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PROXIMATE COMPOSITION OF SELECTED FEEDSTUFFS AND THEIR PREFERENCE BY GROWING GIANT AFRICAN LAND SNAIL, *ARCHACHATINA MARGINATA*

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ABSTRACT

The chemical composition and preference of selected feedstuffs by giant African land snail (GALS) were investigated for a period of 14 days. Growing GALS (n=240) weighing 60±5g were sourced from the local market and randomly allotted to six experimental cubicles (40 snails/unit). Each experimental cubicle measured 1.25m×1.0m×0.74m. Using a cafeteria feeding system, 100g of each feedstuff; Maize Chaff (MCh), Pawpaw Leaf (PL), Pumpkin Leaf (PuL), Pawpaw Fruit (PF), Moringa Leaf (ML) and Formulated Feed (FF) containing 24% crude protein and 3200 kcal/kg ME were positioned semi-circularly away from the GALS in the cubicle between 17:00 and 19:00 hours and alternated daily. Feeding responses (number of visits/feed) were monitored using CCTV. Feed Intake (FI, g) and Co-efficient of Preference (CoP) were calculated. Results indicated that the crude protein of 33.15% (ML) and 32.31% (PL) were similar and significantly higher than 4.22% (MCh) which was the lowest. Crude fibre ranged from 4.26% in FF to 37.43% in PF while ether extract was significantly higher ($p<0.05$) in FF (4.51%) and least in MCh (1.55%). The GALS visitations to PF (398±12.5) were highest, followed by MCh (376±8.8) and least for PL (89±8.4). The FI of GALS on MCh (38.5), PF (15.3) and FF (5.12) were significantly higher ($p<0.05$) than in PuL (1.59), PL (1.57) and ML (1.32). Only GALS on MCh (3.64) and PF (1.45) had CoP above unity. Maize chaff and pawpaw fruit were most preferred by the GALS. This preference in this study was adduced to higher crude fibre and lower fat content.

Keywords: Cafeteria feeding system, Coefficient-of-Preference, Crude fibre, Crude protein, Feed Intake

INTRODUCTION

More focus is now on wildlife domestication and farming as a source of food supply and alternative means of generating income wherein snail has been considered suitable for this purpose (Aiyeloja and Ogunjimi, 2010). There are different species of edible land snail but the most cultured in Nigeria is *Archachatina marginata* because of its high adaptability and livability compared with other species of snail. This species tastes better and has been found to be species of commercial importance because of its high market value (Hatziioannou *et al.*, 2014).

The conventional feeds of snails are mainly of plant origin and are therefore, classified as vegetarians (Cobbinah *et al.*, 2008). Snails like other livestock, such as camels (Farid *et al.*, 2010) and cattle (Amole *et al.*, 2013) have innate ability to source and choose feed in the environment to achieve appreciable weight gains. Lameed (2006) reported on responses of snailets of GALs to different food items under captivity while Omole *et al.* (2007), showed that

snails preferred juicy leaves and vegetables to dry ones. Ogbu *et al.* (2014), observed that the preference of the two species of GALs (*Archatina archatina* and *Archachatina marginata*) under free choice feeding differed significantly based on feed selection. Feed selection being a function of the attractiveness measured by choice test and palatability are quantified by intake. However, information on the nutrient composition of the preferred feeds of GALs is scanty. Therefore, the nutrient compositions of selected feedstuffs fed to GALs were investigated.

MATERIALS AND METHODS

Location of the study

The study was carried out at the Snailery Unit, Wildlife Domestication Centre, Department of Wildlife and Ecotourism Management, Faculty of Renewable Natural Resources, University of Ibadan. Ibadan is located in south western Nigeria, 128km inland north-east of Lagos and 530km south-west of Abuja. It has a tropical wet and dry climate with a lengthy west season and relatively constant temperatures throughout the year. Ibadan wet season runs from March through October, with a break in August which nearly divides the wet season into two. November to February forms the city's dry season, during which Ibadan experiences the typical West African harmattan. The mean total rainfall is 1,420 mm falling in approximately 109 days with two peaks for rainfall, June and September. The mean maximum temperature is 26.5ºC, minimum 21.4ºCand relative humidity is 74.6%. The study area is located between Latitude 7º26′55″N to Latitude 7º26′56″Nand Longitude 3º53′48″E to longitude 3º53′52″E, covers total area of 126.34m^2 within University of Ibadan.

