ASSESSMENT OF NUTRIENT QUALITY OF FORMULATED FEED FOR SNAIL
(Archachatina Marginata)

BY

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CERTIFICATION

I certify that this project work was carried out by SALAKO ALAO RASAKI of University of Technology Akure under my supervision.

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Signature.

DEDICATION.

This project work is dedicated to the Almighty God, for his mercies, guidance and protection throughout my sojourn in the university.

It is also dedicated to my Mum, Teachers and entire members of Salako family.

ACKNOWLEDGMENT

My profound gratitude goes to Almighty God who has been giving me opportunity to perform effectively in everything I am doing till today.

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I also wish to acknowledge the support of my lecturals I therefore wish to say thank you all sir. I do appreciate the efforts of my parents, brothers and sisters for their moral and financial support may Almighty God bless you all.

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ABSTRACT

This experiment was conducted to assess the nutrient composition of compounded feeds on snail (*Achachatina marginata).* A total of seventy five (75) snails of average mass 105 to 115g were used for the experiment which lasted for 12 weeks. The snails were randomly distributed into five (5) treatments with three (3) replicate each containing five (5) snails. The experiment was arranged as treatments 1, 2, 3, 4 and 5.

The snails in treatments 1, 2, 3 and were fed with compounded feeds containing maize, brewery dried grain (BDG), Wheat offal, palm kernel cake (PKC), Groundnut meal, soymeal, lysine, Methionine oyster shell, bone meal and growers premix. The protein level of these treatment (T_1, T_2, T_3, T_4) were 16%, 18%, 20% and 22% respectively. The snails in treatment five (5) were fed with pawpaw leaf and served as control.

The result of the experiment revealed that treatment 4 had the highest mass gain, shell length and shell width.

The proximate analysis of the edible portion of the snail showed that, the snail in treatmenmt four (4) had the highest crude protein and fat. There is no significant difference in the moisture and ash content of the edible portion of the snail in all treatment. The snails in treatment 4 had the highest calcium (Ca) and phosphorus (P). But there is no ($P<0.05$) significant difference in the Zinc (Zn) magnesium (Mg) and iron (Fe) of the snails in all treatments.

The result of proximate analysis of the feeds showed that treatment 5 (pawpaw leaf) had the highest crude protein, moisture and fibre content but low in fat. Treatment 4 is recommended for rearing snails since it produced the highest mass gain.

CHAPTER ONE

LITERATURE REVIEW.

1.1 INTRODUCTION.

The importance of protein cannot be over - emphasized in the nutrition of man. Protein is required for normal growth and repair of body tissue and is the principal constituent of the organs and soft structures of the animal body, hence a liberal and continuous supply of it is needed in the food throughout life for growth and repairs.

The low intake of animal protein in developing countries such as Nigeria has resulted in rapid deteriorating state of health Akinokum (1975) observed that the average Nigerian consumed less than three quarters of his animal protein need. The average Nigerian consumed between 6.5 - 8.6g of animal protein per day compared to the United Kingdom, 54g and Federal Republic of Germany , 40g of Animal protein (Abdulkadir, 1985).

While plant protein is deficient in one amino - acid or other, for example Soya - beans contain anti-nutritional factors and deficient in methionine. Animal protein is of high biological value and possesses all the essential amino -acid in desirable quantities.

The protein of animal origin is more closely related to that of man in amino acid profile therefore certain proportion of the dietary protein should come from animal origin.

According to Ikpi *et al* (1978), out of average of 58.8g of total protein reported to be available to an average person in Nigeria, only 8.4g comes from animal source as food, The Agricultural Organization (F.A.O 1969) recommended 70g of protein per adult per day of which 35g should come from animal protein. It is then important and necessary to make animal protein available to the population at reasonable prices so that the standard of living could be improved.

Titilola *et al* (1988), estimated the current animal protein intake as varying from 2.69g to 27.60g per caput per day depending on the geographical location in the country.

Animal protein is obtained from milk, beef cattle, mutton from sheep, pork from pigs, games as well as giant land snails. However, snail production is a new field, It has not been explored to any great extent as an animal protein source despite the fact that the snail meat is relatively easier to produce due to its high reproductive rate, shorter production cycle, rapid growth rate and cheap source of feed.

The war against malnutrition in Nigeria could be fought successfully by the use of snail. This is because snail has an important role to play in human health mainly for its high relatively high protein content and as a considerable source of vitamins(Mba,1980). It requires little investment in terms of finances and infrastructure. Snails are widely used in human food as important source of protein.

The concept of utilizing wild - life as a source of meat is not new. Before man rely on the limited domesticated animals as source of meat, bush meat was the main source of meat. The management of indigenous wild life in natural areas and under domestication therefore offers new prospects for making a significant contribution to meeting the animal protein requirements (Ajayi *et al* 1985).

The problem of shortage of animal protein has led to increased nutritional and malnutritional diseases and disorder such as kwarshiokor and retarded growth etc. There is thus a great need to explore all available avenue that could lead to improvement and production of snail.

