Influence of Different Management Systems on Gut Microbes and Chemical Constituents of Giant Land Snail (*Archachatina marginata*)

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Abstract

The impact of management systems on the African giant land snail, Archachatina marginata found in Abeokuta, Nigeria was investigated. The gut microbial load, haemolymph biochemical values (proteins, lipids, glucose, Na^+, Ca^{2+},K^+, CL^- PO_4^{2+}) and proximate composition (crude protein, fat, fibre, ash and carbohydrates) of the flesh were determined in these snails. There were significantly ($p<0.05$) higher colony forming units (cfu) in the gut of snails from the wild (5-24 $x10^3$) than the domesticated snails (3-13 $x10^3$). The haemolymph biochemical values and flesh proximate composition were significantly higher in the snails from the wild than the domesticated ones. However, antinutrients and mineral composition of the flesh were not significantly affected by the management systems. The implication of these results on snail meat value in Nigeria is discussed.

Key words: *Archachatina marginata*, management systems, heliculture, gut microbes

Introduction

The numerous benefits of African giant land snails, *Archachatina marginata,* have been enumerated in the past (Orisawuyi, 1989 and Akinnusi, 2002). Snail has a high nutritive value and forms part of diets of both urban and rural dwellers (Udoh *et al.,* 1995 and Ademolu *et al.,* 2007). Its medical importance and ability to cure diseases was highlighted by Amusan and Omidiji (1999). The presence of vital ions like Ca^{2+}, Na^+, PO_4^{2+}, CL^- and other metabolites in its haemolymph might be responsible for its m medicinal use. (Ogunsanmi *et al.,* 2003 and Ejidike, 2002).

Due to these and other benefits of snails, there has been an increase in its demand over the years and this has made its rearing and domestication inevitable,as collections from the wild do no longer meet up with demand. In addition, bush burning, deforestation and indiscriminate hunting have over the years destroyed the habitat of these snails species thereby reducing their population.

Heliculture is the practice of rearing and raising snails in captivity for human consumption and it involves the provision of physical conditions required for feeding, growth and reproduction. In captivity or intensive system, snails are reared in various housing units: basket, old tyres, drums, pots, pen and cages. However, conditions in captivity do not always mimic perfectly those in the wild which may result in slow growth rate, immortality and non-reproduction (Odaibo, 1997). Similarly, lack of suitable space and over crowding are common factors associated with intensive snails rearing (Amusan and Omidiji, 1998).

Over stocking had been reported to affect

the growth and sexual development of snails (Orisawuyi, 1989) and survival (Agbelusi and Adekugbe, 1999). However, Ademolu *et al.* (2006) observed that stocking density influences the growth performance and haemolyph biochemical value of *A. marginata*. Hence, as snail domestication is now gaining popularity in Nigeria there is need to access how well the conditions in captivity mimic those in the wild where the snails were originally residing. This study thus set out to examine the impact of management systems on African giant land snail; *A. marginata*

Materials and methods

Snail samples

Eighty (80) individual snails (average weight 115.4± 0.4g) were used for this study. Forty (40) individual snails were collected from the forest near Osiele village Abeokuta, Nigeria. The remaining forty snails were acquired from the Snail Pen of the Department of Forestry and Wildlife Management at University of Agriculture, Abeokuta, Nigeria (temperature of 28-31^{0}C and relative humidity of 64-70%) . At the pen, the snails were maintained from hatchling to adult stage on maize (*Zea mays*) chaff and pawpaw (*Carica papaya*) leaves. These feeds and water were given daily to the snails *ad libitum* between 6pm and 7pm.

Haemolymph collection

The haemolymph was collected by breaking the shell at the apex and haemolymph oozing out was collected into labeled heparinised bottles as described earlier by Ademolu *et al.,* (2006).

Chemical analysis of the haemolymph

The protein content of the haemolymph was determined by Biuret method (Henry *et al.,* 1974), while the Glucose content was estimated by Calorimetry method (Baumniger, 1974). The lipids content were measured by the method of Grant (1987). The ionic contents of the haemolyph (Na^+, K^+, Ca^{2+}, PO_4^{2+} and CL^-) were determined using the standard method of A.O.A.C. (1990).

Proximate composition of the flesh

The crude protein, crude fibre, ash, fat content and moisture content of the flesh of snails from the two locations were analyzed by the method of A.O.A.C (1990).

Total oxalate was determined by the method of Dye (1956), Hydrocyanic acid was analysed by alkaline titration method (Hotwitz,1980), while Tannic acid was determine by Colorimetry method by Burns (1971). All analyses were done in triplicates.

Microbiological techniques

Preparation of the gut contents

Dissection of the snails was done as described by Segun (1975). The alimentary canal was neatly separated from the common hermaphroditic duct and totally removed using flamed forceps and scissors. The isolated alimentary canal was then cut into various sections: oesophagous, crop, stomach and intestine. These sections were then opened to expose the content of each section which was later emptied into separate labeled sterilized Petri dishes.