Site Preparation

Six experimental cubicles with the dimension 1.25m × 1.0m × 0.74m raised above the ground, outside walls and inner partitions consist of sandcrete blocks, covered with aluminium lids with chicken wire plus nylon mesh to prevent predators and protected with padlocks to discourage intruders. The cage area was roofed with Adex roofing sheet to shield the snails from the direct scorching effect of the sun and penetration of light into the cage. One camera (SPY03-CVBS 800TVL) per cage was installed and connected to the eight channel dvr machine of the CCTV to record the activity of the snail and saved in the hard disk of the machine. Lighting was provided by the small size 15watts energy saver cool daylight bulb to provide light from the rear of the camera in each of the experimental units. These bulbs were covered with a cut Swepp plastic bottle to provide an intensity equivalent to an overcast day in the night (Riley and Wratten, 1994). The cages were filled up with the humus collected to a depth of 10cm (4 inches), the soil was treated with garlic solution and left for a week to drive away insects that could likely prey on the snail. The soil was thereafter wetted to prepare the cages for stocking.

Experimental Feeds

Six commonly available GALS feedstuffs namely; Maize Chaff (MCh); Pawpaw Leaf (PL); Pumpkin Leaf (PuL); Pawpaw Fruit (PF); Moringa Leaf (ML) and Formulated Feed (FF; 24% crude protein and 3200 kcal/kg ME) were selected for the study. Details of the formulated feed are shown in Table 1 below.

Table 1: Gross composition (g/100gDM) of formulated feed

Ingredients	%Composition
Fish meal	4.00
Soybean meal	39.65
Ground maize	29.00
Guinea corn	18.50
Soya oil	5.00
Oyster shell	1.50
Bone meal	2.00
Premix (grower)	0.25
Salt	0.10
Total	**100.00**
Calculated analysis	
Crude protein	24.47
Crude fibre	3.57
Ether extract	3.28
ME (kcal/kg)	3209.81
Cost/kg of feed (N)	209.40

Premix composition per kg of diet: Vitamin A- 3,000,000i.u, Vitamin D_3 – 400,000i.u, Vitamin E-720mg, Vitamin K- 280mg, Vitamin B_1 - 200mg, Vitamin B_2- 720mg,Vitamin B_6 – 72mg, Vitamin B_{12} – 2mg, Pantothenic acid -1280mg , Folic acid -20mg, Choline Chloride – 25200mg, Nicotic acid – 1600mg, Manganese – 14,000mg, Copper – 600mg, Iron -4000mg , Iodine – 288mg, Zinc – 6000mg, Cobalt- 72mg

Experimental Animal and Management

Growing snails (n=240) weighing 60±5g were sourced and randomly allocated to six experimental units. Forty snails were stocked per unit and allowed to acclimatize for one week before the commencement of the feeding trial. An alphanumeric system was used to identify the snail in each experimental unit, this consisted of a number assigned chronologically followed by a letter indicating the experimental unit according to Rees (2015). This identification was written on the snail shell with glossy paint. Each feedstuff (100g) was positioned semi-circularly in a cafeteria feeding system away from the GALS in the experimental cubicle between 17:00 and 19:00 hours daily for 14 days. The arrangement of each feed material was alternated daily to avoid positional effect and bias for the feed of choice. Daily feeding responses of GALS were monitored using CCTV. Number of visits per feed was extracted from the video records, feed leftover were measured to determine feed Intake (FI, g) and Co-efficient of Preference (CoP).

Feed Intake (g) = Feed given (g) – Feed leftover (g)

Determination of Coefficient of Preference

CoP = Intake of Individual feed offered

Mean Intake of all the feed offered

Therefore,

If CoP < 1, feed not acceptable

If CoP $\geq$ 1, feed well accepted

Chemical analyses

The experimental feeds were assayed for chemical composition according to AOAC (2005) methods.

