БІОТЕХНОЛОГІЇ ТА БІОІНЖЕНЕРІЯ

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Influence of cellulolytic preparation on the productive qualities of snails of the *Helix Aspersa Maxima* species

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Heliciculture is a branch of animal husbandry that deals with cultivation and using edible terrestrial snails for food and cosmetic purposes. This type of animal husbandry has an advantage over others in terms of simplicity of technology, as snails do not require complex technical equipment and care. In addition, they are unpretentious in feeding and resistant to diseases.

Heliceculture has significant potential for development in Ukraine, as there is already considerable demand for snails in the food and cosmetics market. This industry is also developing rapidly and becoming increasingly popular among farmers and businessmen worldwide.

At the same time, achieving success in snail farming requires specific knowledge and skills. For example, it is essential to choose a suitable cultivation method, ensure optimal keeping and feeding conditions, and adhere to the standards of product storage and processing.

It is also worth considering the specifics of the legislation regulating the breeding and circulation of snails and the possible risks associated with pollution and animal diseases.

An essential aspect of the development of helicopter culture is research and development to improve the quality and quantity of products, as well as the technology for reproduction and keeping snails. Such research should help improve efficiency and make the industry more competitive.

Exploring opportunities to improve the efficiency of nutrient use in snail feed can significantly increase the profitability of production. Enzyme preparations are widely used in heliceculture to enhance the digestion of complex compounds, reduce the negative impact of anti-nutrients, and improve feed conversion. The use of such products in heliculture is reasonable and can have a positive impact on production efficiency.

The direction of complex feeding in heliceculture has not been studied much, and the influence of this cellulolytic drug on the productive qualities of Helix Aspersa Maxima species snails has yet to be clarified.

The results obtained during the study can substantiate the positive aspects of using special preparations to increase snail cultivation efficiency and the use of nutrients in the diet.

The study was conducted to investigate the effect of cellulosolytic enzyme preparation «AGROCELL» on the productivity of snails of the species Helix Aspersa Maxima.

The results of the work showed that the addition of the enzyme preparation «AGROCELL» to the diet increases the absolute increase in live weight of snails by 1.2 g and the chain weight by 0.1-1.1 g.

Key words: snails, industry, enzyme preparation, productivity, feeding, technology, cultivation.

Problem statement and analysis of recent research. The current state of the global development of snail farming and the historical genesis of the formation of snail culture as a full-fledged branch of agriculture are vividly described in the works of foreign scientists, among which it is worth highlighting the scientific results of Apostolou K., Dyal S., Cabaret J. [13, 16, 18].

According to research results by foreign scientists [14, 15, 17] in Western and Central European countries, snail cultivation is profitable due to the constant demand for this product. In this regard, large farms actively breed snails in Western Europe.

In contrast, snail farming has limited opportunities in Ukraine for several reasons. First, Ukrainian consumers need to be used to perceiving snails as a food product. Second, including snail dishes in the menu of restaurants and cafes is risky because they are not popular among a wide range of customers. Third, retail grocery stores are not interested in purchasing snail semi-finished products. As a result, snail farming in Ukraine is mainly an export industry [2].

Heliciculture is a young trend under development in Ukraine and European countries, which are the primary consumers of snail meat. The total demand for this product is estimated at 120,000 tons annually, but it satisfies only 60-65% of the market. It indicates a need for more products, particularly meat from edible snail species [5].

The snail farming has enormous potential, and the international consumer market for snail-related products is growing. Snail processing products, such as snail protein mucin, snail caviar, meat semi-finished products, cellular biomaterials, and dried snail droppings, which have great potential in the international market, are up-and-coming [1, 8].

Analysts estimate that snail farms can be very profitable, with over 100 % profitability due to several factors:

– the niche is relatively narrow, and production volumes in Ukraine are minimal, which leads to the fact that the average market value of snails is higher than other meat products;

- the productivity of snails is excellent - each snail can produce up to 60 individuals per year, and productivity increases exponentially;

- costs for keeping mollusks are small;

- the possibility of obtaining meat and roe (at a price not far behind that of sturgeon) and mucin, a valuable component for cosmetic products [6,10].

The industry's success largely depends on the ease of development and the size of the initial investment, which is influenced by the snail farming format. There are several options for the growing format, including:

1) growing indoors all year round. The ideal option for this format is a hangar-type space with optimal temperature (+20...+23 °C) and humidity (about 85 %).

2) cultivation in enclosures in open spaces. This method works well in regions with mild, warm climates and when using intensive cultivation technology. In spring and summer, as much as possible, the snail herd must be increased to marketable sizes to prepare the snails for wintering.