The bacteria enumeration and identification were done by method of Sneath *et al.,* (1986).Identification of fungi was done by Bernett and Hunter (1972) techniques.

Statistical analysis

All data collected from the above experiments were analyzed using One Way Analysis of Variance (ANOVA) with the Minitab (1998) computer package and where significant difference existed, means were separated by Student Newmen-Keuls (SNK) test.

Table 1: The microorganisms (bacteria/ fungi) load (cfu x10^3) of the *Archachatina marginata* gut under different management systems

	Bacteria load		Fungi load	
Gut regions	Domesticated	Wild	Domesticated	Wild
Stomach	13.00	6.00	4.00	6.00
Crop	3.00	5.00	9.00	17.00
Oesophagus	10.00	24.00	14.00	4.00
Intestine	7.00	12.00	9.00	6.00

Results

The colony forming units (cfu) of the microorganisms (bacteria and fungi) in the guts of *A .marginata* are shown in Table 1. There were more cfu in the gut of the snails from the wild than the domesticated ones (except in the stomach) for bacteria and oesophagous and intestine for fungi. The stomach and oesophagus recorded the highest cfu value for bacteria and fungi respectively in domesticated
snails while the oesophagous and crop had the highest cfu values for bacteria and fungi in the respectively in the snails from the wild.

The organisms isolated from the gut regions making up the microbial flora of the snails are shown in Table 2. *Aspergillus flavus* and *streptococcus spp* were the most abundant organisms in the gut regions.

The result of the haemolymph chemical analysis is shown in Table 3. There were significant difference ($P<0.05$) in the concentrations of the haemolymph metabolites across the two locations. The haemolymph of the snails collected from

Table 2: Organisms isolated from the gut regions of *Archachatina marginata* under different management systems

Gut/system	Domesticated	Wild
Oesophagus	*Streptococcus sp* *Neisseria sp* *Aspergillus flavus*	*Streptococcus sp* *Staphylococcus aureus* *Neisseria sp* *Aspergillus flavus*
Crop	*Streptococcus sp* *Aspergillus flavus*	*Streptococcus sp* *Aspergillus flavus*
Stomach	*Neisseria sp* *Streptococcus spp* *Rhizopus oligosporus*	*Neisseria sp* *Streptococcus spp* *Rhizopus oligosporus*
Intestine	*Aspergillus niger* *Aspergillus flavus* *Staphylococcus aureus*	*Aspergillus niger* *Aspergillus flavus* *Staphylococcus aureus* *Streptococcus sp*

Table 3: The haemolymph biochemical values (mg/dl) of *Archachatina marginata* under different management systems

	Domesticated	Wild	SEM
Glucose	23.50[b]	26.80[a]	1.01
Total protein	27.90[b]	36.00[a]	0.96
Lipids	10.20	10.40	0.23
Ca^{2+}	1.80	1.90	0.16
PO_4^{2-}	2.40	2.50	0.54
Na^+	49.00[b]	60.00[a]	0.01
K^+	2.80	3.10	0.26
Cl^-	20.00[b]	25.00[a]	0.11

Mean values in the same row having different superscript are significantly ($p<0.05$) different

the wild recorded significantly higher values in glucose, total protein, Na^+ and Cl^- than the domesticated snails. (26.80mg/dl, 36.00g/l, 60.00mg/ml and 25.00mg/ml respectively)

The proximate composition of the flesh of domesticated snails and those collected from wild is shown on Table 4. Snails gathered from the wild had a significantly higher ($P<0.05$) total protein, ash and fat content than their domesticated counterpart (21.01%, 1.75%, 2.71% respectively).

The anti-nutrients analysis of the flesh of snails from the two management systems as shown in Table 5 revealed no significant difference ($P>0.05$) in these parameters.

Table 6 showed the result of mineral analysis of the flesh of experimental snails. No significant difference ($P>0.05$) was observed in the values from the two management systems.