Statistical Analysis

Data were subjected to descriptive statistics and analysis of variance (SPSS 23.0). The means were separated using Tukey multiple mean comparison test at $\alpha_{0.05.}$

RESULTS AND DISCUSSION

The chemical composition of the feeds and feedstuffs offered to experimental snails are shown in Table 2. Crude protein of 33.15% (ML) and 32.31% (PL) were similar ($p>0.05$) and significantly higher ($p<0.05$) than 4.22% (MCh) which was least. Crude fibre ranged from 4.26% in FF to 37.43% in PF. Ether extract was highest in FF (4.51%) and least in MCh (1.55%) while ash content varied from 3.11% in MCh to 48.14% in PL.

Crude protein could be an indication of the quantity of amino acids in the feedstuffs. The amino acids are required daily for growth and optimum performance of snail. The consumption of pawpaw leaf and moringa leaf in this study provided relatively the similar concentration of amino acid to snails. Earlier reports showed crude protein of 30.29% in *Moringa oleifera* (Moyo *et al.*, 2011), 27.5% in pawpaw leaf (Dev and Iqbal, 2015), 31.19% in pumpkin leaf and 3.65% in maize chaff (Iyaka *et al.*, 2014). Ani *et al.* (2013) reported a range of 18-24% crude protein in the formulated feed.

The crude fibre content is the indigestible fraction of the feed which aids digestion and motility of alimentary canal (Ademolu *et al*., 2004). Crude fibre also helps in lowering the body cholesterol level (Iyaka *et al.*, 2014), reduce absorption of cholesterol and starch, aids absorption of minor element (Lawal *et al.*, 2014). Iyaka *et al.* (2014) reported 9.44% crude fibre in moringa leaf, 20% in maize chaff (Lawal *et al.*, 2014) and 2.55% in pumpkin leaf (Emelue and Dododawa, 2017).

Ether extracts are important source of stored energy, which can also be utilized by the animal for body maintenance and production (McDonald *et al.*, 2010). Ether extract content of the feeds compared favourably with reported 2.43% in *Moringa oleifera* leaf (Sodamade *et al.*, 2013) and 2.0% in pumpkin leaf (Mohd *et al.*, 2016) except for formulated feed (4.5%) but still lower than a reported range of 5-6.15% (Lameed, 2006). This is moderate and good for consumption by the snails without any health implication.

Ash is a measure of inorganic mineral present in a feed (Lawal *et al.*, 2014). The ash content of the feedstuffs varied from values in literature; 6.27% level reported for maize chaff (Lawal *et al.*, 2014), 10.8% in pawpaw leaf (Dev and Iqbal, 2015) and 9.0% in formulated feed (Ejidike, 2016). The ash content of 1.5% in pumpkin leaf (Orhuamen *et al*., 2012), 2.56% in pawpaw fruit (Lameed, 2006) and moringa leaf (6.0%) reported by Sodamade *et al*. (2013). Thus, the feedstuffs contained the needed minerals for animal growth.

Table 2: Chemical composition of experimental feedstuffs and feeds (%DM) fed to snails

Parameters	MCh	PL	FF	PuL	PF	ML	SEM
DM	71.23^{b}	14.95^{d}	91.06^{a}	13.19^{e}	26.08^{c}	11.27^{f}	9.47
CP	4.22^{d}	32.31^{a}	25.99^{c}	29.09^{b}	26.21^{c}	33.15^{a}	2.94
EE	1.55^{d}	2.41^{b}	4.51^{a}	2.20^{bc}	1.80^{cd}	2.49^{b}	1.85
CF	11.28^{d}	14.48^{c}	4.26^{e}	17.86^{b}	37.43^{a}	17.71^{b}	10.4
Ash	3.11^{f}	48.14^{a}	7.82^{e}	24.01^{c}	19.56^{d}	32.57^{b}	12.5

