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PRELIMINARY ANALYSIS OF THE PRODUCTION PERFORMANCE OF EDIBLE SNAILS *HELIX ASPERSA ASPERSA* FED A DIET SUPPLEMENTED WITH CALCIUM PIDOLATE

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Abstract. In the last few decades there has been an upward trend in consumption of edible snails of the species *Helix aspersa* in European countries. In the 1990s the first *Helix aspersa aspersa* snail farms in Poland appeared, and the country's heliculture now accounts for about 10% of European production. Parameters used to calculate the profitability of production play an important role in all farming systems; in the case of snails these include the feed conversion rate and yield (kg per m^2). Recent years have seen growing interest in organic sources of microelements as feed additives to increase productivity and enhance immunity. Therefore the aim of the study was to conduct pilot research on the effect of the addition of calcium pidolate to the diet on selected production and quality parameters in snails *Helix aspersa aspersa*. The experiment was carried out on two plots on a snail farm. Agrimony was grown on the two plots. The snails were fed grower and finisher diets. The diet for the experimental group was supplemented with 0.075% calcium pidolate. The experiment was continued until the snails reached somatic and commercial maturity. The snails in the experimental group were shown to mature earlier and weigh more, resulting in more kilograms of live weight per m^2. Moreover, the percentage of snails classified as quality class I was higher in the experimental group. The amount of feed provided until completion of the cycle was higher in the control group, which could result in a longer fattening period and higher FCR. The pilot experiment carried out in snails *Helix aspersa aspersa* demonstrated that the addition of calcium pidolate to the diet of snails can result in a higher final weight and lower feed consumption.

Key words: *Helix aspersa aspersa*, production technology, calcium pidolate.

INTRODUCTION

In the last few decades there has been an upward trend in consumption of edible snails of the species *Helix aspersa* in European countries (Caullan et al. 2014). Products obtained from *Helix aspersa aspersa* include not only meat, but also eggs, which are processed for caviar, shells, used in fishkeeping and catering (Ligaszewski and Pol 2021), and mucus, used in production of cosmetics. Snail mucus may also have pharmaceutical applications, including for treatment of

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colorectal cancer; Matusiewicz et al. (2018) showed that following in vitro application of extracts of freeze-dried mucus and foot tissues from *Helix aspersa*, a decline in the viability of a colorectal cancer cell line (Caco-2) was observed. The importance of land snails of the species *Helix aspersa* is not limited to the food or pharmaceutical market. They are also excellent bioindicators, due to their capacity for bioaccumulation of heavy metals both in field conditions and in the laboratory (Gomot de Vaufleury and Bispo 2000; Gomot de Vaufleury and Pihan 2000), providing an important source of information for assessment of pollution in a given environment (Carbone and Faggio 2019). Snails respond rapidly even to trace amounts of an element, following consumption of water, plants or microbes contaminated with toxic metals or skin contact with soil. This can be exploited by observing their sensitivity and the effect of metals on their metabolism, developmental damage, growth inhibition, or impairment of reproductive capacity (Carbone and Faggio 2019). These observations have practical applications for animals and humans living in areas exposed to heavy metals. In some cases the demand for snail meat, which is considered an exotic product, has led to their acquisition from the natural environment (Vieites et al. 2007). Production in captivity is an alternative to extraction from their natural habitats (González et al. 2005) and at the same time provides safe meat from a known source. Until recently, production of edible *Helix aspersa aspersa* in Poland was considered a niche industry. In the 1990s the first *Helix aspersa aspersa* snail farms appeared in Poland, and the country's heliculture now accounts for about 10% of European production (Ligaszewski and Pol 2021). Recent years have shown that this branch of industry is becoming increasingly popular. In Poland 2,000 tonnes of edible land snails are produced every year, and in Europe even tens of thousands of tonnes per year (Ligaszewski and Pol 2021). Breeders in Poland choose the species *Helix aspersa aspersa* (Ligaszewski et al. 2016). Important quality characteristics of raw snails for the processing industry include shell strength (Ligaszewski 2005), while significant parameters for breeding are those that can be used to calculate the profitability of production, such as the length of the fattening period, feed conversion rate, mortality, yield (kg per m²), and quality classification. The level of nutrition has a very important influence on production results, and new solutions are continually sought to improve production parameters. Recent years have seen an increase in interest in organic sources of microelements as feed additives to increase productivity, enhance immunity and correct deficiencies of elements (Szostak 2017). One supplement of this type, which is increasingly used not only in animal diets but in humans as well, is calcium pidolate, a calcium salt consisting of 13% calcium and 87% pidolic acid (Laurenceau et al. 2011). The positive effect of calcium pidolate added to feed for laying hens was shown in a study by Al-Zahrani and Roberts (2015), who reported improvement in the internal characteristics of eggs. Roulleau et al. (2015) claim that calcium pidolate has a significant effect on bone mineralization in broiler chickens through deposition of organic and mineral bone matrix. The inclusion of calcium pidolate in the human diet has also been shown to inhibit bone resorption (Rico et al. 1990). Therefore the aim of the study was to conduct pilot research on the effect of the addition of calcium pidolate to the diet of snails *Helix aspersa aspersa* on selected production and quality parameters.

