DEVELOPMENT OF AN EXPERIMENTAL MODEL OF AVITAMINOSIS F

Abstract

The article analyzes the role of essential polyunsaturated fatty acids (PUFA), especially omega-3 series in humans and animals. The biosynthesis of essential PUFA in humans and animals is very limited, so they must be consumed with food (feed). The ratio of omega-3 and omega-6 PUFA is very important. Biomembranes of animal cells contain about 30% PUFA with a ratio of ω-6/ω-3 1-2. As this ratio increases, the physicochemical properties of biomembranes and the functional activity of their receptors change. The regulatory function of essential PUFA is that in the body under the action of oxygenase enzymes (cyclooxygenase, lipoxygenase) are formed extremely active hormone-like substances (eicosanoids and docosanoids), which affect a number of physiological processes: inflammation, immunity, metabolism. Moreover, ω-6 PUFA form eicosanoids, which have pro-inflammatory, immunosuppressive properties, and ω-3 PUFA form eicosanoids and docosanoids, which have anti-inflammatory and immunostimulatory properties. Deficiency of essential PUFA, and especially ω-3 PUFA, leads to impaired development of the body and its state of health, which are manifestations of avitaminosis F. Prevention and treatment of avitaminosis F is carried out with drugs that contain PUFA.

To create new, more effective vitamin F preparations, it is necessary to reproduce the model of vitamin F deficiency.

An experimental model of vitamin F deficiency in white rats kept on a fat-free diet with the addition of coconut oil, which is almost completely free of unsaturated fatty acids, and saturated fatty acids make up almost 99% of all fatty acids was developed.

The total content of ω-6 PUFA (sum of linoleic and arachidonic acids), the content of ω-3 PUFA (α-linolenic, eicosapentaenoic and docosahexaenoic acids) in neutral lipids (triglycerides and cholesterol esters) defined. The content of ω-6 PUFA under the influence of coconut oil decreased by 3.3 times, and the content of ω-3 PUFA - by 7.5 times.

The influence of coconut oil, the content of ω-6 PUFA decreased by 2.1 times, and the content of ω-3 PUFA - by 2.8 times. The most strongly reduces the content of ω-3 PUFA, namely eicosapentaenoic, coconut oil, starting from 5%. Consumption of FFD with a content of 15% coconut oil reduces the content of eicosapentaenoic acid to zero, i.e., we have an absolute deficiency of one of the most important essential PUFAs, which determined the presence of vitamin F deficiency.

Key words: essential fatty acids, coconut oil, vitamin F deficiency, ω-6 PUFA, ω-3 PUFA, fatty nutrition.

Introduction

Avitaminosis F – is a deficiency of essential polyunsaturated fatty acids (PUFA), especially omega-3 series [1]. It is known that the composition of PUFA includes fatty acids, the radical of which is two, three, four, five or six double bonds and which are divided depending on the location of the double bond in the third from the terminal methyl group of the carbon atom or in the sixth from the terminal methyl group of the carbon atom. Omega-3 PUFA include α-linolenic acid (C18:3, ω-3), eicosapentaenoic (C20:5, ω-3) and docosahexaenoic (C22:6, ω-3). Omega-6 PUFA include linoleic (C18:2, ω-6), γ-linolenic (C18:3, ω-6), arachidonic (C20:4, ω-6).

The biosynthesis of essential PUFA in humans and animals is very limited, so they must be consumed with food (feed).

Essential PUFA have two main functions: structural and regulatory. The structural function of PUFA is that they are necessary for the construction of biomembranes, without which there is no cell of the body. Moreover, the ratio of omega-3 and omega-6 PUFA is very important [2]. Biomembranes of animal cells contain about 30% PUFA with a ratio of ω-6 / ω-3 1-2 [1]. As this ratio increases, the physicochemical properties of biomembranes and the functional activity of their receptors change.

The regulatory function of essential PUFA is that in the body under the action of oxygenase enzymes (cyclooxygenase, lipoxygenase) are formed extremely active hormone-like substances (eicosanoids and docosanoids), which affect a number of physiological processes: inflammation, immunity, metabolism [3].

Moreover, ω-6 PUFA form eicosanoids, which have pro-inflammatory, immunosuppressive properties, and ω-3 PUFA form eicosanoids and docosanoids, which have anti-inflammatory and immunostimulatory properties.

Deficiency of essential PUFA, and especially ω-3 PUFA, leads to impaired development of the body and its state of health, which are manifestations of avitaminosis F. Prevention and treatment of avitaminosis F is carried out with drugs that contain PUFA.

To create new, more effective vitamin F preparations, it is necessary to reproduce the model of vitamin F deficiency.

The aim of our work was to develop an experi-
mental model of vitamin F deficiency in white rats kept on a fat-free diet with the addition of coconut oil, which is almost completely free of unsaturated fatty acids, and saturated fatty acids make up almost 99% of all fatty acids [4].

Materials and methods of research
White Wistar rats were used. Rats were fed a 30-day fat-free diet (FFD) supplemented with 5, 10, or 15% coconut oil. The content of ω-6 PUFA (linoleic and arachidonic) and ω-3 PUFA (eicosapentaenoic and docosahexaenoic) in gas and liquid chromatography was determined in neutral lipids of the liver and blood serum.