Snail production have the potentials for very huge returns on investment with extreme low level of inputs and it requires little technical experience. Snail production is more of a necessity in order to save the species from extinction due to environmental degradation occasioned by human activities and natural occurrence which deplete natural supplies.

Snail production is environmental friendly and leaves no known hazardous effects. More so, snail farming is technically feasible venture which involved simple technology, feeds are easily and cheaply sourced.

Production of snails will have advantages of reducing the short falls in the supply of animal protein and will enhance the people's standard of living by way of economic empowerment through improved incomes sources and better health from its potential medicinal value.

Mead, (1981) confirmed the medicinal substances extracted from the giant snail to be or tho calcium phosphate. This compound (corthocalcium phosphate) can cure kidney disease, anaemia, tuberculosis, diabetes, prevent influenza, improve constipation, astina, restore vitality and certain circulatory disorder.

The shell of snails are widely used in the manufacturing of poultry feeds as calcium source, snail shells are also used for making ash trays and well decorations. They also have potential for curing cancer. The fat content of snail meat is generally very low ranging from 1.3% to 1.5% (Asibey and Eye 1975) and it has very low cholesterol content. The giant African land snail (*Archachatina Marginata*) is a native of African which provides nutritions, all these make it a suitable meat for all ages. The iron deficiency anaemia which is common in tropical countries could be treated by consuming snails. Snail rearing could be combined with conventional livestock for complete utilization of feed. The rearing of snails does not require much space compared to the rearing of large animals. It is an attractive venture for house wives retired civil servants, young school leavers without substantial capital and those looking for something to argument their salaries (Omole, 1998).

Snails are easily got to consumer or market from rain forest belt and the supply is relatively higher during the raining season (i.e April to October) which is the main snail breading season than during the dry season (November to March) when the snail become scarce due to unfavorable climate condition (Hot weather).

1.2 DESCRIPTION OF SNAILS.

Snail is a terrestial shell rearing animal which belongs to the *Phylum Mollusca*, it is air breathing and usually herbivorous, with a complex haemaphrodite reproductive system, although demanding cross fertilization (Akinnusi, 1997). The snail is a gastropod but it is different from other gastropods because its respiration is highly modified for terrestrial life contrary to most others which are adapted to aquatic life.

1.3 MORPHOLOGICAL FEATURES OF THE SNAIL.

The structure of a snail is like elongated form which coils spirally around a central axis. The snail shell is hard and make of calcium compound especially calcium carbonate. The shell of a matured giant land snail is about 12 -16cm in length and 0.5 - 1mm thick. The colour of snail varies, and it depends on the species. The shell of a snail is secreted by a specialized sheet of tissue called Mantle.

The body

This comprises of the head, the visceral mass, and large muscular foot.

The head

The dorsum part of the head is the mouth which bears teeth like projections called radula which help the snail to rasps its feed. The head possess two pairs of tentacles in which the shorter is the seat of the sense of smell and the longer pair

possess simple eyes and their tips.

The Visceramass

This lies above the foot and carries the internal organ like the kidney, heart, loop of intestine and reproductive materials etc. Malcom *et al* (1976) stated that the visceral mass is unsegmented and the digestive is well developed with a mouth and anus. Imevbore (1987) noted the visceral mass of *A. marginata* is not edible to man.

The Muscular foot

This is an organ of slow locomotion, used for burrowing and swimming , it also carries the sense organ and the heard (Malcolin *et al* 1976). The outer part of the edible portion is rough, triangular in shape being blunt exteriorly and v -shaped posteriorly. The sole of the smooth ventral surface of the foot is usually light greyish in colour while the dorsal surface is brown or blackish (Yoloye, 1988).

The secretion of mucous- lime (muscoved by mucous gland which is seen along the mouth of snail facilitate sole of foot from drying as well as allowing adherence to surface.

1.4 CLASSIFICATION OF SNAILS.

Class -- Gastropoda ---- English, name is Gastropoda meaning possessing foot - like stomach.

Sub- class ----- Pulmonate ----- English name is Pulmonates i.e Haemophrodite gastropods.

Order --- (1) Stylommatophora --- meaning having eyes on the longer pairs of tentacles.

(2) Basommatophora ---- meaning having eyes on the shorter pair of the tentacles.

Family - Achatinidae (African name) or Helicidae (European name). The helicidae is very tiny and its rearing is referred to as heliculture while the rearing of achatinidae is called Achaculture

(Amusan 1999).

Genus: (1) *Archachatina marginata* (African giant)

(2) *Archatina achtina* (Snails)

(3) *Limicolaria* (flammulate).

(4) *Achatina fulica* (Sulvatica)

Species

There are several species under the following

(1) Land Snail

(2) Water Snail.

1.5 *EDIBLE* LAND SNAILS

Archachatina maginata - Big black snails

Archachatina ventricosa

Archachatina suturalis.

(a) ***Archachatina marginata*** - This is a big black snail called " Igbin A pinu" in Yorubaland , Ibo called it Ejuna, while Esan (Edo) called it Uro. It is a large bread and called African bread .It has a multi colour shell and brown skin.