MATERIAL AND METHODS

The experiment was conducted on two plots of a snail farm in the Świętokrzyskie Voivodeship, made available by the owners. An area of 1200 m² was used for each group – experimental and control. The plots were previously cultivated for sowing of agrimony. Snails reared to the age of 60 days were placed on the experimental plots at a density of 300/m². They were fed grower and finisher. The diet for the experimental group was supplemented with 0.075% calcium pidolate (Table 1, 2). The grower diet was used from 60 to 120 days of the rearing cycle, and the finisher diet after day 120 (Table 3, 4). The experiment continued until the snails had reached somatic and commercial maturity (90–105 days of fattening on the snail farm). The age of the snails at the completion of the experiment was estimated at 150–165 days. Following rearing on the farm the snails were collected, washed, and classified.

Table 1. Composition of grower diet used from days 60 to 120 of snail fattening

Ingredient	Control [%]	Experimental group [%]
Chalk	30.62	30.545
Soybean meal	22.00	22.00
Wheat bran	15.00	15.00
Maize	5.00	5.00
Mineral and vitamin premix	5.00	5.00
Soybean oil	2.00	2.00
Wheat	15.40	15.40
Sunflower meal	4.98	4.98
Calcium pidolate	0.00	0.075

Table 2. Chemical composition of grower diet

Component	%
Crude protein	16.50
Fat	3.48
Lysine	0.91
Methionine	0.40
Crude ash	37.59
Calcium	13.30
Total phosphorus	0.75
Cellulose	3.30

Table 3. Composition of finisher diet used from day 120 to completion of snail fattening

Ingredient	Control [%]	Experimental group [%]
Chalk	45	44.925
Soybean meal	26	26
Wheat bran	15	15
Maize	7.3	7.3
Mineral and vitamin premix	5	5
Soybean oil	1.7	1.7
Calcium pidolate	0	0.075

Table 4. Chemical composition of finisher diet

Component	%
Crude protein	15.00
Fat	3.05
Lysine	0.92
Methionine	0.37
Crude ash	51.56
Calcium	18.90
Total phosphorus	0.69
Cellulose	2.33

RESULTS AND DISCUSSION

Table 5 presents the performance results of snails *Helix aspersa aspersa* in the two feeding groups. Differences were found in the final performance results between the experimental and control groups. The fattening period in the control group was 15 days longer, as the snails needed more time to reach maturity and market weight. The snails in the experimental group matured earlier and weighed more, which translated to more kilograms of live weight per m² of farming area. Moreover, the experimental group had a higher percentage of snails assigned to quality class I. The amount of feed provided until the completion of the cycle was higher in the control group, which could result in a longer fattening period or a higher FCR. Ligaszewski and Pol (2021) reported that feed utilization by *Helix aspersa aspersa* ranged from 0.9 to 1.2 kg per kg of increase in commercial weight. In the present study, feed consumption per kg of weight gain in the control group was 0.36 kg higher than in the experimental group. Mortality was relatively high at 30% in both groups. It should be noted that breeding took place on an open farm, unprotected by a net, so that it was not secured against wild birds and rodents. Calculations of the original density of the young snails per m² took into account the possibility of losses caused by wild animals. Studies by other authors also indicate high mortality of snails (30%) reared at a high density (Lazaridou-Dimitriadou et al. 1998).