Means along the same row with different superscripts are significantly different ($p<0.05$)
MCh-Maize chaff; PL - Pawpaw leaf; FF - Formulated feed; PuL - Pumpkin leaf; PF -Pawpaw fruit; ML - Moringa leaf; DM – Dry matter; CP – Crude protein; EE – Ether extract; CF – Crude fibre; SEM- standard error of the mean

Feeding responses of giant African land snails
The daily visits of fed snails per experimental units are presented in Figure 1. A range of 12-24 snails fed daily except for days 6, 12, and 14. However, an average of 18 snails fed daily in each experimental cubicle throughout the study. This indicated that not all the snails fed daily. The number of snail visit to the different feeds over a 14-day period is presented in Figure 2. The snail visit was highest for PF (398±12.5), MCh (376±8.8), and FF (300±13.0) than PuL (117±4.32), ML (94±4.62) and least in PL (89±8.37). These results revealed the degree of preference by the snail which could be related to factors which controlled feed intake; such as physical characteristics of the ingredients, chemical composition of the feeds, positioning of the feeding trough and previous experience (McDonald *et al.*, 2010).

The physical characteristics such as particle size, feed preparatory method and the bulk density of the feed have been shown to affect intake. The particle size of feed determines the acceptability of the feed; the smaller/finer the particle size, the better the intake by the snails (Omole *et al.*, 2004).

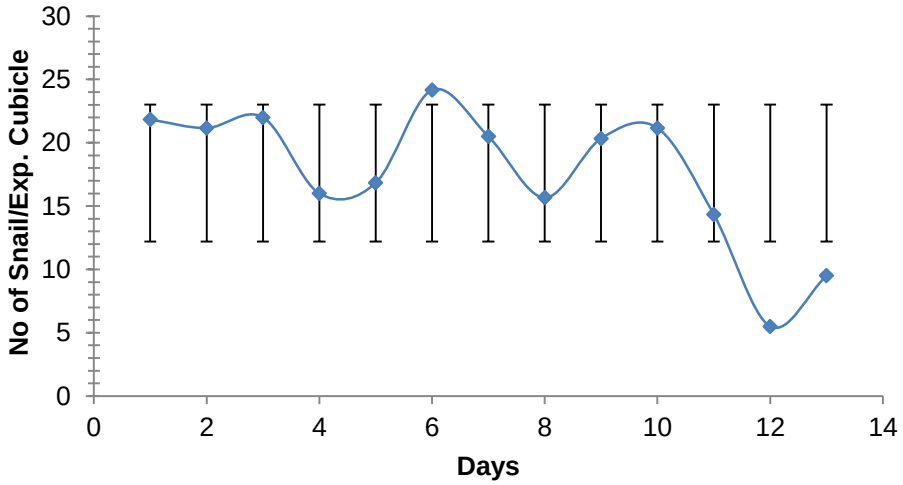


Figure 1: Daily visit of Snail per experimental cubicle
Means and Standard deviation for 6 independent sets of result, Population mean μ=18 (marked by the dotted line)