(b) ***Achatina Achatina*** _ This is called "Ilako" in Yorubaland.The Esan called it Aginiso while the Ibo called it Njala or Upuro. It is found in the forest of West Africa. The shell is pink and the skin is black with whitespots . It has cone shaped and can lay 100- 500 eggs per cluth once or twice a year.

(c) ***Achatina fulica*** **(sulvatica)** : It is called Ilakose or Igbin orisa in Yorubaland, it is found in garden and farms and therefore called garden snails. The shell colar is pink. It weighed 15-25g at maturity and measuring 5-7cm in length. The skin is whitish -grey, many people do not eat it because of taboo associated with it.

(e) ***Limicolaria species*** : They are also garden snail like *A. Fulica* where they may become a major pest of many crops like maize, yam, cocoyam banana, leafy vegetable etc. It is called ipere, esan, ikoto, in Yorubaland and called Npioro in Igboland. There are about four known species of this, The Southern species is smaller than the one found in the Northern parts of Nigeria.

The Visceral Hump - This is the softest part of the snail which always confined at the upper whole of the snail's body It is a thickened collar which is the edge of the mantle, it secret the principal layers of the shell, it secret calcium trioxocarbanate (iv) ($CaCO_3$) that makes new shell around the aperture.

1.6 ECONOMIC IMPORTANCE.

Snail being a good source of protein in nutrition of man, can be eaten as substitute for protein supply. The protein contents of snail ranges from 12-16%, and the protein of snail contain two important amino acid, lysine and aginime that are 1.5 times and 2.5 times respectively richer than amount found in chicken egg (Mead and Kemvere 1953).

Snail meat is low in sodium, fat and cholesterol but contain high amount of iron and calcium. According to Awesu (1980), the edible portion of *A. marginata* contained crude protein 18.28%, ether extract 1.36%, crude fibre 0.07, Ash 1.57%, N.F.E. 95%, calcium 160.5mg/100g, magnesium 30.3mg/100g, potassium 71.7mg/100g, and iron 12.2mg/100g. Unlike the other conventional animals such as beef, mutton and chicken etc. The protein and iron contents of snail meat are relatively high.

It is just recently that people are knowing the relevance of snail as animal protein source that beats other common animals in terms of protein and minerals.

1.7 MEDICINAL IMPORTANCE OF SNAILS

The eaten of snails is not only to supply protein and minerals, but cure or prevent some certain deseases. Research studies by Imevbore *et al* (1998) confirmed the usefulness of snail the treatment of some diseases of human beings as a result of certain substances found in snails. Snail meat is low in sodium, fat

and cholesterol but contains high amount of iron, phosphorus, copper and calcium which are very helpful to the body of its consumers. Snails also contended, possess low fatty acid such as myriotic and palmitic acid which other protein sources (meat) in similar category have in high percentage, hence it is used in treatment of Arteriosclerosis, Anaemia, Hypertension, High blood pressure and other fat related Ailments, *Astma* and poor eye sight. It helps to reduce haemerrhoids and constipation.

In traditional medicine according to Akinnusi (1998), snail meat is used in the preparation of concotions for various cases such as reduction of labour pains and blood loss in during delivery. It also used in preparation of love medicine to restore peace between husband and wife and among wives in polygamous homes.

The ortho- calcium phosphate extracted from the snail could be used to cure kidney disease, circulatory disorder, tuberculosis, anaemia, diabetes, to increase the beauty, clear the skin, to restore virility of manhood and vitality and to cure smallpox It is also recomended for the musicians (Mead,1961) serotinin secreted in the snail body can be used in the maintenance of normal behaviour after depression caused by its deficiency in the brain (Burger and Mitchel, 1979)

According to Bowman and Rand (1980), the parkinonism disease (unnecessary movement of some parts of the body) which normally due to unbalance between dopamine and acetylcholine in the body could be overcome by serotinin which increases the level of dopamine in the body.

OTHER USES OF SNAILS.

Because of the fact that the shell of snails is rich in calcium, the ground shell can be used in the formulation of animal feed as good source of calcium. Moreover, The ground shell can be incorporated into the soil to reduce acidity.

1.8 GENERAL MANAGEMENT PRACTICES.

It is relevant to know the basic knowledge involved in snail farming before venturing into it. Presently, there is association of Nigerian Snailery Farmers, established by the management of the Institute of Agricultura Research and Training (IAR&T) to elevate the rearing of snail in Nigeria and to teach the members the fundamental principle and methods involved in rearing of snail.

Snail production requires little technical experience and it is an attractive business for retired civil servants, young school leavers and secondary occupation for traders, bankers, lawyers etc. as well as aged people because it requires less capital and management practices is simple compare to piggery, sheep, poultry and other conventional livestock it can also be combine with conventional livestock for complete utilization of feed.