Discussion

The result of the colony forming units (cfu) of the gut regions of the snail from the two rearing systems revealed that the gut of the wild snails harbored more microbes or had more microbial load than the domesticated ones. The presence of microbes in the gut is actually traceable to the food consumed by the snails (Yoloye 1974 and Adedire *et al.,* 1999), the gut microbial load was higher in the wild snails than those snails in captivity that were fed formulated/restricted diet or ration. This higher cfu in the snails from the wild means better utilization of food and

Table 4: The Proximate Composition of the flesh of *Archachatina marginata* (%) under different management systems

	Domesticated	Wild	SEM
Moisture content	81.29[a]	72.89[b]	0.01
Fat content	1.56[b]	2.71[a]	0.20
Ash	1.53[b]	1.75[a]	1.02
Crude fibre	0.25	0.29	0.05
Crude protein	14.78[b]	21.01[a]	0.23
Carbohydrates	0.79	1.32	0.17

Mean values in the same row having different superscript are significantly ($p<0.05$) different

Table 5: Anti nutrients content (mg/100g) of the flesh of *Archachatina marginata* under different management systems

Antinutrients	Domesticated	Wild	SEM
Total oxalate	0.45	0.44	0.43
Hydrocyanic acid	0.05	0.05	0.12
Tanic acid	1.38	1.42	0..09
Phytic acid	2.45	2.41	0.11

better growth performance than those in captivity as the microbes aid digestion of the food plants (Idowu *et al.,*2008)

The crop and oesophagous had the highest number of organisms. This corroborates well with the report of Idowu *et al.,* (2008) where most organisms were isolated from the oesophagus of *A. marginata.*

The species isolated from the gut regions in this study are similar to those found in the gut regions of *A. marginata* by Idowu e*t al.,* (2008). The presence of *Streptococcus sp* in the gut of snails from both the wild and captivity reflects the nature of their foods. Snails feed on decaying plant materials which will support the growth of microorganisms (Yoloye, 1974).

Snails cannot synthesize cellulose, thus the microbes live symbiotically in their gut and assist in the production of cellulase that digest cellulosaic food plants. However, unlike the findings of Adedire *et al.,* (1999), fungi were isolated from the gut of the experimental snails which are in agreement with the findings of Idowu *et al.,* (2008) where fungi like *A. niger, A. flavus* and Rhizopus were isolated from the gut of *A. marginata.*

There was a significant difference ($P<0.05$) in the concentrations of glucose, protein, Na^+ and Cl^- in the haemolymph of the snails from the two management systems. Snails from the wild had significantly higher values/concentrations than those in captivity. Similar observation was noted for the proximate composition of the flesh inthis study. This observation agrees with the findings of Ademolu *et al.,* (2007) and Akinloye and Olorode (2000) that the haemolymph reflects the physiological conditions in the flesh of snails

Snails in the wild had access to varieties of feeds (leaves, fruits, seeds and earthworms) which contribute to their better development. Ademolu *et al.,* (2007) had earlier observed that feed types had a significant effect in the nutritional value of *A. marginata.* Also, snails fed with different food plants had earlier been observed to

Table 6: Mineral content (mg/100g) of the flesh of *Archachatina marginata* under different management systems

Mineral	Domesticated	Wild	SEM
Na^+	1.26	1.72	0.06
K^+	4.02	4.16	0.03
Mg^{2+}	1.42	1.35	0.15
Zn^{2+}	0.06	0.06	0.22
Fe^{2+}	0.19	0.19	0.10
Ca^{2+}	2.05	2.02	0.33

have better growth performance (Omole *et al.,* 1999) than those on sole/single diet.

Lack of adequate space in captivity might likewise contribute to this lower concentration of metabolites as space had earlier been reported to be one of the limitations of snail domestication (Odaibo, 1997; Amusan and Omidiji, 1999). Stocking density affects the reproductive performance and haemolymph biochemical value of *A. marginata* (Ademolu, *et al.,* 2006 and Akegbejo-Samson and Akinnusi 2000).

Na^+ and Cl^- are the most abundant ions in the haemolymph of snails from both management systems. This is in conformity with the findings of South (1992).The higher concentrations of Na^+ K^+ and PO_4^{2+} in the haemolymph of snail from the wild is of physiological importance. Na^+ and K^+ are needed for nervous communication (Ademolu *et al.,* 2009). The higher concentration of these ions implies a higher activity of the snails from the wild due to large space to explore unlike those confined to limited space in captivity. Furthermore, snails (*A. marginata)* that lived in larger space had earlier been observed to have higher haemolymph biochemical value (Ademolu *et al.,* 2006) than those reared in small compartment.

There was no significant difference ($P>0.05$) in the mineral and antinutrients composition of the flesh of snail from the two locations. This implies that snails from these two management systems are safe for consumption as earlier noticed by Udoh *et al.,* (1995).

Conclusion

Management system of rearing had a profound impact on the chemical and bacterial composition of Giant African land snails. However, the meat of snails from both captivity and the wild are good and safe sources of nutrients as its antinutrients concentrations are far below the lethal dose for man (the lethal dosages of oxalate and HCN are 2 - 5g and 0.5mg-3.5mg/kg respectively).

Acknowledgement

The authors acknowledged with thanks Mrs. Olanloye, O for the identification of the microorganisms, Mr. Amusan, T.O and Bankole, S.O for rendering technical assistance in the chemical analysis.

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Received: 9th January, 2011
Accepted: 23rd march, 2012