The experiments were performed on 24 Wistar rats (males, 3 months), which received a fat-free diet (FFD) [5], the composition of which is presented in table 1. All rats were divided into 4 equal groups:

**Table 1 - The composition of the fat-free diet for rats [5]**

| №   | Component            | Content, g / kg |
|-----|----------------------|-----------------|
| 1   | Maizestarch          | 660             |
| 2   | Soybean mealisdefatted | 150          |
| 3   | Ovalbumin            | 50              |
| 4   | Sugar                | 90              |
| 5   | Mineralmixture       | 40              |
| 6   | Vitaminmixture       | 10              |

1st - control, which received FFD, 2nd received FFD with the addition of 5% coconut oil (instead of starch), 3rd received FFD with the addition of 10% coconut oil and 4th - with the addition of 15% coconut oil. The duration of the experiment was 30 days. After euthanasia, the animals were isolated liver and received serum. In the neutral lipids of all tissues, the content of PUFA was determined by gas chromatographic method [6].

Results and discussion
Consumption of coconut oil dose-dependently reduces the total amount of PUFA in neutral lipids of liver and serum. The content of ω-6 PUFA is reduced in the liver by 3.3 times and in the serum by 2.1 times when consuming a diet of 15% coconut oil. The content of ω-3 PUFA is reduced in the liver by 7.5 times, in the serum by 2.8 times.

Under these conditions, the content of eicosapentaenoic acid decreased.

The total content of ω-6 PUFA (sum of linoleic and arachidonic acids), the content of ω-3 PUFA (α-linolenic, eicosapentaenoic and docosahexaenoic acids) in neutral lipids (triglycerides and cholesterol esters) of rat liver is shown in table 2, what does the content of ω-6 PUFA under the influence of coconut oil decreased by 3.3 times, and the content of ω-3 PUFA - by 7.5 times.

The ratio of ω-6 / ω-3 increases by 1.32 times and for the group with the addition of 15% coconut oil is 24.6.

The most strongly reduces the content of ω-3 PUFA, namely eicosapentaenoic, coconut oil, starting from 5% (Fig. 1).

**Table 2 - The total content of PUFA in neutral lipids of rat liver, who received FFD with the addition of coconut oil (%)**

| №   | Group                          | Σ ω-6 PUFA | Σ ω-3 PUFA | ω-6/ω-3 |
|-----|--------------------------------|------------|------------|---------|
| 1   | FFD                            | 14,3±1,8   | 0,75±0,24  | 19,1    |
| 2   | FFD + 5% coconut oil           | 5,9±1,0    | 0,25±0,19  | 23,6    |
| 3   | FFD + 10% coconut oil          | 4,5±0,9    | 0,17±0,08  | 26,5    |
| 4   | FFD + 15% coconut oil          | 4,3±1,1    | 0,10±0,06  | 43,0    |

**Table 3 - The total content of PUFA in neutral serum lipids of rats, who received FFD with the addition of coconut oil (%)**

| №   | Group                          | Σ ω-6 PUFA | Σ ω-3 PUFA | ω-6/ω-3 |
|-----|--------------------------------|------------|------------|---------|
| 1   | FFD                            | 14,6±2,0   | 0,78±0,23  | 18,7    |
| 2   | FFD + 5% coconut oil           | 10,2±1,4   | 0,72±0,24  | 14,2    |
| 3   | FFD + 10% coconut oil          | 7,6±1,1    | 0,40±0,19  | 19,0    |
| 4   | FFD + 15% coconut oil          | 6,9±0,9    | 0,28±0,14  | 24,6    |

Consumption of FFD with a content of 15% coconut oil reduces the content of eicosapentaenoic acid to zero, ie we have an absolute deficiency of one of the most important essential PUFAs, which determined the presence of vitamin F deficiency.

Conclusions
An experimental model of vitamin deficiency F (PUFA deficiency) was developed, which consists in feeding rats FFD with the addition of 15% coconut oil for least 30 days. Fat-free diet does not eliminate the presence of PUFA in the body.

The consumption of coconut oil (in an amount of 15%) in a fat-free diet causes the development of experimental deficiency of vitamin F.
Дforgettable Experimental Model of Avitaminosis F

Анотація
У статті проаналізовано роль незамінних поліненасичених жирних кислот (ПНЖК), особливо групи омега-3 для людій та тварин. Вісновігні незамінних ПНЖК у людини та тварин дуже обмежені, тому їх необхідно взимкувати разом з їжею (кормом). Співвідношення омега-3 та омега-6 ПНЖК є дуже важливим. Біомембрани клітин тварин містять близько 30 % ПНЖК у співвідношенні омега-6 / омега-3 1:2. З більшою частю цього співвідношення фізико-хімічні властивості біомембран та функціональна активність їх рецепторів змінюються. Регулююча функція ПНЖК полягає в тому, що в організмі під дією ферментів оксигенази (циклооксигенази, ліпоксигенази) утворюються надзвичайно активні гормоноподібні речовини (електраноїди та докозаноїди), які впливають на низку фізіологічних процесів: запалення, імунітет, обмін речовин. Більше того, омега-6 ПНЖК утворюють ейкозаноїди, які мають прозапальні, імуносупресивні властивості, а омега-3 ПНЖК утворюють ейкозаноїди та докозаноїди, які мають протизапальні і імуностимулюючі властивості. Дефіцит найважливішої ПНЖК, особливо омега-3 ПНЖК, призводить до порушення розвитку організму та його самопочуття, що є проявами авітамінозу F.

Ключові слова: незамінні жирні кислоти, кокосова олія, дефіцит вітаміну F, омега-6 ПНЖК, омега-3 ПНЖК, жирове харчування.

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