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 PUFAs 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, eicospentaenoic 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, ie 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 PUFAs 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 \( \omega-6 \) PUFA (linoleic and arachidonic) and \( \omega-3 \) 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]

<table>
<thead>
<tr>
<th>№</th>
<th>Component</th>
<th>Content, g / kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maizestarch</td>
<td>660</td>
</tr>
<tr>
<td>2</td>
<td>Soybeanmealisdefatted</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>Ovalbumin</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>Sugar</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>Mineralmixture</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Vitaminmixture</td>
<td>10</td>
</tr>
</tbody>
</table>

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 \( \omega-6 \) 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 \( \omega-3 \) 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 to zero.

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

The ratio of \( \omega-6 \) / \( \omega-3 \) 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 \( \omega-3 \) PUFA, namely eicosapentaenoic, coconut oil, starting from 5% (Fig. 1).

![Fig. 1 - The effect of coconut oil on the content of eicosapentaenoic acid in neutral lipids](http://grain-feed.onaft.edu.ua)

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.

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 at 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.
У статті проаналізовано роль незамінних поліненасичених жирних кислот (ПНЖК), особливо групи омега-3 для людей та тварин. Біосинтез незамінних ПНЖК у людини і тварин дуже обмежений, тому їх необхідно вживати 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. Зі збільшенням цього співвідношення фізико-хімічні властивості біомембран та функціональна активність їх рецепторів змінюються. Регулюючи дія ферментів оксигенази (циклооксигенази, ліпоксигенази) утворюються надзвичайно активні гормоноподібні речовини (індоаналоги, індоаналоги) які впливають на багато фізіологічних процесів: запалення, імунітет, обмін речовин. Більше того, омега-6 ПНЖК утворюють індоаналоги, які мають проапаплічні, імуносупрессивні властивості, а омега-3 ПНЖК утворюють індоаналоги та індоаналоги, які мають протизапальні та імунозабезпечуючі властивості. Дефіцит найважливішої ПНЖК, а особливо омега-3 ПНЖК, призводить до порушення розвитку організму та його самопочуття, що є проявами авітамінозу F. Профілактика та лікування авітамінозу F здійснюється препаратами, що містять ПНЖК.

Розробка експериментальної моделі авітамінозу F

Для створення нових, більш ефективних препаратів вітаміну F необхідно відтворити модель дефіциту вітаміну F. В роботі було розроблено експериментальний модель дефіциту вітаміну F у білих щурів, що знаходились на жировій дієті та отримували поїдання з кокосовою олією. Свідчення дефіциту вітаміну F в дієті з додаванням кокосової олії, яка майже повністю не містить ненасичених жирних кислот, а насичених жирних кислот становить близько 99% всіх жирних кислот.

**Література**

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