



Influence of palm oil enriched diet on the morpho-functional condition of rat's mandibular condylar cartilage

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Abstract

Currently, it is known that saturated fatty acids in palm oil have a negative effect on the body: they activate the thrombus formation process, increase blood cholesterol levels and develop other metabolic disorders, which leads to the development of cardiovascular and oncological diseases, and also to dysfunction of the organs of the gastrointestinal tract. The aim of the study was to establish the morpho-functional condition of mandibular condylar cartilage in white rats of different ages under conditions of excessive use of palm oil and to assess the possibility of correcting the identified changes using the *Garcinia Cambogia* extract. The study was conducted on 216 white rats of three age groups: immature, mature and senile, divided into 3 groups. 1st group - control; 2nd group - animals treated with palm oil at the rate of 30 g / day / kg; Group 3 - rats, which after 6 weeks of administering palm oil began to receive *Garcinia Cambogia* extract at a rate of 0.25 g / kg body weight. The periods of observation were 1, 10, 30 and 60 days after the end of 6 weeks from the start of palm oil use. The histologic slides of mandibular condylar cartilage were made according to standard methods. The total width of the condylar cartilage of the lower jaw, the width of its individual zones, the volume content of primary spongiosa, and the number of cells in the zone of subchondral osteogenesis were measured on the sections obtained. The use of palm oil for 6 weeks at the rate of 30 g / day / kg is accompanied by inhibition of the osteogenic function of the condylar cartilage of the lower jaw of experimental animals, which increases with the duration of addition of palm oil to the diet. On day 1 of observation, the maximum in amplitude deviations are observed in immature animals, the minimum - in senile animals. In the future, the rate of increase of changes are maximum in senile animals. The introduction of the *Garcinia Cambogia* extract at the rate of 0.25 mg / day / kg starting from the 7th week of using palm oil is accompanied by smoothing the negative influence of the experimental conditions on the osteogenic function of the condylar cartilage from 10 to 60 days of observation in immature and mature rats and from 30 to 60 days in senile rats.

Keywords: rat, mandible, condylar cartilage, palm oil, *Garcinia Cambogia* extract

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INTRODUCTION

It was found that in the developed countries, 15 to 25% of the adult population suffers from obesity. At the same time, an increase in the frequency of obesity in children and adolescents is observed worldwide: in the developed countries, 25% of adolescents have overweight, and 15% are obese. An overweight in childhood is a significant predictor of obesity in adulthood: 50% of children who were overweight at age 6 become obese as adults, and this probability increases to 80% in adolescence (Dedova and Mel'nichenko 2004). Thus the consumption of various saturated fatty acids plays a considerable role in the development of these processes (Il'ina and Radyuk 2012).

In particular, the saturated fatty acids, which are contained in palm oil, have a negative effect on the organism, comparable to hydrogenated fats (Akbari et al. 2016). Thus it should be noted that in the nature the normal spatial structure of unsaturated fatty acids corresponds to the cis-form, and in the process of hydrogenization the molecule «breaks down» and it becomes a trans-form providing an «aggressive» effect on the organism (Barmagambetova 2013). The spatially modified fatty acids activate the process of thrombosis, assist an increase in cholesterol levels in the blood and

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the development of other metabolic disorders, which leads to the development of cardiovascular and oncological diseases, as well as to dysfunction of organs of the gastrointestinal tract (Yashina 2005).

Therefore, the research of influence of the excessive consumption of palm oil, which is the most common of vegetable fats in the diet of humanity, as well as a recognized factor in the modeling of experimental obesity, on various organs and systems of the organism is very actual.

PURPOSE

To investigate the morpho-functional condition of mandibular condylar cartilage in white rats of different ages under conditions of excessive consumption of palm oil and to assess the possibility of correction of the identified changes using *Garcinia Cambogia* extract.

METHODS

The research was conducted on 216 white rats of three age groups: immature (1 month), mature (6 months) and senile (18 months). The animals were contained in accordance with the requirements and provisions established by the «European Convention for the protection of vertebrates used for experimental and scientific purposes» (Strasbourg 1986). Animals of the control (1st) group were kept in standard vivarium conditions and received intragastrically 0.9% isotonic sodium chloride solution. In the 2nd group, the animals received palm oil at the rate of 30 g/day/kg body weight (experimental model of alimentary obesity) in addition to the standard diet (Bibik et al. 2014). Finally, in the 3rd group of rats after 6 weeks of intragastric administration of palm oil at the rate of 30 g/day/kg body weight, along with further administration of palm oil, intragastric *Garcinia Cambogia* extract was obtained at the rate of 0.25 g/kg body weight.