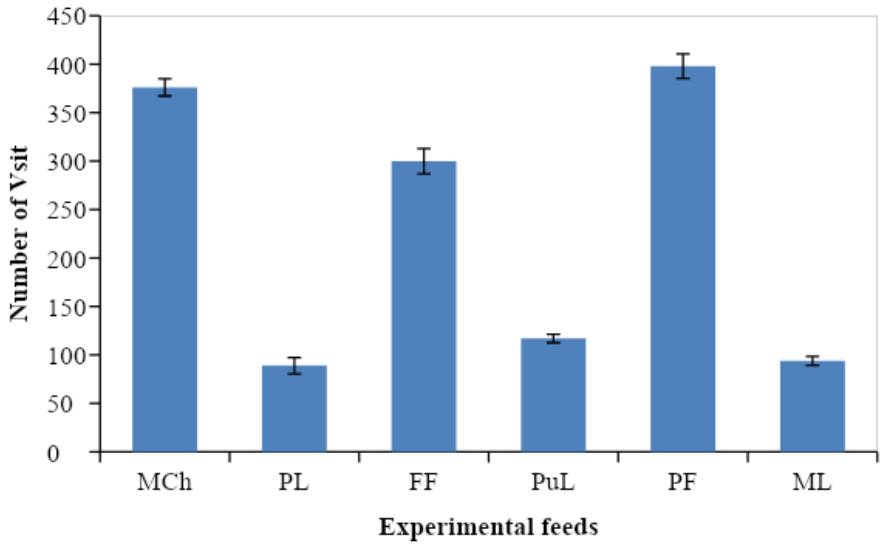


Figure 2: Feeding response of the snail over 14-day period
MCh – Maize chaff; PL – Pawpaw leaf; FF – Formulated feed; PuL – Pumpkin leaf; PF – Pawpaw fruit; ML – Moringa leaf

The methods of preparing the feed could affect feed intake. Dusty feed causes irritation of the sensory organs, and the roles played by the sensory organs cannot be overlooked during feed selection. These sensory cues influence whether or not a feed will be ingested by the animal (Forbes, 2007). Taste, as one of the oropharyngeal receptors used by domestic animals in feed selection, allows for the sensing of nutrients and harmful substances in order to guide selection of nutritious foods and avoid toxins. McDonald *et al*. (2010), surmised that young pigs had preference for sucrose solution rather than ordinary water because of the taste. Food texture equally has an additional signal in characterising a feed. Animals cease eating any food that requires more pressure and longer time to chew because this can lead to jaw fatigue. As such, snail preferred feeds or feedstuff that will not cause injury to their radula (Omole *et al*., 2007).

The chemical compositions of the feeds also influence preference. The pawpaw fruit and maize chaff had higher crude fibre and lower fat content. Crude fibre aids the digestion and motility of alimentary canal (Ademolu *et al.*, 2004), absorption of minor elements and reduced absorption of cholesterol and starch (Lawal *et al.*, 2014).

The effect of time of the day on the number of feeding snails per experimental feeds is presented in Figure 3 while in Figure 4, the number of feeding snails at the different time of the day were summarised. The snails were observed to be feeding mostly on all the feed types within 20:00 and 21:00 hours daily, except for Pawpaw leaf and Pumpkin leaf. However, highest number of snails fed within 20:00 and 21:00 hour of the day and gradual decrease in number as the daybreak (Figure 4). This observation conforms to the report of Ogbu *et al*. (2014) on *A. marginata* with peak feeding period within 20.30 and 21.30 hour of the day.

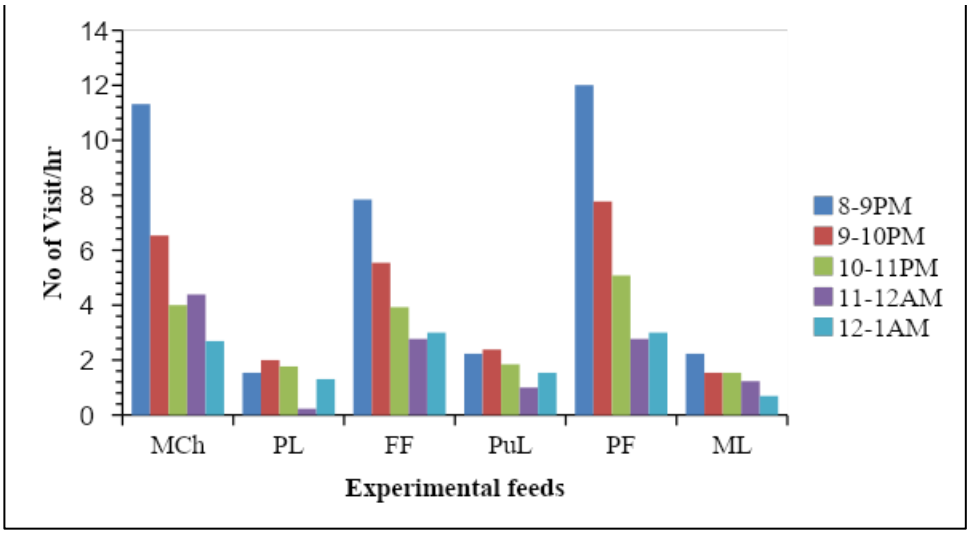


Figure 3: Period of feeding per feed types
MCh – Maize chaff; PL – Pawpaw leaf; FF – Formulated feed.
PuL – Pumpkinleaf; PF – Pawpaw fruit; ML – Moringa leaf