3) cultivation in greenhouses. This format combines the advantages of a hangar and an open format. Snails are protected from external threats, and temperature and humidity can be flexibly regulated. However, it is unsuitable for winter use [4, 9].

Snails can produce various products such as frozen fillets, canned snails in oil, slime for creams and masks, cooked escargot, delicatessen shells, pâté, and unique caviar.

Commercial breeding of snails remains an attractive direction that can be successfully developed if you approach the matter accordingly and study its specifics. In various regions of Ukraine, there are already successful snail breeding farms, proving the viability of this business idea.

Therefore, scientific and research work to increase product quality and quantity and improve snail reproduction and maintenance technologies is essential to developing heliceculture. Such studies should help increase efficiency and make it more competitive in the market [11].

Investigating opportunities to improve nutrient use efficiency in snail feed can significantly increase production profitability. Enzyme preparations are widely used in heliceculture to enhance the digestion of complex compounds, reduce the negative impact of antinutrients, and improve feed conversion. The use of such drugs within the framework of heliceculture is justified and can positively affect the indicators of production efficiency.

Heliceculture is a branch of animal husbandry that deals with breeding and using edible land snails for food and cosmetic purposes. Snails are a simple and low-maintenance animal to raise, as they don't require any complex equipment or care, are not picky eaters, and are resistant to many diseases [20].

Many of Ukraine's territories have favourable climatic conditions for growing edible snails. Currently, a small number of enterprises and farms are engaged in the technological cultivation of snails. Around 90 % of the snails farmed in Ukraine are exported to European Union countries, while the remaining 10 % are sold domestically. A promising new branch of animal husbandry is emer-

ging in the country, dedicated to cultivating edible snails. This development has the potential to significantly increase the level of snail exports and processed snail products to European countries shortly. This can also affect the formation of the culture of consumption of snail dishes in Ukraine. Accordingly, the demand for these products will increase within the country. In addition, such an industry can create new jobs and contribute to infrastructure development in rural and adjacent areas [3].

Cultivating snails has several advantages compared to traditional animal husbandry. First, snails are an environmentally friendly product that does not contain harmful substances and antibiotics. Second, cultivating snails does not require high costs for maintaining and feeding animals.

One of the main tasks for the development of snail farming in Ukraine is to increase the volume of production and improve the quality of products. For this purpose, it is necessary to provide enterprises engaged in cultivating snails with modern equipment and technologies and provide them with financial support. In addition, it is essential to carry out scientific and research work on improving the genetic potential of animals and developing new feeds and additives that increase the efficiency of snail cultivation [12].

The research aimed to assess the impact of the cellulolytic enzyme preparation «Agrocell» on the productivity of Helix Asperse Maxima snails.

Material and methods of research of young animals (from 1 month) and snails reaching marketable weight in farms with intensive cultivation technology.

- to conduct a theoretical review of the technology of growing snails and prospects for the development of snail culture in Ukraine;
- to experimentally investigate the effect of the enzyme preparation on the productive indicators of snails;
- calculate optimal concentrations when using the drug;
- comprehensively describe the rational technological process of growing snails in Ukraine.

Growing snails requires special attention to feeding conditions, which must be adequate to ensure high quality and productivity. Enzyme preparations are essential when feeding snails. Enzymes help break down complex substances into simpler ones, allowing the body to assimilate useful substances better and reduce feed costs [16].

The main component of «Agrocell» feed enzyme additive is cellulase, which is involved in the enzymatic hydrolysis of glycosidic bonds of non-starch polysaccharides, primarily β-glucans and xylenes contained in plant cell walls. The use of «Agrocell» reduces the viscosity of chyme in the gastrointestinal tract and allows you to split cell walls into smaller molecules.

Adding a feed supplement to the diet improved nutrient digestibility and increased animal absorption and productivity.

The strain Trichoderma longibrachiatum TW-420 BKM F-3880 D, which has not undergone genetic engineering, is a cellulase producer. «Agrocell» enzyme additive is standardised by cellulase activity, which is at least 4000 units/g, and contains xylase activity in 1000 units/g and β-glucanase in 3200 units/g.

«Agrocell» is a stabilized micro granular powder. This allows it to be stored in various conditions, including as an addition to vitamin-mineral premixes of any concentration. It also ensures the drug's stable technological characteristics and high thermal stability during storage.

