Technological and Economical Considerations for Breeding Terrestrial Snails *Cornu aspersum* (*Helix aspersa* Muller) and *Helix pomatia* as Alternative Animal Protein Source for Human Consumption towards Ecological Protection and Sustainable Development

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Abstract. Farming potential of the most popular edible terrestrial snails, it was investigated within the context of efficient agricultural land use of for maximum animal protein production. The stress induced by climate changes upon the snail’s development is a considering factor, therefore snails are tested for fitness. Sel-Plex™ is used as concentrated forage additive in both 2009 and 2010 experiments involving *Cornu aspersum* (*Helix aspersa* Muller) and *Helix pomatia* edible terrestrial snails. Young snails of 4-7 days were tested for crawling speed as fitness component, an expression of vitality and resistance during prolonged heat waves and drought season. Using proper white led based cold lighting sources and high definition highly sensitive video recording equipment snail’s activity has been recorded. Snails crawling on graded paper allowed for measuring their speed. Seeing thru the snail’s shell due to proper light positioning, heartbeat was counted as well during the crawling. While the heartbeat rate of the snails is relatively high on all snail batches, respectively 97-102 bpm (bits per minute) due to the high temperature, the snails fed with Sel-Plex™ 0.10% have the highest speed, namely 1.5694±0.0504 mm/s followed by the snails fed with Sel-Plex™ 0.04%, averaging 1.4403±0.0323 mm/s respectively. The paper introduces for the first time the concept of “Gain to the Proposed Norm” (GPN), presented as a development indicative, a progress indices towards meeting a predetermined goal target. The yield upon slaughter is a factor that plays a major roll as to recommend *Cornu aspersum* species for farming as opposed to its counterpart *Helix pomatia*.

Keywords: Sel Plex, fitness component, heartbeat rate, crawling speed, economics, gain to the proposed norm

INTRODUCTION

Human’s health start with a proper nutrition as to supply the human body with the right amount of protein averaging 70-100 grams per day as reflected in a FAO/WHO/UNU Technical Report No. 935 (2002). According to Avagnina, (2006), snail farming is a very lucrative agricultural activity given the fact that snail’s meat provides high levels of protein.

Microelements are also important for human nutrition. Selenium (Se) is of a special interest having high antioxidant properties and essentiality to animals and human beings, describes Golubkina and Papazyan, (2006).

Most of European countries suffer of Se deficiency shows Thorling *et al.*, (1986), deficiency that can be responsible for an increased risk of cardiovascular diseases and several forms of cancer (Navarro-Alarcon, Cabrera-Vique, 2008).

The meat of domestic animals is an important source of Se in human diet, reason for witch feeding edible terrestrial snails with an organic form of Se, namely Sel-Plex™, as additive to concentrated forage has been investigated in order to evaluate its effect upon the
growth, survival rate, prolificacy and the bioaccumulation of selenium. Sel-Plex™ it’s a product manufactured and a trademark owned by Alltech, USA, a company that holds the U.S. Patent No. 6,045,834 C1 valid until April 16, 2019 as stated by IPFrontline, (2011).

MATERIALS AND METHODS

A prim part of studies has been carried out during month of September-October 2009 for 38 days in order to observe the behavior, growth pattern and meat quality/chemical composition of the 1-year-old Helix pomatia (local species) as opposed to the 1-year old and 3-month old Cornu aspersum (Helix aspersa Muller). It is important to have knowledge of snail’s development and resistance towards the end of the farming season under the specific climate of Cluj County, Crâiești snail farm, where temperature tend to drop drastically; the data is being presented in Table 1.

Meteorological data recorded during the 38 days experiments, September 3rd –October 11th, 2009

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum</td>
<td>29°C (September 3rd-4th)</td>
</tr>
<tr>
<td>minimum</td>
<td>2°C (October 4th)</td>
</tr>
<tr>
<td>mean</td>
<td>16°C</td>
</tr>
</tbody>
</table>

All snails distributed in four different batches, one control CF-1(C) and three experimental batches CF-2(E), CF-3(E), CF-4(E) populated with 40 snails of each species and age, experiment replicated in tandem using four repetitions, using therefore a total of 16 enclosures, each populated with a total of 120 snails.