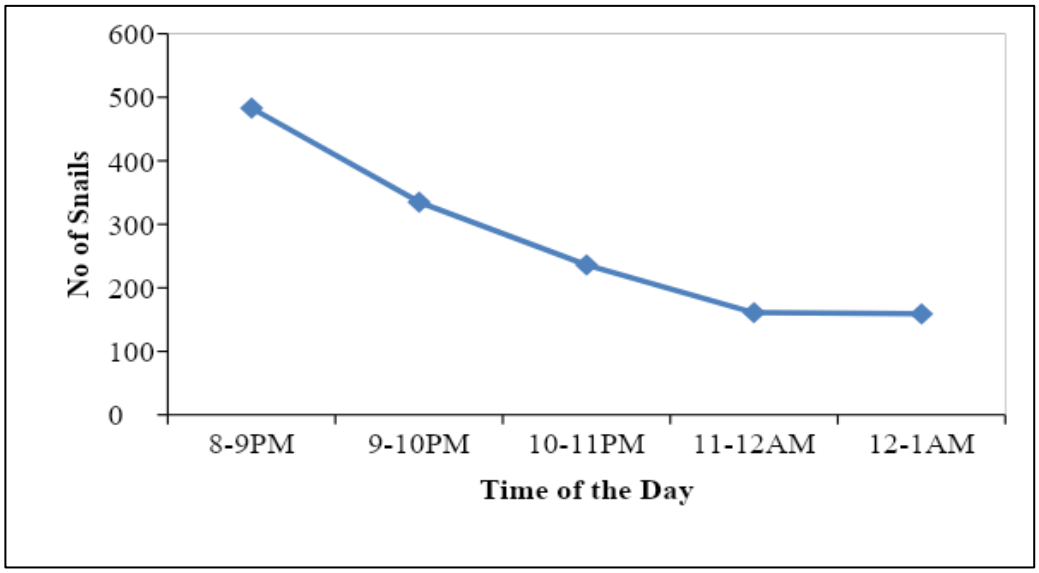


Figure 4: Period of feeding activity

Snail Feed intake and Preference Coefficient
The weekly feed intakes by the snails are presented in Figure 5 and weekly coefficient of preference in Figure 6. The feed intake by the snails were higher in the first week in all the feeds except for Pumpkin leaf where intake was observed to be higher in the second week; this could be on account of the antinutritional factor of the given feed. Zereu (2016), reported that animals have sensible choices between foods they eat to achieve their nutrient requirement. Therefore, animals change the proportions of foods selected as they grew to keep a suitable balance between protein and energy (McDonald *et al.*, 2010). The decrease in feed intake resulted in decreased CoP of the respective feeds in the second week (Figure 6).