The enzyme preparation has an optimal granulometric composition and volume density at 0.4-0.5 g/m³, ensuring high homogeneity of its distribution in the feed. This is achieved thanks to a high-quality selective producer and enzyme preparations' unique micro granulation technology. Microgranules quickly dissolve when moistened, and during feed granulation, they form an enzyme-substrate complex that is resistant to high temperatures. Such features of the drug made it possible to use it in feed granulation without increasing the administration dose.

The drug has unique properties, including fermentative activity in a wide pH range - from 2.5 to 7.0- and insensitivity to fungal enzyme inhibitors, usually contained in grain raw materials of compound feed. The recommended dose of the drug is 50-100 g/t of feed and is effective for most rations containing a large amount of barley, oats, processing products, and ingredients with a high fibre content, such as cake and meal. When using «Agrocell», the rations contain up to 40 % wheat, rye and triticale.

The research was conducted based on the farm «Snail Valley» in the city of Zhmerynka, Vinnytsia region, in 2022. The group method was used for the experiments. The control group of young snails was placed in enclosure №3, and the experimental group was placed in enclosure №2 (with a planting density of 300 pieces/m²). The housing and feeding conditions in the equalization period were the same. Still, in the primary period, a biologically active feed additive - cellulolytic enzyme - was added to the feed of the experimental animals (table 1).

Table 1 – **Characterisation of the experimental scheme according to the periods of snail cultivation**

Groups	Number of animals, pcs/m²	Conditions for experimenting by periods	
		compensatory (10 days)	basic (120 days)
Control	300	OR*	OP
Experimental	300	OR*	AR+BAD (cellulose-lytic drug)

*** Note:** OP - is the main ration: a feed mixture including corn, wheat and soybean meal, cake, sunflower oil, salt and chalk.

The monthly feed consumption and consumption rate were recorded to assess the efficacy of an experimental biologically active supplement in commercial snail feed.

With the aid of control weighings of 30 individuals, carried out every decade, the growth intensity of animals and their productivity based on the consumption of a new feed factor were determined. This was achieved by calculating the absolute and relative increase in live weight. At the end of the main period of research, the anatomical parts of commercial snails were determined by separating and separately weighing the bodies and shells of animals to 0.01 g (on analytical scales).

A cellulolytic enzyme preparation is an enzyme that performs the function of a catalyst in the bodies of animals. It is produced at the «Enzym» plant of enzyme preparations (Ladyzhyn, Ukraine).

The drug is supplied in multi-layered paper bags packed in 25 kg. It is recommended to store it in the manufacturer's packaging in a dry place protected from direct sunlight at temperatures from -25°C to +25 °C. The drug's shelf life is one year from the date of manufacture. The optimal values of introducing the drug for adjusting the nutritional level of feed components are given in (table 2).

The use of the drug «Agrocell» has the following advantages:

- the ability to use available and more profitable domestic raw materials for the production of compound feed;
- the ability to increase the digestibility of nutrients from diets that include wheat, oats, barley, triticale and rye;
- the possibility of reducing the cost of the diet due to the increase in the assimilation of nutrients;
- the possibility of improving the quality of products;
- the possibility of improving the sanitary condition of the farm.

The drug «Agrocell» can be used with feed ingredients, medicines, and additives. Although it has not been studied in *Helix Aspersa Maxima* snails, it is safe to operate.

Research results and discussion. The main goal of the research is to establish the effectiveness of cellulolytic enzymes and to study their effect on the digestion and assimilation of feed by the grape snail (*Helix Aspersa Maxima*).

Enzymes improve animal feed assimilation, allowing you to work with various types of rations, use less expensive feed, and get the desired results. However, the effectiveness of enzymes as catalysts depends on many factors, and it is necessary to know their main characteristics and features for their rational use.

Table 2 – **Nutritional value of feed components of the ration per introduction of the drug «Agrocell»**

Feed components	Increase in released exchangeable energy, %	Increase in digestibility of amino acids, %
Rye	3,5	4
Oat	5	4
Barley	5	4
Wheat	5	4
Wheat bran	4,5	5
Triticale	5	4
Corn	5	6
Pea	5	7
Rapeseed meal/cake	6	5
Sunflower meal/cake	5	6
Soybean meal	5	7

Add fiber-degrading enzymes to compound feed. They will be active in the digestive tract and, together with animal enzymes, allow access to valuable nutrients that would otherwise be lost to the body [11].

In addition, wheat, barley, oats, and rye contain a large amount of soluble fibre, which has an anti-nutritive effect. Soluble fibre forms a thick gel in the digestive tract, reducing the activity of the body's enzymes, complicating absorption processes, and increasing the risk of developing pathogenic microbes.