1.9 REPRODUCTION.

Sanils are hermaphrodite (Etsmilie, 1982). In some species of snails there is self fertilization and in most edibile land snails, fertilization is by interchange of

sperm (spermatophyles) between two compatible partners.. According to (Akinnusi, 1997) snails practice sexual reproduction. A virgin snails kept in isolation for two years will not lay eggs (Mead, 1961).

1.10 MATURITY.

The maturity period of *A. marginata* is 9-10 months (plummer, 1975), According to Awesu (1980) The maturity period is 18 months while Akinusi (1997) reported 7 to 11 months in A achatina and 9-10 months in *A. marginata.*

1.11 BREEDING SEASON.

A. marginata is active only during raining season both in capitivity and wild. Ajayi *et al*, (1978) reported on the same *Spp.* and found that it grew and produced throughout the year in the captive population, provided water is regularly supply.

1.12 CLUTCH SIZE AND EGG SIZE.

Clutch size is the number of eggs laid, and it varries, it depend on the Spp of the snail. Plumer (1975) gave the clutch size of *A. marginata* to be between 3-16 eggs; Ajayi *et al* (1978), reported 6-12 eggs, while Awesu (1980), observered 8-16 eggs.

The clutch size of A marginata was recorded to be smaller than those of *A achatina* which vary between 37-305 eggs (Hodasi,1978).

However (Plummer, 1975) reported that the size of egg in A marginata are more bigger than those of other species. According to Hodasi (1979) the process of eggs laying in snail involve making of egg chamber (1-2cm deep holes) in loose soil with the radula. These eggs was deposited into these holes in quick succession.

1.13 INCUBATION PERIOD.

This is the time taken by the eggs to hatch from the first day they are laid. The incubation period of snails depend on species. The incubation period of *A marginata* was given as 29-35 days (Plummer, 1975), 30 -45 days (Ajayi, *et al* 1978), 19-32 days (Awesu, 1980), 32 -28 days (Ogogo, 1986), and 10 -31 days was reported by (Hodasi, 1978).

1.14 SIZE AND WEIGHT OF HATCHLINGS

The Average length of the shell of 100 snails of *A achatina* at hatching is 6.9mm (ranges between 6.2-7.6mm) while the average weight of the same number of snails was 0.10g (ranges between 0.09-0.13g) Hodasi (1979)

The size at hatchting of *A.marginata* was given as 18.3 -19.9 mm in length, 16.0 -17.3mm in width (Plummer,1975). Ajayi *et al.* (1978) gave the mean weight of. The hatching of *A. marginata* as 2.14g.

After hatching, young snails remained in the soil for some days before they come to the surface of the soil.

Hodasi (1979), noted that the newly hatched snails tend to aggregate in groups for few days and rasped only soft food and egg shells. In addition to this, he confirmed that newly hatched snails fed voraciously and the shells became hardened as they grow.

Ajayi *et al* (1978) reported that the average growth rate was 0.85g while Hodasi (1979) note that the growth rate of young snails was rapid but varies for the first six mouth.

1.15 EGG LAYING / HATCHING.

Snail dig a hole in the ground and lays its eggs in a clutch and closes up the hole with soil. Egg laid by snails can be arranged in a separate box or plastic container which could be termed. The in "incubator" sterilised rich loamy soil is used to fill the box or plastic container used and the fresh eggs are burried inside it. There must be water supply regularly untill hatching. After an incubation period of between 29-32 days, newly hatched snails called "baby snails" or "hatchling" come out of the holes.

1.16 REARING

The young baby snails are usually reared seperately in a rearing box filled to a depth of 8- 10cm with heat sterilised rich loamy soil slightly limed .They are fed with fresh green pawpaw fruit (unripe) and cocoyam leaves. Feeding and watering of baby snails should follow the pattern of the adult.

1.17 CARE OF SNAILS.

Like the other animals, proper hygiene with adequate care will make snails active and reduce the incidence of enemies such as parasites, pests, predators and disease. Pilfering is one of the greatest threat in snail farming. Because of the fact that snails are noiseless and relatively small sized several of them can be carted away by man unnoticed, this is why it is generally recommended that snail farms are located as close as possible to human residence and that such forms be securely fenced and locked to reduced the incidence of theft.

A number of organism constitute danger to snails, these include toads, frogs, millipedes, centripedes, mice, rats shrews, moles, slugs and others like birds that eat snails meat, termites, lizards, cockroaches, solder ant, rodents etc.

Budu (1993) These enemies attack snails bitting which may lead to death. Some of these enemies break the soft shell of the young body snails and once the flesh becomes shelless, it dies as it cannot develop new shell around itself, neither can it enter into an empty shell. Also some tiny eyes of the snails.

1.18 AESTIVATION.

This is a state of inactivity or dormancy that occurs when the relative humidity of the environment is very low (less than 75%) it is common during the dry season. This occur when snail seals it self into the shell with a white, calcareous layers (epiphragm or operculum) in order to prevent loss of water from the body, and exist thus untill the weather impoves. This can be prevented by adequate watering of the pens. It should be noted that growth reduces during this period. In this condition they are able to survive many months without feed or water but draw their body reserve substances (Akinusi, 1998) ..