A second part of the studies was conducted in Băișoara, Cluj County for 91 days from May 29th to August 29, 2010 in order to observe the behavior, survival rate, prolificacy and growth dynamics of the 9-12 month old Cornu aspersum. Each of the batches BF-1(C), BF-2(E) and BF-3(E) each of the four repetition in tandem consisted of 40 snails each. The summer of 2010 presented very high temperatures and extreme high humidity for long periods as presented in Table 2.

Meteorological data recorded during the 91 days experiments May 29th–August 29th, 2010

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum</td>
<td>34°C (June 11th-13th)</td>
</tr>
<tr>
<td>minimum</td>
<td>9°C (June 2nd)</td>
</tr>
<tr>
<td>mean</td>
<td>21°C</td>
</tr>
</tbody>
</table>

Concentrated forage consisting of 60% wheat flour, 20 % corn flour and 20 % calcium carbonate (CaCo₃) mix it was used to feed all snails. The control batches did not receive Sel-Plex™ while the experimental batches received Sel-Plex™ as it is shown in Tab. 3 for the 2009 experiments and Tab. 5 for the 2010 experiments. Sel-Plex™ contains 2000-2400 mg Se/Kg (97-99% of organic selenium) as indicated in EFSA Journal (2011).

The weight was registered using an electronic scale AWS ScaleMate-501 Digital Pocket Scale 500 x 0.01 grams evaluating the entire snail group at once.

The young offspring snails of 4-7 days old were examined for crawling speed as a fitness component, indicating the eventual differences given by the different feeding regiments under the extreme weather conditions of summer 2010, Table 2.

Using white led based cold lighting and high definition highly sensitive video recording equipment, RICOH CX1 camera, snail’s activity has been recorded. Snails crawling
on graded paper were filmed using 30 fps allowed for measuring their speed. Seeing thru the snail’s shell due to proper light positioning, the heartbeat was observed as well during the crawling. The snails were sacrificed using a novel technique by being exposed to microwaves. The leg of *Helix pomatia* has been detached using a scissor as seen in *Figure 1.*

![Fig. 1. Detaching the leg of *Helix pomatia.*](image)

In the case of *Cornu aspersum*, the entire meat content has been analyzed for chemical composition since all the meat is consumed by humans, whereas in the case of *Helix pomatia* only the leg is being consumed. The biochemical composition of snails’ meat has been determined using the Wendee method. The data was statistically processed using GraphPad 5.03 software.

In order to properly manage natural resources as non-monetary values, agricultural activity has to be bioeconomically efficient, as all human endeavors should be. Snail farming efficiency needs to consider market preferences. As is the case for pigs, being preferred young up to 80-100 kg, not only from the meat’s quality but also from the weight gain efficiency, *Cornu aspersum* snails can reach 14-16 grams each, but the consumers prefer the smaller one in the area of 8-10 grams. For a better growth progress evaluation, snails development is expressed by a novel production criteria named “Gain to the Proposed Norm” (GPN), presented as a development indicative, an indices towards meeting a predetermined goal target. GPN(%)=WG(grams)/{(WPN(grams)-WI(grams)), where WG represents the weight gain, WPN represents the proposed norm weight and WI the initial weight. The complement indices “Remaining Difference to Proposed Norm” (RDPN)(%)=100−GPN.

Product’s gross weight obtained from a unit of land, net meat production based on slaughter yield and its protein content are factors that determine the non-monetary value of snail farming, respectively expressed hereby as protein production per square meter. In the case of *Cornu aspersum* slaughter yield (%) $Y_{sCa}=Wm \times 100/WT$ where for *Helix pomatia* only the leg is being consumed the slaughter yield (%) is obtained by $Y_{shp}=WL \times 100/WT$.