The primary purpose of using a new enzyme additive in growing commercial snails was to increase its growth rate. The dynamics of snail growth were analysed to determine effectiveness. Shields were randomly selected in the feedlot, where the animals congregated during the day. Up to 400 guards are placed in each unit, so 1% (4 shields) were selected and marked. 5-10 snails were randomly chosen from each protection and weighed to the nearest 0.01 gram. The results of the study are presented in (table 3).

According to the data in the table, in the first month after planting young snails in feeding cages, there was no noticeable difference in weight between the control and experimental groups. However, in June, a statistically significant ($p<0.001$) difference in live weight was found in animals from the experimental group, which were heavier by 1.1 g compared to the control group. Later, during rearing, snails given an enzyme supplement had a higher live weight than animals from the control group.

Calculations of absolute and chain increments of snails for the experimental period are given in (table 4).

The material presented in the table shows that commercial snails that received the enzyme preparation with feed had higher absolute gains compared to the control by 1.2 g during the growing period. The chain live weight gains of the snails of the experimental group exceeded the control indicators by 0.1-1,1 g at all stages of research, except for July.

The results of calculating the growth rate of snails are presented in (table 5).

The results of the studies shown in the table provide evidence of a higher baseline rate of snail growth in the experimental group. In addition, analysis of the chain rate of growth showed that the animals that received the enzyme preparation in their diet increased their body biomass faster. This is confirmed by a higher chain growth rate of 30 % in June and 10 % at the end of the growing period compared to the control group.

To get a more accurate picture, relative indicators of the intensity of mass accumulation, such as average daily and relative live weight gain, were calculated since absolute indicators of mass accumulation do not reflect the productive effect of the studied feed factor. Table 6 shows that the snails' live weights increased during the experimental period.

Table 3 – **The dynamics of live weight of snails under the influence of an enzyme preparation,** X ± m, n=30

Month	The live weight of one snail from the group, g		
	control	experimental	deviation (+/-)
May	3,6±0,15	3,6±0,50	0
June	10,2±0,20	11,3±0,1	+1,1
July	13,8±0,53	14,5±0,65	+0,7
August	20,5±1,05	21,8±2,15	+1,3
September	25,9±2,03	27,3±0,95	+1,4

Table 4 – **Absolute and chain increments of snails during feeding enzyme preparation,** X ± m, n=50

Indexes	Groups:		deviation (+/-)
	control	experimental	
Absolute increase, g	24,9±3,05	26,1±1,05	+1,2
- %	-	4,8	
-t_d	-	0,3	
Chain growth by months of cultivation, g:	3,5	3,5	0
May	6,6	7,7	+1,1
June	3,6	3,2	-0,4
July	6,7	7,3	+0,6
August	5,4	5,5	+0,1

Indicators of the chain growth rate of snails in the experimental group in June were 30% higher than in the control group, which indicates a positive effect of the studied biologically active additive on animal productivity.

To assess this effect, the number of snails in experimental and control feeding cages was compared, and the percentage of non-conforming individuals and the weighted mass of commercial products were determined.

The results of the determination of productive parameters and comparison in the control and experimental groups are given in (table 7).

Thus, studies of the productivity of snails have shown that the use of an enzyme preparation has a positive effect on the intensity of accumulation of body weight of animals and the effective use of feed.

Table 5 – **Growth rates of snails during the accounting period for feeding enzyme preparation**

Indexes	Groups:		Deviation (+/-)
	control	experimental	
Basic growth rate	2,59	2,73	+0,14
Chain growth factor:	36	36	0
May	2,8	3,1	+0,3
June	1,4	1,3	-0,1
July	1,5	1,5	0
August	1,2	1,3	+0,1
September	254	273	+14
Basic growth rate, %	3600	3600	0
Chain growth rate, %:	280	310	+30
May	140	130	-10
June	150	150	0
July	120	130	+10

Table 6 – **Increases in live weight of snails during the experimental period**

Indexes	Group:		Deviation (+/-)
	control	experimental	
Average daily growth during the growing period (150 days), g	0,172	0,181	+0,009
Chain daily gain, g: May	0,11	0,11	0
June	0,22	0,26	+0,04
July	0,12	0,10	-0,08
August	0,22	0,24	+0,02
September	0,20	0,19	-0,01
Relative (chain growth rate, %: May	3500	3500	0
June	183,3	213,9	+30,6
July	35,3	28,3	-7,0
August	48,6	50,3	+1,7
September	26,3	25,2	-1,1