According to Mead (1961) during the dry water months, *Achatina fulica* hibernates.

1.19 SOIL TYPE PREFERENCE OF SNAILS.

Any mineral soil with P^H 7.2 - 8.7 is suitable for rearing of snails. Ogogo (1989) reported that Alkaline soil (P^H 7.00 -8.00) would ensure the stability of $CaCO_3$ which is essential to the snail. The main compoment of snail shell is calcium trioxo carbonate (iv) $CaCO_3$) which is very important in metabolism, snail obtained Ca from shell and food plant.

1.20 SOIL STRUCTURE.

It is very important to take the structure of soil into consideration in snail venture, snails prefer medium of light soil, so that they can easily make holes and lay their eggs. It also ease the climb of newly born snail to the surface after hatching. This is hard in clay soil in dry season hard soil and dry season cause low production of snails. Hibernating snails and active snails are viable to climb to satisfy! The land that is liable to flooding or water logging for any reason is unsuitable for snail farming (Elmsilie,1982).

1.21 FEEDS AND FEEDING

Much research works have been carried out on the food resources in the wild and under culture by Awa (1994 & 1997), Akinusi (1996), Hodasi (1986), Akinusi (1997) and determination of food resources requirement by Awa (1997). Plummer (1975), Stervenart (1994), Cobbinah *et al* (1988) and many other scientist. Not every plant which grows within an ecosystem is acceptable to animals as food. Those plants that are acceptable have varied degrees of acceptability. Some components of acceptability of a plant as food to snail have been described by Airey *et al* (1989). The two kinds of chemical characteristics of some plants that influence the snail in its feeding habits are attractants and phago stimulants mostly surgery in nature induce the snail to eat more of the stuff after a first morsel.

Snail consumes feed like fresh plant materials, livestock feaces, dead animals Ajayi *et al* (1978).

According to Hodasi, (1982) less feed would be consumed at normal darkness hours, which made snails reared under perpetual darkness grow lesser than those reared under perpetual light.

Mead, (1961) reported that, leaves and fruit are universal favourite food items of wild giant snails. This was surported by the feeding trial experiment of the snails in captivity carried out by Ajayi *et al* (1978) he concluded that *A. marginata* preferred the leaves and fruit of *Carica papaya* to other food materials.

According to Imevbore (1990) young snails seem to prefer leaves of pawpaw to fruit when a mixture of fruits and leaves is offered. Some factors such as environment , the age of the snail, the moisture content of the feed, and general attractiveness of the feed influence the consumption of feed by snails (Awesu, 1980).

According to F.A.O. (1986) The most important factors in snail growth and attainment of early maturity is nutrition. Other factors include relative humidity, extreme temperature etc. Indiscriminate feeding of plants to snails without understanding of their qualities in terms of meeting the animals requirement could have adverse effect on its growth or reproduction. It is therefore necessary to know the proper understanding of the quality of plant foods in promoting the growth of snails if progress is to be made on snail farming.

Snails are vegetarians and will accept many types of food. Snails feeds mainly on green leaves, fruit, tubers, flowers, household wastes, grains, industrial by - products, mineral supplement, blood meal, mushroom and compoundedration.

LEAVES

Cocoyam *xamthosoma mafaffa*

Pawpaw *Carica papaya*

Cassava *manihort esculentum* variety of low cynide.

African spinach *(Amarathus Spp).*

Milk weed *(Euphobia hiria)*

Cabbage *(Bracica Spp)*

Lettuce

water leaf *(Talinum triangulare)*

Okro *(Abeimoschus esculentus)*

Egg plant *(Solamun melengena)*

Cowpea

Plantain *(Musaparadiziaca)*

Banana *(Musasaplentum).*

FRUITS.

Unripe and ripe pawpaw *(Caricapapaya)*

Ripe plantain *(Musa paradiziaca)*

Ripe banana *(Musa saplentum)*

Guava *(Psidum spp)* Gujava

Oil palm -mesocarp *(Elaeis guineesis)*

Egg plant *(Solamum melengena)*

Pear *(Persia americana)*

Fig *(Ficus spp)*

Tomato *(Lycopensium esculentum).*

Cucumber *(Cucumis lenga)*

MELON (Litrellu lanatus)

Treculia africana

Pawpaw

Mango

Coconut

Bread fruit

Cashew

Orange and melon

TUBERS

Cocoyam *(Xanthosomamafaffa)*

Cassava *(Manihot esculentum)*

Yam (*Discorea Spp)*

Sweet potata (*Ipomea Spp*)

Carrot (*Dancus carot sativa*)

FLOWER.

Pawpaw

Sun flower

Milk-bush etc

GRAINS.

Ground maize

Guinea -corn

Millet etc

INDUSTRIAL BY- PRODUCT.

Wheat offal

Rice bran

Spent grains

Maize brain.

HOUSE HOLD WASTES.

Peels of banana, plantain, pawpaw peneaple, sweet potato, cassava, cocoyam, pounded yam, eba, amala, fufu, eko (solid pap) cooked rice, cowpeabran, beans.Such wastes should not table salt (sodium chloride).

