Effect of Different Humidity Levels On Weights of Reproductive Organs and Growth Traits of *Archachatina Marginata* Snails

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***Abstract*—** The effect of different humidity levels on weight of reproductive organs and growth traits of *Archachatina marginata* snails was investigated. Hundred growing, medium-sized *Archachatina marginata* snails of average mean weight of 280.33 g were allotted to four different humidity (treatment) levels with five replication of five snails per replicate. The four treatments were different humidity levels which include; Low Humidity (No water sprayed), Medium Humidity (water sprayed at 8 am), High Humidity (water sprayed at 8 am and 12 pm) and Very High Humidity (water sprayed at 8 am, 12 pm and 4 pm). Results showed that *Archachatina marginata* snails reared under Low Humidity (LH) recorded the lowest ($P<0.05$) weight of ovotestis, oviduct and retractor penile muscle (RPM), while those under High Humidity (HH) had the highest ($P<0.05$) weight of ovotestis, little hermaphrodite duct (LHD), oviduct and RPM. The highest ($P<0.05$) total eggs laid was recorded for snails under HH compared to those in other humidity levels. *Archachatina marginata* snails reared under LH had the lowest ($P<0.05$) final body weight (FBW), body weight gain (BWG), daily weight gain (DWG) and daily feed intake (DFI). The highest ($P<0.05$) DWG was recorded for *Archachatina marginata* snails reared under HH, although, they are statistically similar ($P>0.05$) to those under Medium Humidity (MH). The FBW and BWG were highest ($P<0.05$) for *Archachatina marginata* snails reared under HH. *Archachatina marginata* snails reared under Very High Humidity (VHH) recorded the highest ($P<0.05$) total feed intake (TFI) and daily feed intake (DFI) compared to those under other Humidity levels. Feed conversion ratio (FCR) was better ($P<0.05$) for *Archachatina marginata* snails reared under HH compared to those under other Humidity levels. It was concluded that *Archachatina marginata* snails reared under High Humidity had a better reproductive activities and growth traits.

Keywords: Eggs, Feed intake, Growth traits, Humidity, Ovotestis, Snail.

Manuscript received November 18, 2022. The authors wish to acknowledge the research office of Cape Peninsula University of Technology, Cape Town, South Africa for their financial support.

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I. Introduction

Micro-livestock have the potential of a good source of animal protein in the diets of humans [1]. Snail is one of the micro-livestock that could serve as cheap source of meat for the human population where snails thrive widely [2]. The high content of iron in snail meat is important in the treatment of anaemia [3]. It has been recommended for the treatment of ulcers, asthma, high blood pressure and other related ailments due to its low cholesterol levels [4], [2]. Orthocalcium phosphate extracted from snails can cure kidney disease, tuberculosis, anaemia, diabetes and asthma [5]. Snail meat is palatable, nutritious, and rich in essential amino acids such as lysine, leucine, isoleucine and phenylalanine [6], [2]. It is therefore important to encourage snail farming (heliculture) in order to conserve this important resource. Farmers are complaining of slow growth and low reproductive performance of the animals during dry season.

Dry season is a period of partial or total limitation or reproductive activities depending on the degree of humidity. At this period (dry period), feed consumption may be affected. The normal breeding time for African giant land snails (*Archachatina marginata*) is usually the raining season which is characterized by high moisture with moderate temperature [7]. Snails are ectothermic organisms that are affected by changes in the local climate, especially high or low humidity which has been reported to affect their physiological functions [8], [9]. Prominent among the key function in snail that is seriously affected is the reproductive activity as well as growth traits [10]. African giant land snails are hermaphrodites and they have some reproductive traits (such as hermaphrodite gland or ovotestis which produces the ova and the spermatozoa) that are affected by different Humidity levels. African giant land snails show a wide variation in egg production from different Humidity [11]. However, studies on different Humidity levels on snails during dry season are needed to boost their reproductive and growth productions, to meet-up with the protein and market demand.

https://doi.org/10.17758/IICBE4.C1122218

II. Materials and Methods

A. Ethical consideration

Ethical principles were taken into consideration during the study to adhere to the national and international standards governing research of this nature with regards to the use of research animals. The permission to use animals was obtained from the Ethical Clearance Committee of Chukwuemeka Odumegwu Ojukwu University Igbariam Campus, Awka, Anambra State, Nigeria.