Table 7 – **Productivity of snails *Helix Aspersa Maxima***

Indicator	Control group	Experimental group
Mass of 1 snail, g	25,9±2,03	27,3±0,95
Total weight of collected snails, kg/bag	1521,6	1555,2
Mass of non-condensing snails, kg	123,6	114,5
Attrition (of unconditioned individuals), %	8,1	7,4
Weight of conditioned snails, kg/garden	1394	1440,7
Deviation: kg	-	+42,7
%	-	+3,05

Conclusions. Based on the literature review, heliceculture is developing rapidly in Ukraine and the world. The demand for snail products is growing every year, and advanced scientific research must be used to improve cultivation efficiency.

To study the effect of the cellulolytic enzyme on the digestion and assimilation of feed by the grape snail Helix Aspersa Maxima and to evaluate its effectiveness, the conditions of the «Snail Valley» farm in the city of Zhmerynka, Vinnytsia region were used.

«Agrocell» enzyme additive is compatible with all feed ingredients, medicinal preparations, and other feed additives; it was not previously used in heliceculture.

As a result of research on the productivity of commercial snails, it was established that using an enzyme preparation positively affects the intensity of mass accumulation and the efficiency of feed use. During the growing period, commercial snails that received the enzyme preparation with food had higher absolute gains compared to the control by 1.2 g. in the rations of the commercial snail Nelix Aspersa Maxima led to an increase in the percentage of digestibility and bioconversion coefficients of the primary feed nutrients. With the use of the enzyme additive in the rations, there was an increase in the digestibility of feed protein by 3.4 %, fat by 2.1 %, and nitrogen-free extractives by 1 %.

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Вплив целюлозолітичного препарату на продуктивні якості равликів виду *Helix Aspersa Maxima*

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Описано вплив целюлозолітичного препарату на продуктивні якості равликів виду *Helix Aspersa Maxima*.

На сьогодні геліцекультура – це галузь тваринництва, що займається вирощуванням та використанням їстівних наземних равликів для харчових і косметичних цілей. Цей вид тваринництва має перевагу над іншими завдяки простоті технології, оскільки равлики не потребують складного технічного обладнання і догляду. Крім того, вони невибагливі у годівлі та стійкі до хвороб.

Геліцекультура має значний потенціал для розвитку в Україні, оскільки вже є суттєвий попит на равликів на ринку харчових та косметичних продуктів. У світі ця галузь також розвивається швидко і стає дедалі популярнішою серед фермерів та бізнесменів. Водночас досягнення успіху в равликівництві потребує певних знань та навичок. Наприклад, важливо правильно вибрати метод вирощування, забезпечити оптимальні умови утримання і годівлі, а також дотримуватися стандартів збереження і перероблення продукції. Слід враховувати особливості законодавства, що регулює розведення та обіг равликів, а також можливі ризики, пов'язані із забрудненням та захворюваннями тварин.

Важливою складовою розвитку геліцекультури є науково-дослідна робота у сфері підвищення якості та кількості продукції, а також вдосконалення технологій відтворення і утримання равликів. Такі дослідження мають допомогти підвищити ефективність та зробити її більш конкурентоспроможною на ринку. Вивчення можливостей підвищення ефективності використання поживних речовин у кормах для равликів може суттєво збільшити прибутковість виробництва.

У геліцекультурі широко застосовують ферментні препарати для поліпшення перетравлення складних сполук, зменшення негативного впливу антипоживних речовин та підвищення конверсії кормів. Використання таких препаратів у рамках геліцекультури є обґрунтованим та може позитивно вплинути на показники ефективності виробництва.

Напрям комплексної годівлі у геліцекультурі малодосліджений, не з'ясовано вплив цього целюлозолітичного препарату на продуктивні якості равликів виду *Helix Aspersa Maxima*.

Результати, отримані в ході дослідження, підтверджують доцільність використання спеціальних препаратів для підвищення ефективності вирощування равликів, збільшення використання поживних речовин раціону.

У роботі проведено дослідження щодо впливу целюлозолітичного ферментного препарату «АГРОЦЕЛЛ» на продуктивність равликів виду *Helix Aspersa Maxima*.

За результатами роботи виявлено, що додавання до раціону ферментного препарату «АГРОЦЕЛЛ» збільшує абсолютні прирости живої маси равликів на 1,2 г та ланцюгові – на 0,1–1,1 г.

Ключові слова: равлики, галузь, ферментний препарат, продуктивність, годівля, технологія вирощування.

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