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Biotechnological potential of the straight-wing species *Acheta domesticus* as raw material for the production of feed for aquaculture

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Abstract. The article assesses the biotechnological potential of crickets of *Acheta domesticus* species for use as feed for aquaculture. The optimal diet was selected and the most favorable conditions for the reproduction of insects in a mini-farm were determined. Studied the qualitative composition of the substrate on the basis of the crickets of the species *Acheta domesticus*. With the aim of selecting the optimal technological modes of processing of raw materials on the basis of the insects investigated the total antioxidant activity of aqueous extracts of dried crickets of the species *Acheta domesticus* crustaceans of the genus *Gammarus pulex*. For crickets *Acheta domesticus* activity was 1.508 g routine per 100 g absolutely dry sample and 1.888 g routine for *Gammarus pulex*. It was found that the samples of *Gammarus pulex* have the property of thermal stability according to the criterion of total antioxidant activity during drying of dry samples to a constant weight at 105°C.

1. Introduction

The problem of raw materials of animal origin for feeding aquaculture is an urgent topic of food security. In our country, it is aggravated by the shortage, high cost and unstable quality of substrates that are made on the basis of fish meal, meat and bone meal, blood meal, etc. In recent years, there has been an increase in research to find substitutes for animal feed for aquaculture. The winged insects of the *acheta domesticus* species are of considerable practical interest as a source of protein and biologically active components necessary for the growth and development of valuable fish species. The majority of questions connected with technology of cultivation of crickets in artificial conditions and production of full-fledged forages on their basis till now remain open.

Protein is the most important food component in the feed rations of farm animals, including fish and other aquatic organisms, as it largely determines not only the productivity but also the quality of the finished product. The lack of protein in the feed ration is about 25%, which leads to a significant (up to 30%) shortage of products, an increase in its cost and a decrease in the efficiency of the industry [1].



A widespread source of high-quality protein is fish meal, which is a valuable feed product produced by drying and grinding waste from fish, marine mammals, crustaceans, as well as from waste in the cutting and processing of marine products. Fishmeal used to produce feed for fish and pigs, and other farm animals. In the modern world always grows demand for fish flour, recently as a surrogate of fish flour we use plant-based or animal origin commodity as a canola, rapeseed and soy [2]. Because of high demand and high price of fish flour in modern forage production the research of alternate and lower cost source of protein is very important and relevant. In this article was made scientific base of using *Acheta Domesticus* as a source of protein in forage production. Apart from their nutritional benefits, edible insects have suddenly caught the attention of food development and regulatory bodies for other potent reasons. It is unanimously agreed that edible insects can provide ecological and economic advantages as well. These edible insects can be a cheaper substitute of the expensive animal proteins. It can bolster the fragile food supply. Edible insects farming can reduce the pressure from agriculture, aquaculture and animal husbandry, by requiring less turnover time, land, water or feed [3-5].

The food industry develops by using modern technologies, different methods of processing of food substrate, found new sources of protein, carbs, vitamins and amino acids. All this important to meet the growing demands in choice of compound feedstuff, because the natural source of fishing is getting less and farms opposite is growing.

Such feeds, first of all, can be used to feed the fish. Feeding fish in industrial aquaculture is the most important technoregional element. The quality of mixed feeds, which they were combined with, the characteristics of feed-drip technology are highly influential on the most important aquaculture and biological indicators — the survival rate of the fish for the period of growth, speed of growth, physiological health and health.

Most of the digestion, in order to ensure the consumption of fish farming in full-growth old-growing and product rationing feedings, is made by growing European producers.

In the production of mixed feeds, it is necessary to take into account the multifactor requirements for growing hydrobionts. Undoubtedly, the biogenic elements in the water of fish-breeding installations in greater degree are influenced by the systems of bioretic filtering, used in growing the fish, to tightly buy the middle-class fish, the daily substitute water. It can be answered that some extremes of mixed feeds can have a negligent effect on the quality of water, including the content of biogenic elements.