B. Study site

The experiment was conducted at the snailery unit of the Department of Animal Science, Anambra State University, Awka, Nigeria. Awka lies within latitude 06º 22' North and latitude 07º 24' East. It has an annual rainfall range of 1567.05mm to 1846.98mm. Natural day length is 12 – 13 hours and mean maximum and minimum daily temperatures are 20.99^{oC} and 30.33^{oC}. The study lasted for eight weeks.

C. Experimental diet.

The snails were fed with commercial broiler starter feed supplemented with pawpaw leaf. Feed and water were offered *ad libitum*.

D. Experimental animal and management

A total of 100 growing, medium-sized *Archachatina marginata* snails of the same age with an average mean weight of 280.33 g were used for the study. Twenty five snails were randomly assigned to one of the four different Humidity levels (treatments) using a completely randomized design (CRD). Each treatment was replicated five times with five snails per replicate. The different Humidity levels includes, Low Humidity (No water sprayed), Medium Humidity (water sprayed at 8 am), High Humidity (Water sprayed at 8 am and 12 noon), and Very High Humidity (Water sprayed at 8 am, 12 noon and 4 pm).

E. Growth traits

The growth traits measured are as follows;

Initial and final body weights (g); the measurement was done at the beginning and end of the trial, respectively. Weight variations were determined on a weekly basis.

Average body weight gain (g) = Final body weight – Initial body weight.

$$\text{Daily weight gain (g)} = \frac{\text{Average body weight gain within the period of study}}{\text{Number of days within the period of study}}$$

$$\text{Daily feed intake (g)} = \frac{\text{Feed offered (g)} - \text{Feed refusal (g)}}{\text{Number of Snails in each replicate}}$$

$$\textit{Total feed intake (g)} = \textit{Daily feed intake (g)} \times \textit{Number of days of the trial}$$

$$\text{Feed conversion ratio} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

F. Reproductive parameters measured

To monitor the reproductive traits as affected by different humidity levels, two snails per replicate was dissected at the end of the trail. The following parameters were determined using a sensitive scale, ovotestis, little hermaphrodite duct, penis, oviduct and retracted penile muscle. The snails started laying eggs after three weeks of housing in the boxes and was counted and recorded at the end of the trial.

III. Results

A. Growth traits

All the growth traits were significant ($p<0.05$) except for initial body weight that did not differ ($p>0.05$) and these can be found in Table 1. *Archachatina marginata* snails reared under Low Humidity (LH) had the lowest ($p<0.05$) final body weight (FBW), body weight gain (BWG), daily weight gain (DWG) and daily feed intake (DFI).

TABLE I: Growth traits of *Archachatina marginata* snails reared under different Humidity Level

Treatments	LH	MH	HH	VHH	P-value
Parameters					
IBW (g)	280.86±2.53	279.20±2.94	281.66±2.33	280.80±2.81	1.04
FBW (g)	303.60±2.74^{d}	325.46±2.54^{b}	344.80±2.01^{a}	313.40±2.94^{c}	0.05
BWG (g)	22.74±0.95^{d}	46.26±1.00^{b}	66.14±1.06^{a}	32.60±1.07^{c}	0.01
DWG (g)	0.54±0.00^{c}	1.10±0.01^{ab}	1.50±0.05^{a}	0.78±0.00^{b}	0.05
TFI (g)	78.15±1.41^{b}	83.55±1.31^{b}	80.62±1.30^{b}	90.88±1.34^{a}	0.02
DFI (g)	1.86±0.00^{c}	1.99±0.01^{b}	1.92±0.01^{b}	2.16±0.03^{a}	0.04
FCR (g/g)	3.44±0.20^{a}	1.81±0.04^{c}	1.28±0.01^{d}	2.77±0.19^{b}	0.01

Row means with different superscript (a, b, c and d) differ significantly at $p < 0.05$. LH = Low Humidity, MH = Medium Humidity, HH = High Humidity, VHH = Very High Humidity, IBW = Initial body weight, FBW = Final body weight, TEL = Total Egg Laid.