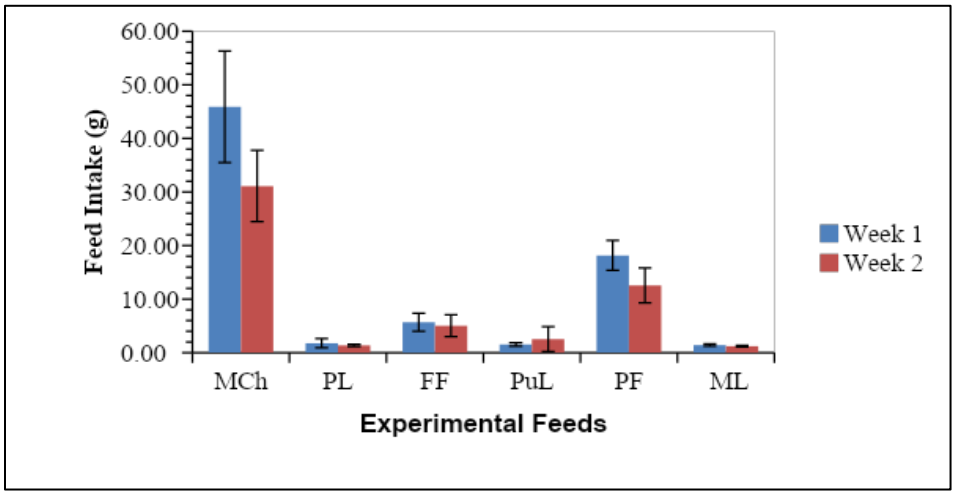


Figure 5: Weekly feed Intake by Snails.
MCh – Maize chaff; PL – Pawpaw leaf; FF – Formulated feed; PuL – Pumpkin leaf. PF – Pawpaw fruit; ML – Moringa leaf; Mean ± SD (standard deviation)

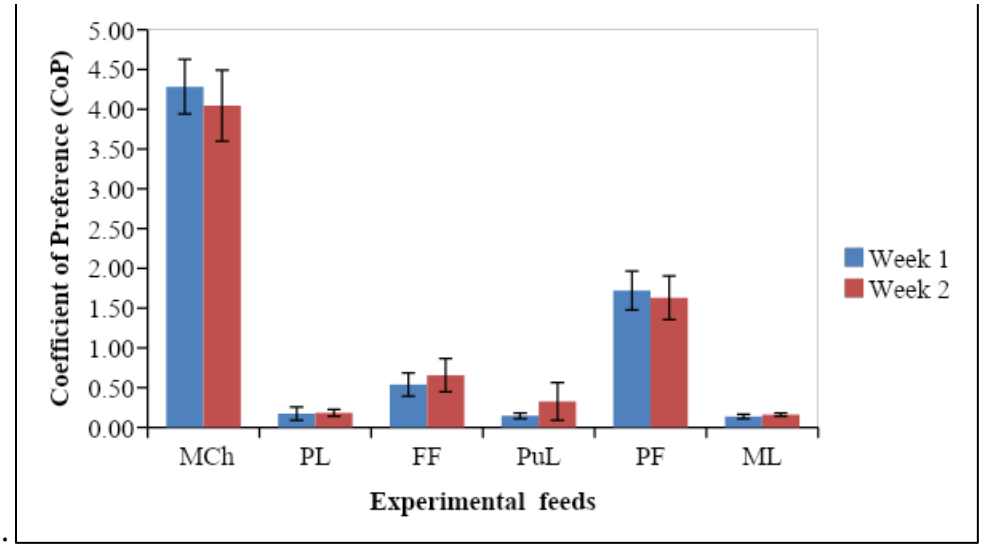


Figure 6: Weekly Coefficient of Preference
MCh – Maize chaff; PL – Pawpaw leaf; FF – Formulated feed; PUL – Pumpkin leaf; PF – Pawpaw fruit; MOL – Moringa leaf; Mean ± SD (standard deviation)

The daily coefficient of preference of feed/feedstuff over a 14-day period by the snails is presented in Figure 7. The daily CoP varied within the feed as a result of different daily feed intake. However, the least daily CoP obtained for the preferred feed (PF; 1.08) was not below unity implying there was no day the preferred feeds were not adequately consumed.