**RESULTS AND DISCUSSION**

The *Cornu aspersum* as imported snail species for the purpose of farming were compared with the local species *Helix pomatia* during 2009 experiments reaching late season when temperature dropped severely. In the presence or not of the additive Sel-Plex™ *Helix pomatia* snails dropped in weight in the control batch as well in the experimental CF-2(E) and CF-3(E) exception being in the case of CF-4(E) were they experience a mean daily increase in weight by a mere 0.004 grams. Under the same conditions, the 1 year old *Cornu aspersum* snails decrease in CF-3(E) and CF-4(E) while registering a 0.145 g/day mean increase in
weight in the presence of Sel-Plex™ 0.02% additive concentration. The 3-month-old Cornu aspersum snails shown the highest weight increase in all batches, topping with 0.950 g/day in the CF-2(E) batch as depicted in Figure 2.

![Graph showing daily weight gain (%)](image)

**Fig. 2.** Comparative performance under experimental feeding conditions for 38 days ending October 11, 2009, using concentrated forage and Sel-Plex™ as additive.

Based on the growth dynamics under the experimental conditions, Cornu aspersum snails were justified to be chemically tested for their meat quality proving to have the best crude protein content of 9.8650% from CF-2(E) batch followed by CF-3(E) with 9.0165% as shown in Table 3.

**Tab. 3**

Meat’s chemical composition of the 1-year-old Cornu aspersum fed with concentrated forage and Sel-Plex™ as additive during the 2009 experiments, Crăiești farm

<table>
<thead>
<tr>
<th>Specification</th>
<th>CF-1 (C) Control batch</th>
<th>CF-2 (E) Sel-Plex 0.02%</th>
<th>CF-3 (E) Sel-Plex 0.04%</th>
<th>CF-4 (E) Sel-Plex 0.10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dry substance (%)</td>
<td>11.8120 ±0.3519</td>
<td>15.9676 ±0.2180</td>
<td>14.2113 ±0.1945</td>
<td>13.2404 ±0.1574</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>8.7376 ±0.1089</td>
<td>9.8650 ±0.1468</td>
<td>9.0165 ±0.1881</td>
<td>8.2114 ±0.2226</td>
</tr>
<tr>
<td>Crude lipids (%)</td>
<td>1.0219 ±0.0365</td>
<td>1.4002 ±0.1290</td>
<td>1.1652 ±0.0476</td>
<td>0.8614 ±0.0620</td>
</tr>
<tr>
<td>Selenium (Se) (ppb)</td>
<td>4.37 ±0.13</td>
<td>13.01 ±0.12</td>
<td>15.08 ±0.31</td>
<td>23.83 ±0.40</td>
</tr>
</tbody>
</table>

The survival rate, or since were counted the snails found can rather be referred to as “the active snail rate”, (some of them could simply be hiding in hibernation in the cracks in the ground), the data appears interesting. Cornu aspersum presented as being almost equally active 71.25%-77.50% in all batches while Helix pomatia from CF-4(E) batch containing concentrated forage with Sel-Plex™ 0.10% additive were found 100% as opposed to 46.88% -10.63% in rest of batches as seen in Table 4.
The survival rate of the 1-year-old *Helix pomatia* and the 1-year-old *Cornu aspersum* (*Helix aspersa* Muller) snails under experimental feeding conditions at the end of the 38 days experiment, October 11, 2009 (%)

<table>
<thead>
<tr>
<th>Specification</th>
<th>CF-1 (C) Control batch</th>
<th>CF-2 (E) Sel-Plex™ 0.02%</th>
<th>CF-3 (E) Sel-Plex™ 0.04%</th>
<th>CF-4 (E) Sel-Plex™ 0.10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helix pomatia</td>
<td>31.88 ±4.27</td>
<td>10.63 ±3.15</td>
<td>46.88 ±2.39</td>
<td>100.00 ±0.00</td>
</tr>
<tr>
<td>Cornu aspersum</td>
<td>77.50 ±4.56</td>
<td>74.38 ±2.39</td>
<td>76.25 ±3.23</td>
<td>71.25 ±4.33</td>
</tr>
</tbody>
</table>

The overall performance of *Cornu aspersum* proved to be superior to *Helix pomatia* snails during the 2009 studies, so the experiments conducted during 2010 summer season became of interest. The best indices were obtained under Sel-Plex™ 0.04% in BF-2(E) as expressed in Table 5 and 6.