The periods of observation was 1, 10, 30 and 60 days after 6 weeks from the start of palm oil use; animals of the 2nd and the 3rd groups continued to receive palm oil during the observation. At the end of the observation period, the animals were decapitated under ether anesthesia, the mandible was isolated, the condylar process was separated, the neutral formalin was fixed in 10% solution, 5% solution of formic acid was decalcinated, dehydrated in alcohols of increasing strength and poured into paraffin. Preparing the sections of the mandibular condylar cartilage up to a thickness of 6-8 μm , which were stained with hematoxylin-eosin (Avtandilov 2002). The obtained sections were used to measure the total width of the condylar cartilage, the width of its separate zones, the volume content of primary spongiosa and the number of cells in the zone of subchondral osteogenesis (Luzin and Morozov 2011, Luder 1994).

All the obtained digital data were processed by methods of variation statistics using standard application programs (Lapach et al. 2000).

MAIN PART

All the obtained digital data were evaluated with the obligatory comparison with the similar indicators of animals of the corresponding control group, all the digital differences given below are reliable ($p \leq 0.05$).

It was established that the excessive content of palm oil in the diet of experimental animals was accompanied by a decrease in the morpho-functional activity of mandibular condylar cartilage, which increased with the duration of observation. At the same time, the severity of the disorders and the rate of their increase depended on the age of the experimental animals.

During all the established observation periods, the total width of the mandibular condylar cartilage was less than similar values of the 1st group, respectively: in immature rats - by 3.20%, 4.06%, 4.89%, 5.78%, in mature animals - by 3.85%, 4.32%, 4.91%, 6.67%, and in senile rats - by 4.60%, 5.28%, 6.44%, 7.40%. This was mainly due to the narrowing of the zone of subchondral osteogenesis, which at all established observation periods was already controlled by 5.20%, 5.94%, 6.08%, 6.53% in the immature, by 6.14%, 6.52%, 7.13%, 8.47% in mature and by 6.84%, 7.51%, 8.29%, 11.04% in senile animals (**Fig. 1**).

Under these conditions, in immature rats in the zone of subchondral osteogenesis, the volume content of primary spongiosa during all observation periods was less than the 1st group by 4.09%, 4.75%, 5.01% and 5.08%, and the number of cells on the surface of bone trabeculae from 10 to 60 days - by 3.73%, 4.98% and 6.32%. In mature rats and senile animals, both of these indicators were less than control values during all periods of observation - by 5.09%, 5.05%, 5.19%, 6.31%, by 3.76%, 4.79%, 5.78%, 5.81%, by 6.61%, 6.49%, 7.01%, 8.12%, and by 4.18%, 4.06%, 5.80%, 6.37%.

Tissues are based on various molecules that include many pro-inflammatory peptides that are involved in many physiological or pathological processes, including inflammation, endothelial damage, atherosclerosis, insulin signaling impairment, hypertension, and bone remodeling (Vendrell et al. 2004).

Dysregulation of adipocines is a strong determinant of mild inflammatory processes in obesity, which triggers a cascade of metabolic changes leading to complications of the cardiovascular system, insulin resistance or diabetes, and loss of bone mass (Chamkori 2013, Kadowaki and Yamauchi 2005). Probably, in these conditions, the osteogenic function of the mandibular condylar cartilage is also disturbed.

The revealed changes in the morpho-functional activity of mandibular condylar cartilages in

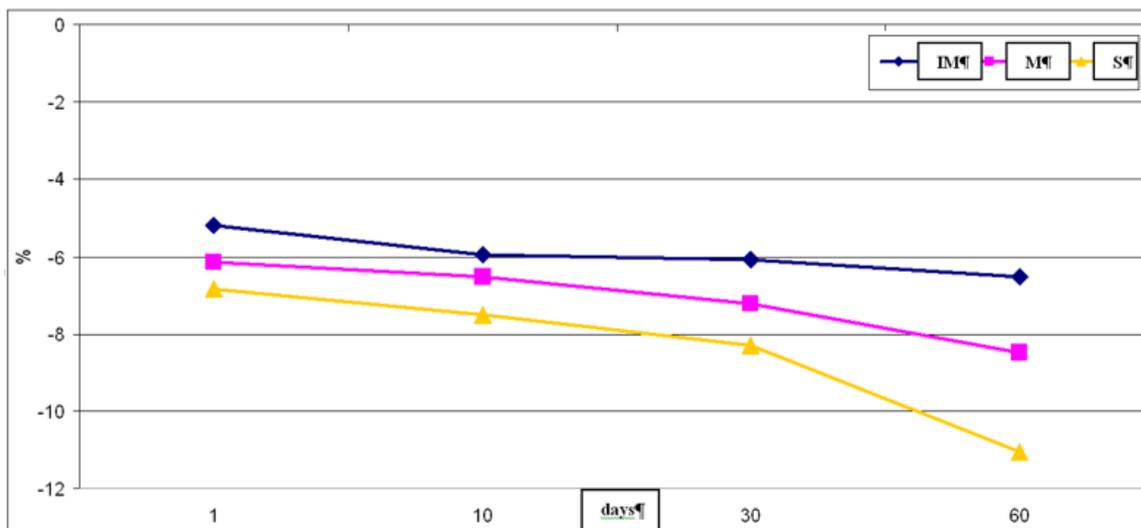


Fig. 1. Dynamics of the width of the zone of subchondral osteogenesis depending on the duration of palm oil use and the age of the animals (in % relative to the control group; all differences shown in this diagram are reliable with respect to the indicators of animals of the 1st group of the experiment).