The highest ($p<0.05$) DWG was recorded for snails reared under High Humidity (HH), although, they are statistically similar to those reared under Medium Humidity (MH). The FBW and BWG were highest ($p<0.05$) for snails reared under HH. Total feed intake (TFI) and DFI were more ($p<0.05$) for *Archachatina marginata* snails reared under Very High Humidity (VHH) while those reared under Low Humidity (LH), Medium Humidity (MH) and High Humidity (HH) were the same ($p>0.05$) for TFI. The feed conversion rate (FCR) was better ($p<0.05$) for *Archachatina marginata* snails reared under HH compared to those reared under different Humidity used in the present study.

B. Reproductive traits

Table 2 showed the weight of ovotestis, little hermaphrodite duct (LHD), oviduct and retractor penile muscle (RPM) were affected ($p<0.05$) among the reproductive traits considered in the present study.

TABLE III: Reproductive traits of *Archachatina marginata* snails reared under different Humidity Level

Treatments	LH	MH	HH	VHH	P-value
Parameters					
Ovotestis (g)	5.66±0.57^{c}	6.33±0.58^{b}	9.66±0.58^{a}	7.00±0.57^{b}	0.04
LHD (g)	2.33±0.11^{b}	2.46±0.11^{b}	3.66±0.11^{a}	2.40±0.11^{b}	0.01
Penis (g)	0.03±0.01	0.04±0.01	0.04±0.01	0.04±0.01	0.07
RPM (g)	0.66±0.57^{c}	1.34±0.57^{b}	2.33±0.57^{a}	1.34±0.57^{b}	0.05
Oviduct (g)	0.21±0.00^{c}	0.70±0.01^{b}	1.20±0.01^{a}	0.62±0.00^{b}	0.02
TEL	48±0.18^{c}	69±0.20^{b}	97±0.24^{a}	53±0.20^{c}	0.01

Row means with different superscript (a, b, c and d) differ significantly at $p < 0.05$. LH = Low Humidity, MH = Medium Humidity, HH = High Humidity, VHH = Very High Humidity, LHD = Little Hermaphrodite duct, RPM = Retractor Penile Muscle, TEL = Total Egg Laid.

Penis weight of the *Archachatina marginata* snails did not differ ($p>0.05$). *Archachatina marginata* snails reared under Low Humidity recorded the lowest ($p<0.05$) weight of ovotestis, oviduct and RPM, while those reared under High Humidity had the highest ($p<0.05$) weight of ovotestis, LHD, oviduct and RPM. The weight of LHD was the same ($p>0.05$) for *Archachatina marginata* snails reared under Low Humidity, Medium Humidity and Very High Humidity. The highest ($p<0.05$) total egg laid was recorded for snails reared under High Humidity compared to those reared in other Humidity levels.

IV. DISCUSSION

A. Growth performance of snail

The growth traits of *Archachatina marginata* snails were affected by different Humidity levels during the dry season. Among all the Humidity (treatment) levels considered in the present study, *Archachatina marginata* snails reared under High Humidity recorded the highest weight gain and a better feed conversion to meat (flesh) ratio compared to other levels of Humidity. This is an indication that at High Humidity environment, snails were able to utilize and convert their diet efficiently into flesh (meat). According to Bloszyk et al. [12] they reported a better weight for Roman snails reared under High Humidity in dry season. It may be that snails reared under High Humidity environment were able to adapt better compared to other Humidity levels used in the present study. There was an increased body weight of Roman snail when there were no adverse conditions or environment [13]. Snails defend itself by falling into hibernation when exposed to unfavourable environmental influence. Due to this defence mechanism, they tend to reduce the impact of harsh environment during dry season which results to loss of weight. Sterbova et al. [14] reported that snails under adverse environment in dry season tend to protect themselves by creating epiphragm and hibernation. Weight loss is a result of unfavourable conditions [15]. Snails reared under Low Humidity during dry season had the lowest weight gain compared to those reared under Medium Humidity, High Humidity and Very High Humidity. Extreme environmental condition, removal from the natural habitat, captivity, overcrowding or a new diet may constitute stress to snails. However, stress on snails has no specific response and one of the response involves avoidance of food which results to weight loss [13].