The production indices obtained in the 0-91 days interval from the 1-year-old *Cornu aspersum* under experimental feeding conditions with concentrated forage and Sel-Plex™ as additive in Băişoara, 2010 (g)

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(C) Control batch</th>
<th>BF-2(E) Sel-Plex™ 0.04%</th>
<th>BF-3(E) Sel-Plex™ 0.10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>∑x</td>
<td>6.1408</td>
<td>7.7644</td>
<td>6.0228</td>
</tr>
<tr>
<td>Mean</td>
<td>1.5352 ±0.1374</td>
<td>1.9411 ±0.1198</td>
<td>1.5057 ±0.1011</td>
</tr>
<tr>
<td>V%</td>
<td>8.95</td>
<td>6.17</td>
<td>6.72</td>
</tr>
</tbody>
</table>

The individual daily average weight gain evolution for the 1-year-old *Cornu aspersum* under experimental feeding conditions with concentrated forage and Sel-Plex™ as additive in Băişoara, 2010

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(C) Control batch</th>
<th>BF-2(E) Sel-Plex™ 0.04%</th>
<th>BF-3(E) Sel-Plex™ 0.10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily average gain (0-40 days) (g)</td>
<td>0.0081</td>
<td>0.0159</td>
<td>0.0183</td>
</tr>
<tr>
<td>Daily average gain (41-91 days) (g)</td>
<td>0.0237</td>
<td>0.0256</td>
<td>0.0152</td>
</tr>
<tr>
<td>Daily average gain (0-91 days) (g)</td>
<td>0.0169</td>
<td>0.0213</td>
<td>0.0165</td>
</tr>
<tr>
<td>Daily average gain (91 days) (%)</td>
<td>0.2454</td>
<td>0.3190</td>
<td>0.2438</td>
</tr>
</tbody>
</table>

The chemical analysis reflects in Table 7 the increase in lipids content as well selenium (Se) content with the increase in Sel-Plex™ concentration administered while the protein is around 13% in all tree batches.

The difference significations are depicted in Table 8.
Meat’s chemical composition of the 1-year-old *Cornu aspersum* fed with concentrated forage and Sel-Plex™ as additive during the May 29 – August 29, 2010 experiments.

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(C) Control batch</th>
<th>BF-2(E) Sel-Plex™ 0.04%</th>
<th>BF-3(E) Sel-Plex™ 0.10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dry substance (%)</td>
<td>18.3911 ± 0.1446</td>
<td>18.3249 ± 0.0998</td>
<td>19.1032 ± 0.1819</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>13.8655 ± 0.1020</td>
<td>13.6775 ± 0.1294</td>
<td>13.5468 ± 0.0741</td>
</tr>
<tr>
<td>Crude lipids (%)</td>
<td>1.5980 ± 0.0605</td>
<td>1.7984 ± 0.0508</td>
<td>2.3593 ± 0.0448</td>
</tr>
<tr>
<td>Selenium (Se) (ppb)</td>
<td>21.01 ± 0.11</td>
<td>33.57 ± 0.16</td>
<td>49.28 ± 0.50</td>
</tr>
</tbody>
</table>

The signification of meat quality differences obtained under experimental feeding conditions with concentrated forage and Sel-Plex™ as additive from the 1-year-old *Cornu aspersum*.