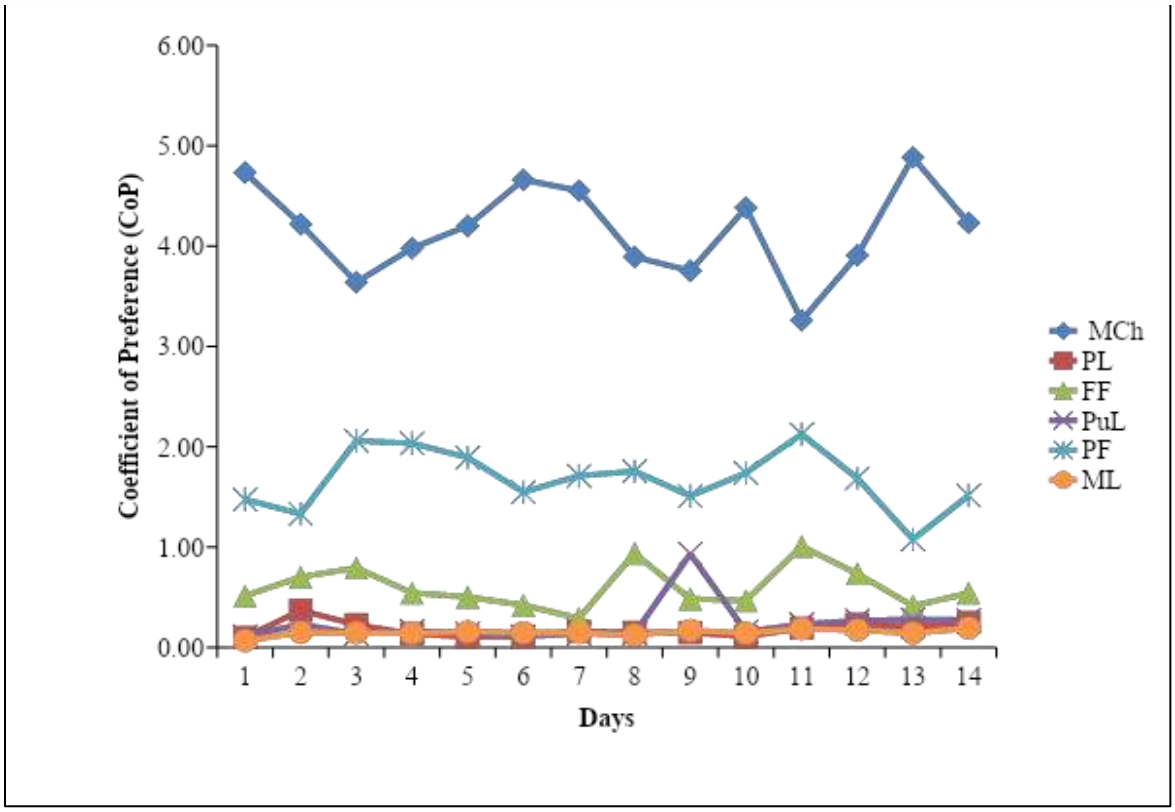


Figure 7: Daily Coefficient of Preference over 14days period
MCh – Maize chaff; PL – Pawpaw leaf; FF – Formulated feed; PUL – Pumpkin leaf; PF – Pawpaw fruit; MOL – Moringa leaf

The total feed intake and preference coefficient of each feed by the snail are presented in Table 3. The feed intake by the snails was significantly higher ($p<0.05$) for MCh (38.5), PF (15.3) than FF (5.12) but similar ($p>0.05$) for PuL (1.59), PL (1.57) and ML (1.32). The same trend was observed for CoP. This implied that MCh and PF were more consumed than other feeds. This agrees with earlier reports (Farid *et al.*, 2010; Amole *et al.*, 2013) that preferred feed usually have the highest intake.

Table 3: Total Feed Intake (DM) and Coefficient of Preference of feed

Parameters	MCh	PL	FF	PuL	PF	ML	SEM
FI (g)	38.51^{a}	1.57^{d}	5.12^{c}	1.59^{d}	15.34^{b}	1.32^{d}	5.59
CoP	3.64^{a}	0.15^{d}	0.49^{c}	0.15^{d}	1.45^{b}	0.13^{d}	0.53

Means along the same row with different superscripts are significantly different ($p<0.05$)
MCh – Maize chaff; PL – Pawpaw leaf; FF – Formulated feed; PuL – Pumpkin leaf; PF – Pawpaw fruit; ML – Moringa leaf; FI- Feed Intake; CoP- Coefficient of preference

CONCLUSION

Maize chaff and pawpaw fruit were the most preferred feed by giant African land snails. The preference in this study was adduced to their seeming higher composition of crude fibre and relatively lower fat content among the tested feedstuffs.

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