C
Carrier gas flow rate	2.4 ml/min
Air flow	400 ml/min
Gorenje gas flow (H2)	40 ml/min
Purge gas flow (N2)	10 ml/min
Sample input volume	1 ml
Thermostat temperature	: 100°C a 4 min) 1: 25°C/мин до 200°C (8 min) 2: 5°C/мин до 250°C (6 min)

RESULTS

For the tests, two samples were taken for parallel analysis. The extraction of samples was carried out in an extractor of the brand Hon SOC406. Upon completion of the extraction process, the resulting oil was brought to room temperature and weighed. In the labeling of the product, information on the fat content was indicated in an amount of 10%. The results obtained during oil extraction are compared with the labeling data. Superior indicators of 10.45% according to the results of the analysis are acceptable according to the norms of the production of infant formula. The oil isolated during the analysis was further dissolved in the organic solvent hexane, in the presence of potassium methylate, after which the fatty acid composition was analyzed on an Agilent Technologies 7820A chromatograph. The obtained data in the form of peaks are recorded and presented in Figure 1.

Fig.1. Chromatogram of methyl esters of fatty acids of oil isolated from dry baby porridge

Based on the results of the studies, the percentage of unsaturated and marginal fatty acids presented in the table was determined 3 [7].

Table 3. The mass fraction of fatty acids of oil extracted from dry baby porridge determined by gas chromatography.

№	Name of fatty acids	Mass fraction of fatty acids, %
1	Palmitic Acid (16:0)	6,12
2	Margarine Acid (17:1)	0,14
3	Stearic Acid (18:0)	2,88
4	Oleic Acid (18:1)	65,26
5	Linoleic acid (18:2) Omega-6	21,30
6	Linolenic acid (18:3) omega-3	0,86
7	Arachidonic acid (20:0)	0,34
8	Eicosenic acid (20:1)	2,47
9	Begenic Acid (22:0)	0,63

CONCLUSION

In modern conditions of intensification of a number of social processes, there is a threat of various diseases associated with an imbalance in the nutrition of mothers and their babies during breastfeeding. The gradual introduction into the diet of children's food makes it possible to rationally compensate for the lack of many trace elements in the nutrition of infants. Such trace elements include omega-3 and omega-6, the lack of which in our intercontinental region due to the lack of sufficient fish and fish dishes causes problems associated with many body processes: attention and mobile joints, skin, hair and nails health [8]. Therefore, it is so necessary to pay close attention to the choice of baby food that combines all the necessary vitamins and trace elements for a growing organism [9].

As can be seen from the last table of calculated data on the content in dry children's rice milk porridge, the content of oleic acid, omega-6, omega-3 prevails. Palmitic, stearic, and eicosanoid acids are contained in small amounts, which gives an additional balance of fatty acids in the diet of children [10].

According to the conducted studies of children's dry milk porridge, the content of valuable omega-3 and omega-6 fatty acids provide grounds for further research in this area to study and understand the need to use healthy fats in the diet of infants.

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