<table>
<thead>
<tr>
<th>Experimental batches</th>
<th>Median difference</th>
<th>q</th>
<th>P &lt; 0.05?</th>
<th>Signification</th>
<th>95% CI of diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry substance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF-1(C) vs. BF-2(E)</td>
<td>0.06626</td>
<td>1.112</td>
<td>No</td>
<td>ns</td>
<td>-0.1745 to 0.3070</td>
</tr>
<tr>
<td>BF-1(C) vs. BF-3(E)</td>
<td>-0.7121</td>
<td>11.95</td>
<td>Yes</td>
<td>***</td>
<td>-0.9528 to -0.4714</td>
</tr>
<tr>
<td>BF-2(E) vs. BF-3(E)</td>
<td>-0.7784</td>
<td>13.06</td>
<td>Yes</td>
<td>***</td>
<td>-1.019 to -0.5376</td>
</tr>
<tr>
<td>Crude protein</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF-1(C) vs. BF-2(E)</td>
<td>0.188</td>
<td>3.34295</td>
<td>No</td>
<td>ns</td>
<td>-0.0392569 to 0.415256</td>
</tr>
<tr>
<td>BF-1(C) vs. BF-3(E)</td>
<td>0.3187</td>
<td>5.66701</td>
<td>Yes</td>
<td>**</td>
<td>0.0914432 to 0.545956</td>
</tr>
<tr>
<td>BF-2(E) vs. BF-3(E)</td>
<td>0.1307</td>
<td>2.32407</td>
<td>No</td>
<td>ns</td>
<td>-0.0965565 to 0.357957</td>
</tr>
<tr>
<td>Crude lipids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF-1(C) vs. BF-2(E)</td>
<td>-0.2004</td>
<td>8.67253</td>
<td>Yes</td>
<td>***</td>
<td>-0.293777 to -0.107023</td>
</tr>
<tr>
<td>BF-1(C) vs. BF-3(E)</td>
<td>-0.7613</td>
<td>32.9461</td>
<td>Yes</td>
<td>***</td>
<td>-0.854677 to -0.667923</td>
</tr>
<tr>
<td>BF-2(E) vs. BF-3(E)</td>
<td>-0.5609</td>
<td>24.2736</td>
<td>Yes</td>
<td>***</td>
<td>-0.654277 to -0.467523</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF-1(C) vs. BF-2(E)</td>
<td>-12.56</td>
<td>104.286</td>
<td>Yes</td>
<td>***</td>
<td>-13.0467 to -12.0733</td>
</tr>
<tr>
<td>BF-1(C) vs. BF-3(E)</td>
<td>-28.27</td>
<td>234.727</td>
<td>Yes</td>
<td>***</td>
<td>-28.7567 to -27.7833</td>
</tr>
<tr>
<td>BF-2(E) vs. BF-3(E)</td>
<td>-15.71</td>
<td>130.441</td>
<td>Yes</td>
<td>***</td>
<td>-16.1967 to -15.2233</td>
</tr>
</tbody>
</table>

*** Very significant positive differences; ** Distinctive significant positive differences; ns – not significant differences

Under the extreme weather conditions such as prolonged heat waves, the survival rate as seen in Table 9, is the highest, namely 52.50% in BF-2(E) under Sel-Plex™ 0.04% additive.

The survival rate of the 1-year-old *Cornu aspersum* snails under experimental feeding conditions with concentrated forage and Sel-Plex™ as additive, Bâșiorea farm, 2010.

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(C)</th>
<th>BF-2(E)</th>
<th>BF-3(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival rate (%) after 91 days</td>
<td>38.13 ± 3.75</td>
<td>52.50 ± 5.40</td>
<td>38.13 ± 12.25</td>
</tr>
</tbody>
</table>

Prolificacy (Tab. 10) of 330% followed by 300% is also the highest in BF-2(E) and BF-3(E) respectively, under Sel-Plex™ 0.04% and Sel-Plex™ 0.10% additive respectively.
The extreme weather conditions have a powerful negative impact on the vitality and resistance of the young snails, therefore, a fitness test, namely crawling speed was applied as to evaluate the influence of Sel-Plex™ as additive upon the 4-7 days old Cornu aspersum snails.

Tab. 10

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(C)</th>
<th>BF-2(E)</th>
<th>BF-3(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolificacy (%) after 91 days</td>
<td>90.00 ±8.90</td>
<td>330.00 ±9.13</td>
<td>300.00 ±6.12</td>
</tr>
</tbody>
</table>

The best results, 1.5694±0.0504 mm/s, were found in the case of the snails fed with Sel-Plex™ 0.10% followed by 1.4403±0.0323 in the case of the snails fed with Sel-Plex™ 0.04%, Table 11.

Tab. 11

The speed as fitness component indices of the 4-7 days old Cornu aspersum snails at the end of the experiments on concentrated forage and Sel-Plex™ as additive.