Table 5. Production performance of snails *Helix aspersa aspersa*

Parameter	Experimental group	Control
Length of fattening period	150 days	150 days + 15 days
Kilograms obtained broken down by market class	Σ 2520 kg class I – 98% = 2470 kg class II – 2% = 50 kg	Σ 2268 kg class I – 95% = 2155 kg class II – 5% = 113 kg
Yield per m²	2.10 kg	1.89 kg
Amount and type of feed	Σ 3000 kg grower 2100 kg finisher 900 kg	Σ 3500 kg grower 2450 kg finisher 1000 kg
Estimated feed conversion (FCR)	1.19 kg per kg weight gain	1.55 kg per kg weight gain
Mortality	30%	30%

The present study confirms the beneficial effect of the addition of calcium pidolate to the diet on the performance of *Helix aspersa aspersa*, expressed as higher weight gain with lower feed consumption. Ligaszewski and Pol (2018) found that the inclusion of betaine hydrochloride in the diet of edible snails reared in a closed system without access to other food sources improved meat performance parameters, increasing the amount of protein and reducing crude fat.

Snail farming around the world is based on a variety of alternative production systems, in which the snails are kept and fed in various ways (García et al. 2005). Snails can be kept in closed, mixed and outdoor systems, in which their living environment often differs from natural conditions (Arditi et al. 2003; Vieites et al. 2007). According to Perea et al. (2006), if the environment in captivity is unfavourable, growth is inhibited and mortality increases. An outdoor system is often chosen, consisting of plots planted with plants, supplemented with balanced feed (San Román et al. 2004). A diet of green vegetables alone, which is popular in the Mediterranean, does not ensure an adequate growth rate (Daguzan 1981). An alternative is intensive feeding systems based on compound feeds designed for the species. Compound feeds for snails should contain 16–21% protein, less than 4% fat and crude fibre, and 10–12% calcium. In the present study, the grower diet contained 16.50% protein, 3.48% fat, and 13.3% calcium, and the corresponding levels in the finisher diet were 15.00%, 3.05% and 18.9%. According to some authors, feed for snails usually consists of about 30% soybean meal and about 30% ground chalk (Ligaszewski and Pol 2021). The feed used in our experiment contained 22–26% soybean meal and about 30–45% chalk. In addition, the snails were kept on plots with agrimony. According to Ligaszewski and Pol (2021), more than 90% of the increase in weight gain in snails is derived from industrial complete feeds for snails, and the remaining 10% from the leaves of plants in their living environment. Research by García et al. (2005) indicates significant differences in the growth and development of *Helix aspersa* Müller fed a diet consisting of vegetables alone and an intensive system based on compound feeds. The diet of vegetables alone resulted in delayed, inhibited and uneven growth, and in consequence the body weight of the snails at 6 weeks was 11 times lower (0.081 g). Some authors link delay and inhibition of growth to genetic predispositions (Sampelayo et al. 1990; Fontanillas and García-Cuenca 2002). However, the study by García et al. (2005) indicates that this phenomenon depends on the feeding system used. Intensive feeding with a compound feed resulted in uniform weight gain, lower variation and low mortality, and the average body weight at 6 weeks was 0.955 g (García et al. 2005). Ligaszewski and Pol (2021) reported that the final body weight of *Helix aspersa aspersa* ranged from 11.2 to 12.7 g depending on the farming system and the content of protein in the diet, while the meat yield and indicators of the nutritional value of the meat were more dependent on the farming system (field vs. greenhouse) than on the protein content in the diet (Ligaszewski and Pol 2016). In greenhouse production with a low level of protein in the feed, higher yield of foot muscle was obtained than in field production (Ligaszewski and Pol 2016). Interesting observations were made by Iglesias and Castillejo (1999) in a study on the diet of the land snail *Helix aspersa* Müller. Snails did not choose their food at random; among all plants available on the experimental plots they preferred a specific plant, common nettle (*Urtica dioica*), a species with high content of protein, ash and calcium. In this way the snails themselves satisfied their need for the most essential nutrients for growth and shell formation, ensuring their optimal level in their diet (Iglesias and Castillejo 1999). In another study, snails were observed to choose beet leaves (González et al. 2009).

