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EFFECT OF DIETARY FAT ON THE ACTIVITY OF PALMITIC ACID ELONGASE IN THE BLOOD SERUM AND LIVER OF RATS

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Abstract

Background. To determine the effect of dietary fats on the activity of palmitic acid elongase by two methods, using indicators of the fatty acid composition of lipids in the blood serum and liver of rats.

Methods. Edible vegetable oils were used: high linoleic (HLSO) and high oleic (HOSO) sunflower oils, palm oil (PO). Fats were introduced into the fat-free diet (FFD) in the amount of 5 % instead of the same amount of starch. The animals were fed for 30 days. A fraction of neutral lipids (triglycerides + cholesterol esters) was isolated from blood serum and liver, and the fatty acid composition was determined in it by gas chromatography.

Results. HLSO consumption reduced the biosynthesis of energy fatty acids (C_{16:0}, C_{16:1}, C_{18:0} and C_{18:1}) in the neutral fraction of serum and liver lipids. A new method for assessing the level of palmitic acid elongase, taking into account the metabolism of palmitic and stearic acids, is proposed, which gives higher values than the commonly used method for assessing elongase. With the help of the new method, elongase activation when HOSO is consumed was determined.

Conclusions. A new method is proposed for the determination of palmitic acid elongase, which takes into account the metabolism of fatty acids. It has been established that the consumption of HLSO reduces the biosynthesis of energy fatty acids. Consumption of HOSO increases elongase activity.

Keywords: fat nutrition; palmitic acid elongase.

Introduction

Energy fatty acids primarily include fatty acids endogenously formed from non-lipid precursors that are easily oxidized in mitochondria to form ATP [1-4]. These include palmitic ($C_{16:0}$), palmitooleic ($C_{16:1}$ n-7), stearic ($C_{18:0}$) and oleic ($C_{18:1}$ n-9). The latter acid is the main energy substrate in the animal organism; it easily penetrates the mitochondrial membrane, is more easily oxidized in mitochondria than other fatty acids, but is more resistant to thermal peroxidation and does not form pro-inflammatory mediators [4, 5].

In the chain of reactions leading to the formation of oleic acid, palmitic acid is converted into stearic acid, which is catalyzed by the elongase enzyme [5, 6].

To determine the activity of elongase, an indirect method is most often used to determine the ratio of the content of stearic and palmitic acids ($C_{18:0}/C_{16:0}$) [6].

Considering all this, we proposed to determine the activity of the elongase enzyme using the following formula:

$$A_{el} = (C_{18:0} + C_{18:1}) / (C_{16:0} - C_{16:1})$$

To determine the content of energy fatty acids, we recommend using the fraction of neutral lipids (NL), which contain the largest amount of triglycerides, the end product of the formation of these acids [7].

The purpose of this study was to compare two methods for determining the activity of elongase, as well as to determine the effect of fat nutrition on these indicators.

Material and research methods

All methodological studies on this work are described by us in previous articles [8-11]. To determine the fatty acid composition of the neutral fraction of blood serum and liver lipids, we used the Dole method in our modification [12] and the gas chromatographic method [13].

Elongase activity was calculated by two methods: by the formula $C_{18:0}/C_{16:0}$ and by the formula $(C_{18:0} + C_{18:1}) / (C_{16:0} - C_{16:1})$.

Results and its discussion

Table 1 presents the results of determining the content of energy fatty acids in the fraction of neutral lipids in the blood serum and liver of rats treated with a fat-free diet (FFD) and fatty diets with the addition of 5 % of the following oils: high-linoleic sunflower oil (HLSO), containing 57.12 % linoleic acid (C_{18:2} ω-6), high oleic sunflower oil (HOSO) containing 84.57 % oleic acid, and palm oil (PO) containing 42.02 % palmitic acid.

From the presented data, it can be seen that the consumption of HLSO significantly reduces the content of energy fatty acids compared with similar indicators for rats treated with FFD: 59.6 % versus 76.8 % for blood serum and 62.8 % versus 85.1 % for the liver. In contrast to HLSO, the intake of HOSO and PO increases the content of energy fatty acids in serum and decreases very little in the liver.

Table 1 - The effect of fat nutrition on the content of energy fatty acids in the fraction of neutral lipids in blood serum and liver of rats

| Groups | Content, % | | | |
|-----------------------|-------------------|-------------------|-------------------|-------------------|
| | C _{16:0} | C _{16:1} | C _{18:0} | C _{18:1} |
| <u>A. Blood serum</u> | | | | |
| FFD | 26,13 | 10,81 | 1,97 | 37,93 |
| HLSO, 5 % | 19,30 | 7,03 | 1,56 | 31,76 |
| HOSO, 5 % | 21,54 | 5,89 | 1,78 | 50,08 |
| PO, 5 % | 26,27 | 7,96 | 2,24 | 42,46 |
| <u>B.Liver</u> | | | | |
| FFD | 31,43 | 11,19 | 2,65 | 39,85 |
| HLSO, 5 % | 21,62 | 6,08 | 1,69 | 33,37 |
| HOSO, 5 % | 20,66 | 4,61 | 1,31 | 54,10 |
| PO, 5 % | 25,27 | 5,69 | 2,23 | 44,86 |

Notes: FFD - fat-free diet; HLSO – high linoleic sunflower oil; HOSO – high oleic sunflower oil; PO is palm oil.

C_{16:0} – palmitic acid; C_{16:1} n-7 – palmitoleic acid; C_{18:0} – stearic acid; C_{18:1} n-9 – oleic acid.

Table 2 presents the results of determining the activity of palmitic acid elongase by two methods. It can be seen that the proposed method, which takes into account the

metabolism of fatty acids, gives higher rates, exceeding those of the first method by 25-35 times.

According to the indicators of the first method, the activity of elongase in both serum and liver changes little with fatty nutrition, while the second method reveals a higher activity of elongase with the consumption of HOSO: by 27.3 % in blood serum and by 64.3 % in the liver.

Table 2 - The influence of fat nutrition on the activity of palmitic acid elongase according to the results of the determination of fatty acids in the fraction of neutral lipids in the blood serum and liver of rats

| Groups | Blood serum | | Liver | |
|-----------|---------------------|---|---------------------|---|
| | $C_{18:0}/C_{16:0}$ | $(C_{18:0}+C_{18:1})/$ $(C_{16:0}-C_{16:1})$ | $C_{18:0}/C_{16:0}$ | $(C_{18:0}+C_{18:1})/$ $(C_{16:0}-C_{16:1})$ |
| FFD | 0,075 | 2,60 | 0,084 | 2,10 |
| HLSO, 5 % | 0,081 | 2,72 | 0,078 | 2,26 |
| HOSO, 5 % | 0,083 | 3,31 | 0,063 | 3,45 |
| PO, 5 % | 0,085 | 2,44 | 0,088 | 2,40 |

Conclusions

A more efficient and adequate method for determining the activity of palmitic acid elongase, taking into account metabolic transformations of substrate and product, has been proposed.

It has been established that fat nutrition with the use of HLSO inhibits the endogenous biosynthesis of energy fatty acids. Consumption of palm and, especially, HOSO does not significantly reduce the endogenous biosynthesis of energy fatty acids, does not reduce elongase activity, and HOSO even increases it.

Since the consumption of HLSO does not reduce the activity of elongase, the reason for the decrease in the intensity of fatty acid biosynthesis may be associated with the inhibition of the activity of stearyl-CoA desaturase [14].

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