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(M)</th>
<th>BF-2(E) Sel-Plex™ 0.04%</th>
<th>BF-3(E) Sel-Plex™ 0.10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snail’s individual average moving speed (mm/s) (n)</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Minim</td>
<td>1.1343</td>
<td>1.3901</td>
<td>1.4627</td>
</tr>
<tr>
<td>Maxim</td>
<td>1.3306</td>
<td>1.5104</td>
<td>1.6344</td>
</tr>
<tr>
<td>(\sum x)</td>
<td>24.4140</td>
<td>28.8060</td>
<td>31.3880</td>
</tr>
<tr>
<td>Mean</td>
<td>1.2207</td>
<td>1.4403</td>
<td>1.5694</td>
</tr>
<tr>
<td>±V%</td>
<td>±0.0393</td>
<td>±0.0323</td>
<td>±0.0504</td>
</tr>
<tr>
<td>The heartbeat rate (HBR) during snail’s moving (bpm) (n)</td>
<td>13</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Minim</td>
<td>97</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Maxim</td>
<td>102</td>
<td>102</td>
<td>102</td>
</tr>
<tr>
<td>(\sum x)</td>
<td>1303</td>
<td>1208</td>
<td>1008</td>
</tr>
<tr>
<td>Mean</td>
<td>100.23</td>
<td>100.67</td>
<td>100.80</td>
</tr>
<tr>
<td>±V%</td>
<td>±1.48</td>
<td>±1.23</td>
<td>±1.23</td>
</tr>
</tbody>
</table>

The heartbeat rate (HBR) means are situated in the area of 100.23-100.80 bpm. The measurements took place under an ambient temperature of 31-32 °C on August 27-28, 2010.

The difference significations as shown in Table 12, indicate the influence of Sel-Plex™ additive upon the strength of the offspring provided by Cornu aspersum parent snails fed with concentrated forage and Sel-Plex™.

The Gain to the Proposed Norm (GPN) indicated 83.89 % realization of the proposed 9 grams norm within the 91 days experiment (Tab. 13). Here is to mention that in normal farming conditions, the fields are populated in April early May, depending upon the status of vegetation, as opposed to May 29th as it’s the case in this experiment. In addition, the snails are left in the field up to September 15-25, enough time to reach a GPN of 100% to 120%.
The signification of the Energetic metabolism indic

differences registered on the 4-7 days old
Cornu aspersum snails at the end of the experiments on concentrated forage and Sel-Plex™ as additive,
August, 2010, Băişoara farm, ANOVA Test–Tukey Test Multiple Comparison Test.

<table>
<thead>
<tr>
<th>Experimental batches</th>
<th>Median difference</th>
<th>q</th>
<th>P &lt; 0.05?</th>
<th>Signification</th>
<th>95% CI of diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snail’s individual average moving speed (mm/s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF-1(C) vs. BF-2(E)</td>
<td>-0.2196</td>
<td>25.995</td>
<td>Yes</td>
<td>***</td>
<td>-0.248752 to -0.190448</td>
</tr>
<tr>
<td>BF-1(C) vs. BF-3(E)</td>
<td>-0.3487</td>
<td>41.2771</td>
<td>Yes</td>
<td>***</td>
<td>-0.377852 to -0.319548</td>
</tr>
<tr>
<td>BF-2(E) vs. BF-3(E)</td>
<td>-0.1291</td>
<td>15.2821</td>
<td>Yes</td>
<td>***</td>
<td>-0.158252 to -0.0999483</td>
</tr>
<tr>
<td>Cardiac rhythm during snail’s moving (bpm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF-1(C) vs. BF-2(E)</td>
<td>-0.4359</td>
<td>1.158</td>
<td>No</td>
<td>ns</td>
<td>-1.745 to 0.8729</td>
</tr>
<tr>
<td>BF-1(C) vs. BF-3(E)</td>
<td>-0.5692</td>
<td>1.439</td>
<td>No</td>
<td>ns</td>
<td>-1.944 to 0.8059</td>
</tr>
<tr>
<td>BF-2(E) vs. BF-3(E)</td>
<td>-0.1333</td>
<td>0.3312</td>
<td>No</td>
<td>ns</td>
<td>-1.533 to 1.266</td>
</tr>
</tbody>
</table>

*** Very significant positive differences; ns – not significant differences

The average individual weight evolution the 1-year-old Cornu aspersum
under experimental feeding conditions with concentrated forage and Sel-Plex™ as additive.

