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EFFECT OF FLOUR FROM PEA STRAW ON LIPID PEROXIDATION AND ANTIOXIDANT PROTECTION IN THE FOOD SYSTEM OF RATS WITH EXPERIMENTAL DYSBIOSIS

Abstract

The work shows that growing peas in Ukraine produces a significant amount of a secondary resource - unused straw, which is inexpedient from both economic and environmental points of view. This also contradicts current global trends regarding the most efficient use of all available types of food and feed raw materials to ensure food security of the population, and reduce the negative impact on the environment. It is shown that the use of pea straw in the feed industry will allow returning a significant amount of natural resources into the chain of creating products for people, in addition, it will contribute to an increase in the production of animal protein. The reasons for the low efficiency of using straw as a component of enriching the nutritional value of compound feed products are given and the expediency of using it as a component with functional properties is shown.

The aim of the work was to determine the effect of the consumption of flour from pea straw on the state of lipid peroxidation in the digestive system under conditions of experimental dysbiosis.

We used flour from the vegetative parts of peas (straw). Dysbiosis was reproduced in rats using the antibiotic lincomycin. The state of lipid peroxidation (LPO) was studied by the content of malondialdehyde (MDA) in the tissues of the digestive system (mucous membranes of the cheeks, small and large intestines, as well as in the liver). Pea straw flour was added to the compound feed in the amount of 10% instead of wheat grain. The experiment lasted 18 days. The activity of the antioxidant enzyme catalase was also determined, and the antioxidant-prooxidant index (API) was calculated from the ratio of catalase and MDA indices.

An increase in lipid peroxidation intensity and a slight decrease in catalase activity in rats with dysbiosis were found. Consumption of flour from pea straw reduced the intensity of lipid peroxidation, especially in the colon mucosa.

It was found that dysbiosis in the digestive system stimulates LPO to a greater extent in organs with low catalase activity. Pea straw flour has antioxidant properties.

Key words: peas, straw, dysbiosis, lipid peroxidation, digestive system, feeding, nutrition

Introduction

The gross harvest of peas in Ukraine in recent years has increased significantly, if in 2012/2013 the volume was 349 thousand tons, then over the past 5 years this figure fluctuates between 478.8 ... 755 thousand tons due to an increase in acreage. This trend is typical for the EU countries. The prerequisites for growth are an increase in world consumption, new trends in healthy nutrition with the use of legumes, the need to restore crop rotation after oversaturation of oilseeds [1].

When growing peas, straw is obtained, the amount of which depends on varietal characteristics, climatic, agrotechnical conditions, but on average is equal to the amount of grain obtained. Taking into account the volume of cultivation, in 2020 about 500 thousand tons of a secondary resource that has not been used was obtained, which is inexpedient from both economic and environmental points of view. This also contradicts current global trends regarding the most efficient use of all available types of food and feed raw materials to ensure food security of the population, and reduce the negative impact on the environment.

Thus, an urgent problem is the search for rational ways to return pea straw to the chain of creating products for people and the best option may be to use it in the feed industry, since it will increase the production of animal protein.

The low efficiency of using straw as a fodder means is associated with its low digestibility, poor feeding, although the energy of straw is equivalent to 40-50% of the energy of grain, however, it is in a form that is difficult to access. All this leads to the limitation of the use of straw for enriching the nutritional value of compound feed products, however, its use as a functional component can be a promising direction.

It was found that in rats with experimental dysbiosis reproduced with the antibiotic lincomycin, inflammatory-dystrophic processes develop in the digestive system, in the pathogenesis of which lipid peroxidation (LPO) plays a significant role [2-5].

To counteract lipid peroxidation in the body, there is an antioxidant system (AOS), one of the components of which is the enzyme catalase, which is capable of breaking down hydrogen peroxide (H_2O_2) [6].

In our previous work, it was shown that flour from pea straw has a high antidisbiotic activity, that is, a prebiotic [7].

The aim of this work was to determine the effect of flour from pea straw on LPO and the antioxidant effect in the tissues of the digestive system of rats with experimental dysbiosis.

Materials and methods of research

Pea straw flour was obtained from the vegetative parts of peas, which were crushed on a laboratory knife grinder and sieved through a sieve with a hole size of 0.8 mm. Experimental dysbiosis was reproduced in white Wistar rats (males 2–2.5 months old, live weight 193 ± 13 g) by administering the antibiotic lincomycin with drinking water at a dose of 70 mg / kg daily for the first 5 days [8]. The rats were divided into 3 levels of the group (5 animals each): the 1st group (control) received a standard diet [5], the 2nd and 3rd groups received lincomycin, the diet of the 2nd group was standard, and in 3 - th group 10% of wheat grain was replaced by flour from pea straw.