It is well-known that even physically physical properties of grained for mixed feeds influence the pollution of water in aquaculture. The speed of solution of grains in water is reflected on the use of food in fish feeding, this factor is one of the most important when growing fish with various methods.

Therefore, it is imperative to select such a technological process that will allow the new feeds to meet all the requirements. But besides the choice of the technological process, it is necessary to select the substrate itself for the production of compound feed.

Fish is an indispensable reliable source of feeds for the farms, as soon as aquaculture is a fast-growing sector, which ensures 50% of the global production of fish. Nevertheless, the production of fish is restrained by the feed prices due to the constant increase of the value of fish meal, an inalienable component of fish feeds. Therefore, it is important to replace fish meal with cheaper, but no less useful components.

The technology of preparation of a substrate-substitute includes many developed eras: collection of a substrate, preparation, special treatment, grinding, drying.

One of the main goals of receiving substrate from the possible substitutes for fish flour is drying. The choice of drying method determines all the previous stages. Therefore, in the development of the technology, the new product was the study of the influence of the drying method of the substrate on the food value of the food.

Acheta Domesticus in a form that is fertilized for consumption, including phosphorephorone, calretium, cholerezo, microaratelents, and vitremoreins.

Frying and drying can lead to a significant reduction in the content of separated vitamins, aminoacid, micro and macrocell effects.

Fish can get some minerals, such as calrecia, sodium and potassium, from the surrounding water, but cannot get enough supply of phosphorer, zinc, jelly and copper from water and, consequently, they have to be fed through feeds. Such feed contains vitamreins A, E, C, B12 and a complex of vitamins of the group B.

The top-priority development of the technology for obtaining feed prey of fishmeal flour is the choice of the best way to remove moisture. Variations of possible varieties of moisture removal from plant and animal tissues: mechanical, physical-chemical, warm-up, radio-green.

The choice of method will depend on the physical and chemical properties of the substances subject to drying. In the course of drying, the substance does not have to decompose or undergo any chemical changes. In addition, the choice of drying method is determined by the fact that moisture removal must be possible.

Physical and Chemical Method - for this purpose, the dried preparation is placed in a vessel with a substance absorbing moisture. Such a substance can be: a) a liquid eater, which has a low pressure vapor suppression, such as, for example, sulfuric acid or chlorate lithium rastvorer or calration (chemical drying process); b) a hard porous substance with a silnorically developed surface - an adsorbent of the type of silica gel (physical drying process). In the chemical and pharmaceutical industry, this method is used mainly in drying on laboratory scales.

Heat - by evaporation of moisture. This method is most widely used in the chemical and pharmaceutical industry, as a basis for the process, when sufficient moisture removal is required. The method of drying should be chosen optimally, to prepare the most reliable substitute for fish meal in the micro and macro-selective mode. The most important requirement for drying method is a soft, minimal effect on the substrate [6].

As a complex criterion for the depth of these reactions in the drying process, we chose an indicator of antioxidant activity, which was determined by the coulometric method using electrogenerated bromine.

2. Materials and methods

The paper used samples of crickets *Acheta domesticus*, grown in a mini-farm. for comparison were selected the samples of dried arthropods of the family of the highest cancers of the family gammarids communities of the detachment of the amphipods *Gammarus pulex*, purchased at a pet store. *Gammarus pulex* were chosen as a reference because they are quite popular and are already actively used as feed for industrial fish breeding at fish farms. *Gammarus pulex* is widely used in the cultivation of trout, sturgeon, carp and other valuable species of fish in the aquarium for feeding medium and large fish, as well as a good ballast feed that helps cleanse the digestive system of fish. *Gammarus* are considered one of the best feed, due to its high nutritional value and high content of carotene. 12.8% of dry weight of *Gammarus pulex* contains 56.2 % protein, 5.8 % fat, 3.2 % carbohydrates.