MINERAL SUPPLEMENTS

For normal growth and egg production, snails requires a lot of calcium which could be supplied from calcium,carbonate powder ($CaCO_3$), ground oyster shell, burnt and ground snail shell, poultry egg shell or bone meal.

BLOOD MEAL

Snails take fresh boiled blood which coagulate when boiling.

MUSHROOM

Snails feed on non- poisonous mushroom.

COMPOUNDED RATION

Compounded ration can be fed to snails. The limitation to the use of compounded ration is that the standard nutrients requirement of different classes of the snails are yet to be determined expecially in the tropic.

SUPPLEMENTARY CALCIUM

Ground limestone ($CaCO_3$) powdered oyster / snailshell, powdered chiken egg shell can be fed by snails

CLEAN WATER.

Avoid the use of chlorinated water, waterfrom the following source are suitable for snails - rain, river or stream, bore holes or well. Where tap water must be used, allow it to settle in a container for few hours for the gas to diffuse before use.

PAWPAW LEAF

Pawpaw plant : Taxonomy and description.

According to Adeyemi, (1987) pawpaw is a short lives perennial plant with a fruit which has a mild, pleasant flavour and is widely consumed in Nigeria. The plant is usually either male or female, that is the inflorescence is unisexually dioecious. The male inflorescence however as a rule bears bisexual flowers.

Friut are green when unripe, but become yellow - green yellow or orange when ripe. The tree bears early (8 -10 months after transplanting) it supplies fruits throughout the year.

Agnew (1957) indicate that pawpaw " a small her herbaceous free reaching a height of 4.6- 6.1 metres" it has a succulent and hollow trunk except at the nodes, fibrous and straight except damaged in some way (Chandler, 1958). Papain, which

can be extracted from the white latex - like juice of the green fruit is used mainly to render meal tender.

The pawpaw fruit is a berry containing numerous black wrinkled seeds each enclosed in a gelationus membrane, and attached to the fruit flesh by a gelatinous stalk. (Chandler,1958, Miller, *et al* (1976).

Pawpaw tress varies in size and shape but depend on either male or female. The female pawpaw tree have round shape while the hermaphrodite pawpaw tree is pyriform. The flesh varies in thickness and its colour ranges from orange to green.(Miller *et al*, 1976).

The research work of Miller *et al* 1976), Oyenuga and Fetuga, 1976) show that pawpaw fruit is an excellent source of vitamin c (ascobic acid) but not poor source of phosphorus, iron, thiamine and niacin.

1.22 ANTI NUTRITIONAL FACTORS.

These are substances that are found in some plants such as cassava, cotton seed, cocoyam, soyabean which usually affect or limit the nutritional potential of the plants. They include gossypol which is a yellow pigment, and is a polyphenotic aldehyde which is an antioxidant, it is found in cotton seed plant - trypsin inhibitors is another antinutritional substance commonly found in raw sweet potato, tuber and in soya bean, it decrease the protein digestibility in the mixed feed. Hydrocynic acid found in cassava is a powerful inhibitor of several essential enzymes catalysed

process notably the cytochrome oxidase for which it has a strong affinity thus making it unable to react with oxygen and consequently aerobic cellular respiration cease.

In general dearth usually result, if proper processing is not adopted before animals fed these crops or if they are given in excess.

NUTRIENT COMPOSITION OF A DIET.

Animal diet have or posses the following constitutes: (a) Carbohydrate (b) protein (c)fat and oil (d) minerals (e) vitamins (f) water.

Each of these constitutes have a role to play in the growth of the snails and defficiency of any of them may affect the snail.

OBJECTIVE

The aim is to determine nutrient quality of formulated feeds for snail (achachatina marginata) with respect to appearance, size and weight.

CHAPTER TWO

MATERIALS AND METHODS.

2.1 LOCATION AND DURATION OF THE EXPERIMENT.

The experiment was carried out at the snailery unit of the Institute of Agricultural Research and Training, Moor Plantation Ibadan.Twelve weeks were used for the feeding trial.

2.2 MATERIALS.

The wooden cage used for the experiment was constructed by a local carpenter. Mettler top loading balance was used for all the weighing.

2.3 CONSTRUCTION OF HOUSING FOR THE SNAILS.

A raised wooden cage of the fifteen compartment was used. The bottom of the cage was perforated to allow free drainage of water, thus preventing water -logging when wetting the soil. Garden soil (sandy loamy) was filled to a depth of 7cm in each compartment of the cage. Each compartment has a door and the cages cover was made of wood and wire netting as shown in Picture 1.

The dimension of each compartment is given below.

Length : 45cm

breath : 30cm.

The stands of the cages were placed inside pan filled with water and engine oil thus preventing soldier ants infestation.

2.4 EXPERIMENTAL DESIGN.

The complete ramdomise design (C.R.D) was used.

Treatment : 5 treatments (T_1 -T_5).