Euthanasia of animals was carried out on the 18th day of the experiment under thiopentane anesthesia (20 mg/kg) and the mucous membranes of the oral cavity (MOC) (cheek), small intestine and large intestine, as well as the liver were isolated. Intestinal mucous membranes were isolated after preliminary washing from the chyme with cold 0.9% NaCl solution. In tissue homogenates, the content of malondialdehyde (MDA) was determined [9], the activity of catalase [8], and the antioxidant-prooxidant index (API) was calculated from the ratio of catalase activity and MDA content [8].

The experimental results were subjected to standard statistical processing [10].

Results and discussion.

Table 1 shows the results of determining the content of the end product of lipid peroxidation - malondialdehyde (MDA).

It can be seen from these data that the highest content of MDA is observed in the OM and in the liver of rats. In rats treated with lincomycin (group 2), the MDA content significantly increased in the MOC by 61.1%, in the small intestine by 202 %, in the large intestine by 224.2% and in the liver by 68.6 %. The data obtained indicate that the greatest activation of LPO in dysbiosis occurs in the mucous membrane of the large intestine. In our previous work [4], it was shown that the greatest increase in inflammatory processes under conditions of dysbiosis is observed precisely in the large intestine. In rats that received flour from pea straw against the background of dysbiosis (group 3), the MDA content was significantly lower than in rats with dysbiosis that received a standard diet (group 2). In particular, the MDA content decreased: in the OM by 34 %, in the small intestine by 16%, in the large intestine by 56 %, in the liver by 15 %, however, complete normalization of LPO to the level of intact animals (group 1) occurs only in the OM.

Table 1. Influence of flour from pea straw on the content MDA (mmol/kg) in the digestive system of rats with experimental dysbiosis

Bioobject	Groups of laboratory animals		
	1 (control)	2 (dysbiosis)	3 (dysbiosis + flour from pea straw)
Oral mucosa	23.3±2.0	38.7±2.8 P<0.01	25.6±3.4 P>0.3 P1<0.05
Small intestine	3.88±0.48	7.74±0.32 P<0.01	6.51±0.55 P<0.05 P1<0.05
Colon	2.31±0.16	7.49±0.59 P<0.01	3.27±0.35 P<0.05 P1<0.01
Liver	19.49±1.35	32.87±1.71 P<0.01	28.05±1.67 P<0.05 P1>0.05

Note P - compared to group 1
P1 - compared with group 2

Table 2 shows the results of determining the activity of the enzyme catalase.

Table 2 - Effect of flour from pea straw on catalase activity, (µat / kg) in the digestive system of rats with experimental dysbiosis

Bioobject	Groups of laboratory animals		
	1 (control)	2 (dysbiosis)	3 (dysbiosis + flour from pea straw)
Oral mucosa	8.78±0.39	7.18±0.39 P<0.05	7.57±0.33 P<0.05 P1>0.35
Small intestine	4.05±0.05	3.31±0.07 P<0.05	3.66±0.19 P<0.05 P1<0.05
Colon	2.18±0.16	1.10±2.03 P<0.01	1.58±0.17 P<0.05 P1<0.05
Liver	5.74±0.13	5.55±0.13 P>0,3	5.68±0.14 P>0.5 P1>0.3

Note P - compared to group 1
P1 - compared with group 2

From the results obtained, it can be seen that the highest activity of catalase is observed in the OSS, and the lowest in the mucous membrane of the colon. With dysbiosis, catalase activity in the colon decreases by 49%, in the OAS and small intestine by 28 %, and practically unchanged in the liver.

Consumption of flour from pea straw does not significantly affect the activity of catalase in the OAS and in the liver, but significantly increases it in the intestine. An increase in the level of catalase in the mucous membrane of the colon by 43.6 %, in the small intestine by 10.6 %, in the OAS and in the liver by 5.43 and 2.3 %, respectively. Normalization of catalase levels is not observed in all tissues. The liver did not respond to the consumption of pea straw flour.

Table 3 shows the results of determining the API index, which is an indicator of the balance of the antioxidant and prooxidant systems of the body [8].