<table>
<thead>
<tr>
<th>Specification</th>
<th>BF-1(C) Mean average initial weight (g) ± standard error</th>
<th>BF-2(E) Sel-Plex™ 0.04% Mean average weight (g) ± standard error</th>
<th>BF-3(E) Sel-Plex™ 0.10% Mean average weight (g) ± standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF-1(C)</td>
<td>6.8750 ± 0.0689</td>
<td>6.6860 ± 0.0267</td>
<td>6.7860 ± 0.0680</td>
</tr>
<tr>
<td>BF-2(E)</td>
<td>7.2005 ± 0.0238</td>
<td>7.3202 ± 0.0687</td>
<td>7.5188 ± 0.0887</td>
</tr>
<tr>
<td>BF-3(E)</td>
<td>8.4102 ± 0.0802</td>
<td>8.6271 ± 0.1040</td>
<td>8.2917 ± 0.0783</td>
</tr>
</tbody>
</table>

Gain to the Proposed Norm (GPN)
| GPN after 40 days (%) | 15.32 | 27.41 | 33.10 |
| GPN after 91 days (%) | 72.24 | 83.89 | 68.01 |

Remaining Difference to Proposed Norm (RDPN)
| RPN after 40 days (%) | 84.68 | 72.59 | 66.90 |
| RPN after 91 days (%) | 27.76 | 16.11 | 31.99 |

Slaughter yield is a very important factor in the determination of economic
efficiency of different snail species. As it can be observed in Tab.14, the slaughter yield of the adult (at consumable age) 1-year-old Cornu aspersum registered Y_{sCa}(%)=75.21±2.61 as opposed to the adult (at consumable age) 2-year-old Helix pomatia Y_{sHlp} (%)=21.36±1.73, at least three times lower than the case of Cornu aspersum snails.

<table>
<thead>
<tr>
<th>2-years-old Helix pomatia</th>
<th>1-year-old Cornu aspersum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Weight Life snails (WT) (g)</td>
<td>Total Weight Life snails (WT) (g)</td>
</tr>
<tr>
<td>Leg’s Weight (WL) (g)</td>
<td>Meat’s Weight (Wm) (g)</td>
</tr>
<tr>
<td>Slaughter yield Y_{sHlp} (%)</td>
<td>Slaughter yield Y_{sCa} (%)</td>
</tr>
<tr>
<td>n</td>
<td>3</td>
</tr>
<tr>
<td>∑x</td>
<td>736.30</td>
</tr>
<tr>
<td>Mean</td>
<td>245.40</td>
</tr>
<tr>
<td>± 20.18</td>
<td>± 7.88</td>
</tr>
<tr>
<td>± 2.61</td>
<td>294</td>
</tr>
</tbody>
</table>
CONCLUSIONS

Edible snails are an excellent vehicle for Se in human nutrition. The selenium content in snail’s meat can be raised by proper snail’s diet using Sel-Plex™. Selenium contributes to resistance to extreme weather conditions, promotes growth, surviving rate and prolificacy. *Helix pomatia* responds positive to Sel-Plex™ as additive in concentrations of 0.10%. *Cornu aspersum* snails respond more dynamically towards the end of snail farming season then *Helix pomatia*. From the economical aspect, *Cornu aspersum* snails have a higher slaughter yield then *Helix pomatia*. The protein content of *Cornu aspersum* snails’ meat is not being influenced by the concentration of Sel-Plex™ in the forage used. The speed as a fitness component of the very young offspring *Cornu aspersum* snails proved to be superior as the parents were fed to higher concentrations of Sel-Plex™. The Gain to the Proposed Norm (GPN) is a more relevant production and development indicator then a growth indicator expressed by weight units such as grams. It indicates the realization of the proposed norm as opposed to the simple weight gain without an included target to reach, target based on market demand, quality of final product and realization efficiency as time, land as capital investment and resource consumption.

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