Treatment : 1-- snails fed on compounded ration of 16% protein.

Treatment :2 -- snails fed on compounded ration of 18% protein.

Treatment :3 -- snails fed on compounded ration 20% protein.

Treatment :4 --snails fed on compounded ration 22% protein.

Treatment :5 -- snails fed on pawpaw leaf (control diet).

Number of replicates per treatment :three (3)

Number of snails per replicate :five (5)

Total number of snails used = seventy five (75).

One hundred (100) snails (*Achachatina marginata*) were purchased at Oje market in Ibadan, of Oyo state. They were acclimatized for two (2) weeks fed with pawpaw leaf which is the control diet of the experiment.

After two (2) weeks of acclimatization, seventy - five (75) healthy snails without shell damage and with weight ranges of 105 -- 115g were selected randomly and distributed into five (5) treatments. They were numbered with red paints for proper identification.

2.5 PROXIMATE ANALYSIS OF THE FEEDS AND EDIBLE PORTION OF THE SNAIL

The proximate analysis of the expermental feeds and edible portion of the experimental snails were carried out according to A O A C (1990) The samples were analysed for crude protein, ether extract, crude fibre, moisture content and ash. Total carbohydrate were obtained by differences.

2.6 ASSESSMENT OF THE SNAIL GROWTH.

The masses of the snails were taken weekly. Daily feed intake was measured by deducting the mass of feed left over from feed given. The length of shell was measured every week with the aid of vernier callipers. The increase was obtained from the weekly difference in length. The width of shell was also measured every week with venier callipers and the increase was obtained from the weekly difference in width.

2.7 WETTING AND TURING OF THE SOIL.

The wetting of the soil was done daily with a watering can. The soil was turned weekly with a hand trowel.

2.8 METHOD OF PROXIMATE ANALYSIS.

The moisture content was determined by weighing 2g of the samples into previously weighed crucible, the crucibles plus sample were then transferred into oven set at 100°c to dry to a constant weight for 24 hours. At the end of 24 hours, the crucibles plus sample were removed from oven and transferred into dessicator, cooled and weighed. The dry matter was then calculated using the formula

$$\% \text{ Dry matter} = \frac{W_2 - W_0}{W_1 - W_2}$$

where w_0 = weight of empty crucible

w_1 = weight of crucible + sample

w_3 = weight of crucible + dried sample.

The ash content was determine by weighing 2.0gm of the sample into porcelain crucible, The crucible plus sample were then transferred into the muffle furnace set at 550°c and left for about 4 hours. At this time it had turned to white ash . The crucible and its content were cooled to about 100°c in air, Then room temperature in a dessicator and weighed.

The percentage ash was calculated from the formula below:

$$\% \text{ ash content} = \frac{\text{Wt of ash}}{\text{Origina wt of sample}} \times 100$$

The protein content of the samples were determined by the routine semi microkjeldah procedure technique of determining nitrogen and multiplied by 6.25. The samples were firstly digested in a fume cupboard.

The digest was distillated with markham apparatus and the distillate collected was titrated aganist 0.01 MHCL. The crude protein content was determined by multiplying percentage nitrogen by a constant factor 6.25.

The crude fibre content was determined by weighing 2.0gm of the samples into the fibre flask and 200ml of 1.25% sulphric acid was added, The mixture was heated under reflux for one hour. The mixture was filtered through a buchner funnel and the residues were washed back into the fibre flask with 200ml of 0.31MNaoH.

The mixture was heated for another 1 hours, 2ml of 150 Amyl alcohol was added, the mixture was filtered through a fibre sieve cloth.The residues was washed with hot water twice and finally transferred into dry weighed crucible, the crucibles and the residue were oven dried at 105^0c for 24 hours, The oven dried crucible and the residue were cooled in dessicator, weighed and transferred into muffle furnace set at 550^0c for 4 hours. The crucible containing the white ash was cooled in dessicator and weighed.

The % crude fibre was calculated thus :

$$\frac{W_1 - W_2}{W_0} \quad X \quad \frac{100}{1}$$

Where W_1 = weight of oven dried sample

W_2 = weight of ash dried sample

W_0 = weight of the sample

The ether extract was determined by weighing 1gm of each dried sample into fat free extraction thimble. A previously dried weighed soxhlet flask were filled to 3/4 of its volume with petroleum spirit (b.p40-60oc) and the soxhlet apparatus was set.The heater was put on for six hours.

The percentage fat (ether extract) was calculated with the formular.

$$\frac{W_1 - W_2}{W_0} \quad X \quad 100$$

Where W_2 = The final weight of over dried flask + fat.

W_0 = Weight of sample taken.

The total carbohydrate of each sample was determined by calculation.

100 -- (% moisture + % ash +% crude protein +%crude fibre +% ether extract).

Atomic absoption spectrophotometer was used to determine Fe, Cu, Zn, and Mg, while Na, Ca and K were determine with flame photometer, spetrophotometer was used to determined phosphorus.