Table 3 - The effect of pea straw flour on the API index in the digestive system of rats with experimental dysbiosis

Bioobject	Groups of laboratory animals		
	1 (control)	2 (dysbiosis)	3 (dysbiosis + flour from pea straw)
Oral mucosa	3.77±0.31	1.85±0.22 P<0.01	2.96±0.30 P>0.05 P1<0.05
Small intestine	10.52±0.17	4.28±0.49 P<0.001	5.62±0.93 P<0.05 P1>0.05
Colon	9.35±0.91	1.47±0.20 P<0.001	4.83±0.47 P<0.05 P1<0.01
Liver	2.95±0.21	1.69±0.19 P<0.05	2.02±0.2 P<0.05 P1>0.05

Note P - compared to group 1
P1 - compared with group 2

It can be seen that the highest level of API is observed in the mucous membranes and the lowest in the liver. With dysbiosis, the API index significantly decreases in all tissues of the digestive system: in the OAS by 5 %, in the small intestine by 59 %, in the large intestine by 84 %, in the liver by 43 %.

Consumption of flour from pea straw increases the level of the API index: in the OSS by 60 %, in the small intestine by 31 %, in the large intestine by 229 %, in the liver by 20 %, however, this indicator normalizes only in the OAS.

The data obtained indicate that according to this indicator, the mucous membrane of the large intestine was the most sensitive to the action of flour from pea straw.

At the same time, the only biological object in which lipid peroxidation is normalized is SOPR, possibly by the level of the highest catalase activity.

A significant increase in LPO under conditions of dysbiosis in the intestinal mucosa (2-3 times) is possibly also explained by the low level of catalase activity in these tissues: 2-4 times less than in the OAS.

Conclusions

Based on the work done, the following **conclusions** can be drawn.

1. In case of dysbiosis in the digestive system, there is an activation of lipid peroxidation (LPO), which is most pronounced in the mucous membrane of the large intestine.
2. The intensity of LPO is to a certain extent inversely related to the activity of catalase.
3. Consumption of flour from pea straw reduces the level of lipid peroxidation, and to a greater extent in the mucous membrane of the large intestine.

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ВПЛИВ МУКИ З ГОРОХОВОЇ СОЛОМИ НА ПЕРЕКИСНЕ ОКИСНЕННЯ ЛІПІДІВ ТА АНТИОКСИДАНТНИЙ ЗАХИСТ В ТРАВНІЙ СИСТЕМІ ЩУРІВ З ЕКСПЕРИМЕНТАЛЬНИМ ДИСБІОЗОМ

Анотація. *В роботі показано, що при вирощуванні гороху в Україні отримується значна кількість вторинного ресурсу – соломи, яка не використовується, що недоцільно як з економічної так і з екологічної точок зору. Це також суперечить актуальним світовим тенденціям сьогодення щодо максимально ефективного використання усіх доступних видів харчової і кормової сировини для забезпечення продовольчої безпеки населення, зменшення негативного впливу на навколишнє середовище. Показано, що використання горохової соломи у комбікормовій промисловості дозволить повернути значний обсяг природного ресурсу у ланцюг створення продуктів для людей, крім того, сприятиме збільшенню виробництва тваринного білка. Наведено причини низької ефективності використання соломи як компонента для збагачення поживної цінності комбікормової продукції та показано доцільність застосування як компонента із функціональними властивостями.*

Метою роботи було визначення впливу споживання муки з горохової соломи на стан пероксидації ліпідів в травній системі за умов експериментального дисбіозу.

В роботі використовували муку з вегетативних частин гороху (солома). Дисбіоз відтворювали у щурів за допомогою антибіотика лінкоміцина. Досліджевали стан перекисного окиснення ліпідів (ПОЛ) за вмістом малонового діальдегіду (МДА) в тканинах травної системи (слизові оболонки щоки, тонкої та товстої кишок, а також в печінці). Муку з горохової соломи вводили до складу комбікорму в кількості 10% замість зерна пшениці. Тривалість досліду становила 18 днів. Визначали також активність антиоксидантного ферменту каталаза і за співвідношенням показників каталаза і МДА розраховували антиоксидантно-прооксидантний індекс (АПІ). Встановлено зростання інтенсивності ПОЛ і деяке зменшення активності каталази у щурів з дисбіозом. Споживання муки з горохової соломи знижувало інтенсивність ПОЛ, особливо сильно в слизовій оболонці товстої кишки. Встановлено, що дисбіоз викликає в травній системі стимуляцію ПОЛ в більшій мірі в тих органах, які мають низьку активність каталази. Мука з горохової соломи виявляє антиоксидантні властивості.

Ключові слова: *горох, солома, дисбіоз, перекисне окиснення ліпідів, травна система, годівля, харчування.*

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