B. Reproductive traits

In this study, snail reared under High Humidity had the highest egg number compared to those reared under other levels of Humidity. Continuous provision of High Humidity environment for snails during dry season enhanced egg production. This result is not in agreement with the observation made by Adio [16] that Roman snails reared under Very High Humidity during dry season produced the highest number of clutches and laid the highest number of eggs. The present study showed that the weight of different parts of the reproductive organs (except for penis) were higher in *Archachatina marginata* snails reared under High Humidity, which may be attributed to the functional reproductive activities of the snails. The active functional reproductive organs was as a result of the favourable environment enjoyed by the snails under High Humidity [17]. Apart from the weight of penis that do not differ, the weight of ovotestis, little hermaphrodite duct, retractor penile muscle and oviduct were better for snails reared under High Humidity than those reared under other Humidity levels. This showed that snails reared under High Humidity environment during dry season favoured better functioning of different reproductive parts. *Archachatina marginata* snails are hermaphrodites which guaranteed the presence of ovotestis that produces ova and spermatozoa [11]. According to Geoffroy et al. [18], Rakshit et al. [19] and Abiona et al. [20], ovotestis is an organ responsible for both spermatogenesis and oogenesis. Snails reared under High Humidity environment recorded the highest body weight as well as ovotestis weight. This may be attributed to the functioning of the organs (ovotestis) in the formation of egg through the deposition of albumin on egg mass [21], [22]. Ovotestis is the biggest organ of the reproductive organ of *Archachatina marginata* snails and it is situated towards the back of the body. It is also closely interlocked with the digestive system [23]. Ovotestis is made up of individual follicles that may be spaced widely or packed closely and each follicle produces oocystes and sperm [24].

The little hermaphrodite duct recorded the highest weight for snails reared under High Humidity environment compared to those reared under other levels of Humidity used in the present study. This is an indication that High Humidity environment supports the spermatogenesis of the snails [20] than those reared under other different Humidity levels. It was reported that little hermaphrodite duct is one of the reproductive organ that store spermatozoa after formation in the ovotestis [25]. This means that the environment created under High Humidity may be a pointer that High Humidity level is tolerable and

adequate for some physiological activities such as spermatogenesis [26]. The reproductive tract weight reflects the total weight of the complete reproductive tract which is made up of ovotestis, little hermaphrodite duct, albumen gland and other accessory glands [27]. According to Abiona et al. [28], the weight reduction of the reproductive organs of snail signifies a reduction of the reproductive activities which may be due to reduced feed consumption or complete aestivation as a result of unfavourable environment. Little hermaphrodite duct (LHD) is a single tube that emanates from the ovotestis to the fertilization chamber and it is divided into three segments namely; preampullar, ampulla and postampullar [29]. The snail’s own sperm is formed in the ovotestis. The sperm is collected and transferred to the ampulla (the main region of LHD) where it matures and stored before copulation [30]. It is interesting to note that the sperms are inactive until ejaculated into a partner [29]. It is important to note that increased weight of the reproductive organs signifies active reproductive activities which will translate to increased number of eggs laid and subsequent higher hatching percentage [31]. The result of the present study showed that the weight of retractor penile muscle was higher for snails reared under high humidity during dry season compared to those reared under different levels of Humidity. The increased weight showed that the reproductive system activities are active under the environmental condition created by High Humidity during dry season [11]. The retractor penis muscle contracts to retract the penis into the sheath and relaxes to permit the penis to extend from the sheath. There was a higher oviduct weight for snails reared under High Humidity environment during dry season compared to those reared under different Humidity level. The performance may be attributed to a better environment that encourage active reproductive activity fostered by High Humidity. According to Sodipe et al. [11], higher weight of oviduct may be due to the active oviduct functions of the snail. It was reported that oviduct showed an increased development and structural complexity due to its involvement in the complex reproductive process, mainly in the transport, fertilization and higher number of eggs laid [32]. The authors showed that larger dimension of the oviduct is needed for snail species with bigger eggs. The higher weight of snails reared under High Humidity environment explains their increased oviduct (reproductive) weight and higher number of eggs laid [33].

V. CONCLUSION

It can be concluded from the results obtained in the present study that *Archachatina marginata* snails reared under High Humidity environment had a better active functional reproductive system that resulted in higher number of eggs laid. Again, they also recorded a higher body weight gain compared to those reared under other Humidity levels used in the study.

ACKNOWLEDGMENT

Many thanks to the Department of Animal Science, Chukwuemeka Odumegwu Ojukwu University Igbariam Campus, PMB 6059, Awka, Anambra State, Nigeria. Again, the authors wish to acknowledge Cape Peninsula University of Technology, Wellington Campus, South Africa for their support.

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