Note: IM – Immature animals, M – mature animals, S – senile animals.

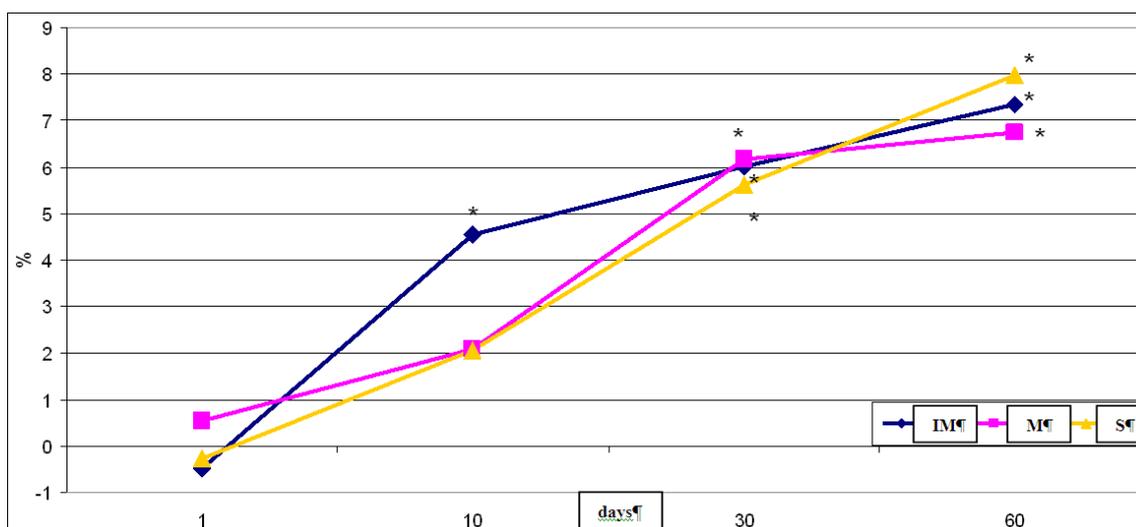


Fig. 2. The dynamics of the width of the zone of subchondral osteogenesis depending on the duration of the use of palm oil and age of animals (in % relative to the 2nd group).

Note: * - indicates a significant difference from the comparison group ($p \leq 0.05$)

experimental animals require searching for ways of their pharmacological correction. We used *Garcinia Cambogia* as a corrector, the preparations of which are characterized by a wide spectrum of pharmacological activity. In particular, its peel contains hydroxycitric acid, which reduces the formation of fatty acids and cholesterol, enhances fat oxidation and regulates appetite (Akdeniz et al. 2018, Saponova 2014, Takzare et al. 2018, Zonouzirad et al. 2016).

When comparing the results of histomorphometry of the condylar cartilage in animals of the 3rd group of the experiment with similar results of the 2nd group, it was found that significant differences were recorded from 10

days of observation in immature and mature rats and from 30 days in senile animals.

As a result, on day 60 of observation in immature rats the total width of the mandibular condylar cartilage was greater than the values of group 2 by 5.92%, the width of the proliferation zone and the zone of subchondral osteogenesis-by 7.09% and 7.35%, and the content of primary spongiosa and the number of cells on the surface of bone trabeculae in the zone of subchondral osteogenesis - by 6.86% and 4.93% (Fig. 2).

In mature rats by the same period, the total width of the condylar cartilage was greater than the control values by 5.88%, the width of the proliferation zone – by 6.73%, and the volume content of primary spongiosa

and the number of cells in the zone of subchondral osteogenesis– by 5.38% and 5.67%.

Finally, in senile rats, the total width of the condylar cartilage was greater than the values of the 2nd group by 5.40%, the width of the zones of proliferation and subchondral osteogenesis-by 5.83% and 7.98%, and the volume content of primary spongiosa and the number of cells on the surface of bone trabeculae in the zone of subchondral osteogenesis – by 7.28% and 3.68%.

CONCLUSIONS

1. The use of palm oil for 6 weeks at the rate of 30 g/day/kg is accompanied by the oppression of the

osteogenic function of the mandibular condylar cartilage, which increases as the duration of addition palm oil into the diet.

2. On the 1st day of observation the maximum amplitude deviations are observed in immature animals, the minimum - in senile animals. Thereafter, the paces of rise changes are the highest in senile animals.

3. Introduction of *Garcinia Cambogia* extract at the rate of 0.25 g/day/kg since 7 weeks of palm oil consumption is accompanied by smoothing of the experimental conditions negative impact on the osteogenic function of the mandibular condylar cartilages in the period from 10 to 60 days observation in the immature and mature rats and from 30 to 60 days in senile rats.

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