In determining SOA aqueous extracts of samples of crickets and gamarus used coulometric method of analysis using electrogenerating radicals of bromine at automotive-certified, serial coulometric "Expert-006-antioxidant. Dante OOO ekoniks-Expert" (Moscow) at certified us technique [7]. Determination of CAO was carried out in terms of a standard sample of rutin in g per 100 g of samples. The device was calibrated with an alcoholic solution of the Russian standard sample (RSO) routine prepared according to the current State Pharmacopoeia of the XI edition. Statistical processing of the results was carried out through the modal value (mode) of 10 definitions, the relative error of the definition of CAO (E resp.) was in the range of 1.79 -2.44 %.

The crushed samples were brewed with boiling distilled water at the rate of 1 g of the sample per 0.1 dm³ of water, extraction was carried out with stirring on a magnetic stirrer for 15 minutes, the extracts were filtered before analysis.

Drying (dehydration) of the samples was carried out in a drying Cabinet SNOL 58/350 at 105°C in parallel with the determination of their humidity.

3. Results and discussion

The definition of SAAO involves the determination of not just a substance or a combination thereof, but to characterize the entire heterogeneous pool of different classes of antioxidant substances in General and identify the "functional" antioxidant activity that can be reproduced in a suitable model system where oxidative reactions occur.

We do not use model systems, as they are most often in the literature, where oxidation reactions occur, and only introducing a biological fluid in a solution full of radicals and measure the number of radicals, which entered into interaction with a given quantity of biological fluid and do the recalculation on 100 g samples. The question of comparison standards is still open according to the literature, but the closest standards are antioxidants such as uric acid, Gallic acid, trolox, tocopherol (but it does not dissolve in water). As a standard substance, we use rutin as the most affordable and acceptable reagent [7], which is used in Pharmacopoeia to determine flavonoids.

Table 1 presents the results of the study of SAA dried samples of crickets *Acheta domesticus* and crustaceans *Gammarus pulex*, and the activity of *Gammarus pulex* at 25.20 % RH. higher. We have studied the resistance to temperature in terms of SAA, the optimal drying time (dehydration) of samples at 105°C to a constant weight of 7.5 hours, while there is a decrease in SAA crickets *Acheta domesticus* by 19.30 % RH. and increase SAA *Gammarus pulex* by 34.59 % Rel. Further high-temperature drying of samples at 105°C for 3 hours leads to a decrease in SAA for crickets *Acheta domesticus* by 7.72 % RH., for *Gammarus pulex* at 18.62 % RH.

Table 1. Summary antioxidant activity (SAA) crushed dried specimens of the crickets *Acheta domesticus* and the crustaceans *Gammarus pulex*.

Samples	Residual moisture of the dry sample (d. s.), %	SAA, g Ru per 100 g of dry sample (d. s.)	SAA in g Ru per 100 g of absolutely dry sample (a. d. s.)	SAA in g Ru per 100 g of absolutely dry sample (a. d. s.) after dehydration at 105°C
After dehydration at 105°C for 7.5 hours				
<i>Acheta domesticus</i>	19,30	1,217±0,029	1,508±0,036	1,217±0,029
After dehydration at 105°C for 10.5 hours				
<i>Acheta domesticus</i>	19,30	1,217±0,029	1,508±0,036	1,123±0,027
After dehydration at 105°C for 7.5 hours				
<i>Gammarus pulex</i>	10,48	1,690±0,036	1,888±0,040	2,541±0,046
After dehydration at 105°C for 10.5 hours				
<i>Gammarus pulex</i>	10,48	1,690±0,036	1,888±0,040	2,068±0,040

4. Conclusion

The total antioxidant activity of aqueous extracts of dried crickets *Acheta domesticus* and crustaceans *Gammarus pulex* was investigated.

For crickets *Acheta domesticus* activity was 1.508 g routine per 100 g absolutely dry sample, and routine for *Gammarus pulex* - 1,888 g.

It is shown that the samples of *Gammarus pulex* have the property of thermal stability according to the criterion of total antioxidant activity during drying of dry samples to a constant weight at 105°C.

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