The growth, development and reproduction of snails are influenced by many experimental factors, such as temperature, photoperiod, rearing conditions (Jess and Marks 1998), and even the magnetic field (Ligaszewski et al. 2011). The effects of temperature and photoperiod on the final body weight of snails have been studied by numerous authors (Jess and Marks 1998; Benbellil-Tafoughalt and Koene 2014; Ligaszewski and Pol 2016). A longer photoperiod and higher temperature act synergistically to accelerate the growth rate of *Helix aspersa* (Jess and Marks 1998). Research by Sampelayo et al. (1991) indicates that the optimum protein level in feed for snails is 16.8–17.5%, and exceeding this level is only justified when the snails are kept in poor light conditions. This was confirmed by Ligaszewski and Pol (2016), who increased the protein level to 18.6% in conditions of field production of *Helix aspersa aspersa*, thereby increasing the weight of the carcass, which is completely edible. Performance results have also been shown to depend on genotype, as in a different subspecies, *Helix aspersa maxima*, the level of protein in the feed did not significantly affect the weight of the meat. A study by Ligaszewski and Pol (2017) analysing the content of calcium and crude ash in the shells and visceral sacs and the content of crude protein in the African snail *Cornu aspersum maxima* and the European snail *Cornu aspersum aspersum* also confirm the effect of genotype.

CONCLUSIONS

The pilot experiment carried out in snails *Helix aspersa aspersa* demonstrated that the addition of calcium pidolate to the diet of the snails can result in a higher final weight and lower feed consumption. The use of calcium pidolate allows snail breeders to reduce feed costs and improve fattening parameters. However, rearing and breeding technology in Poland require further research including new aspects of the breeding environment.

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WSTĘPNA ANALIZA WYNIKÓW PRODUKCYJNYCH ŚLIMAKA JADALNEGO *HELIX ASPERSA ASPERSA* ŻYWIONEGO MIESZANKĄ PASZOWĄ Z DODATKIEM PIDOLANU WAPNIA

Streszczenie. W ciągu ostatnich dziesięcioleci w krajach europejskich spożycie ślimaków jadalnych z gatunku *Helix aspersa* wykazuje tendencję wzrostową. W latach 90. ubiegłego wieku w Polsce powstały pierwsze fermy ślimaka szarego, a w chwili obecnej krajowa helikultura zajmuje około 10% produkcji europejskiej. W każdym systemie chowu istotne są wskaźniki pozwalające na wyliczenie opłacalności produkcji, a w przypadku ślimaka m.in. współczynnik zużycia paszy czy uzysk (kg) z 1 m². Ostatnie lata wskazują na wzrost zainteresowania organicznymi źródłami mikroelementów jako dodatków do paszy, co skutkuje zwiększeniem produkcyjności i odporności organizmu. Stąd celem pracy były pilotażowe badania wpływu dodatku pidolanu wapnia w mieszance paszowej na wybrane parametry produkcyjne i jakościowe w produkcji ślimaka *Helix aspersa aspersa.* Doświadczenie przeprowadzono na kwaterach parku hodowlanego helikultury. Dwa poletka obsiano rzepikiem. Zwierzęta żywiono paszami Grower i Finiszer złożonymi z pszenicy, kukurydzy, śruty sojowej, otrąb pszennych, oleju sojowego, śruty słonecznikowej, kredy pastewnej oraz mieszanki mineralno-witaminowej. Pasza dla grupy doświadczalnej zawierała dodatek 0,075% pidolanu wapnia. Doświadczenie trwało do czasu uzyskania dojrzałości somatycznej oraz handlowej osobników. Ślimaki w grupie doświadczalnej dojrzały wcześniej i miały większą masę, co przekłada się korzystnie na ilość kilogramów żywca uzyskanych z 1 m² powierzchni hodowlanej. Ponadto w grupie doświadczalnej wykazano wyższy wskaźnik kwalifikacji w I klasie jakości. Ilość zadawanej paszy do momentu zakończenia cyklu była większa w grupie kontrolnej, czego skutkiem może być m.in. wydłużenie tuczu oraz wzrost wskaźnika FCR. Pilotażowe doświadczenie przeprowadzone na ślimakach *Helix aspersa aspersa* dowodzi, że dodatek pidolanu wapnia do paszy dla mięczaków może przyczynić się do uzyskania wyższej masy końcowej i niższego zużycia paszy.

Słowa kluczowe: *Helix aspersa aspersa*, technologia produkcji, pidolan wapnia.