2.9 SOIL ANALYSIS.

The chemical analysis of the soil used for the experiment was carried out .The soil was analysed for P^H value, carbon, phosphorous, magnesium, calcium, sodium and nitrogen.The P^H of the soil was determine with electrical P^H meter.

DETERMINATION OF CARBON.

This was determine by firstly well grounded the soil, 0.5g of this was weighed into 250ml conical flask and 10ml of $1NK_2Cr_2O_7$ was added. 20ml of conc H_2S0_4 was also added and distilled water was added to 250ml mark on the conical flask. It was allowed to cool, after which 8 drops of diphenylamine indicator was added. This was then titrate with 0.4N ferrous Ammonium Sulphate until a violet colour changes to green. A blank was prepared with 10ml of $1NK_2Cr_2O_7$ by followed the step as for the sample.

The percentage (%) carbon was then calculated thus

$$\% C = \frac{\text{Blank - Titre value of sample X 0.39}}{W_t \text{ of sample.}}$$

DETERMINATION OF PHOSPHORUS.

5g of the soil sample was weighed into a dry cup and 25ml of bray 1 was added, The content in the cup was shaked for 1 minute and then filtered with no1 whatman filter paper. 8ml of the filtrate was pipette into a test tube and 8mls of

standard was pipetted from 1ppm, 2ppm, 3ppm, 4ppm and 5ppm. To each of these standard 5 drops of F.S.indicator and amonium molybdrate were added and allow to develop. The sample was read on spectrophotometer at wavelength of 460um.

DETERMINATION OF Na, K, Ca, and Mg.

5g of the soil sample was weighed into a dry cup and 50ml of Ammonium Acetate of PH 7.0 was added. It was then shaked very well for 30mins in a mechanical shaker.

After 30mins, it was filtred Na, K and Ca were read with flame photometer while Mg was read with Atomic Absorption Spectrophotometer after 1/10 dilution of the filtrate of the soil.

DETERMINATION OF NITROGEN.

The Nitrogen was done by conversion from %C determined as thus

$$\%N = \frac{\%C}{10}$$

2.10 STATISTICAL ANALYSIS.

The data obtained from all parameters were subjected to statistical analysis. The analysis of variance (Anova) was used according to Steel and Torrie (1981).

Table 2.1 Gross Composition of the Experimental Diet (kg)

	T_1	T_2	T_3	T_4	T_5
Maize	40	37	35	32	
Brewery dried grain (BGD)	10	2	11	10	
Wheat offal	8.2	9	9.8	8.5	
Palm Kernel Cake (PKC)	7.0	8	7.0	7.5	
Groundnut Meal	5.5	5	5.0	5.0	Control
Soya Meal	14.5	16.5	19.0	22	
Fish Meal	4.0	4.5	4.0	4.0	
Lysine	0.2	0.2	0.2	0.2	
Methionine	0.07	0.07	0.07	0.07	
Oyster Shall	9.0	9.25	9.25	9.25	
Bone Meal	1.28	1.28	1.23	1.25	
Grower Premix	0.25	0.25	0.25	0.25	

T_1, T_2, T_3, T_4 represent the various feed formulations respectively and T_5 the control feed.

Picture 1: The picture of the Cage used for the Experiment.

CHAPTER THREE

RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1 PROXIMATE COMPOSITION OF THE EXPERIMENTAL DIET.

Treatment 4 containing 22% soyabean has the highest % crude protein, while other formulations have crude protein level of 16.07%, 18.16% and 19.98% respectively (Table 3.1)

Treatment 1 containing 40% maize has the highest % crude fibre and ash contents. The crude fibre content of other formulations are 6.10%, 4.91%,4.28% respectively, while the ash content are 5.23, 5.41, 4.49 respectively.

Pawpaw leaf has the largest moisture , protein and ash content, it has minimum fat content. This control diet (pawpaw leaf) will normally be deficient in vitamins and some minerals since they were added as was done for other treatments.

3.1.2 FEED INTAKE

The feed intake increase progressively from first weak to the twelfth week of the feeding trial in all treatments.

Treatment five which is the control had the highest average feed intake from the first week to the seventh week this was followed by treatment four (22%cp) while treatment one (16%cp) had the lowest feed intake. The snails in treatment four had

the highest feed intake from seventh week to the twelfth week of the experiment. The reason for the high consumption of the pawpaw leaf(control) in treatment five from first week to the seventh week is explainable by the fact that the snails are more used to eating leaves than compounded ration, so is more readily acceptable. (Table 3.2)

3.1.3 MASS GAIN.

With treatment one mass gain ranges from 3.23 - 7.81g for twelve weeks. The ranges observed within the same period for treatment two, three, four and control are 3.79 -9.00, 3.37 -9.99, 3.08 -1032 and 1.58-2.91g respectively (Table 3.3) .The mass gain for feeding with pawpaw leaf is smaller after a week because other treatments contain more nutrient.

Results obtained from the formulations after 12 weeks show not much difference in mass gain. This is because they have comparable amount of nutrients.

3.1.4 SHELL LENGTH INCREASE.

The ranges observed for treatments one, two, three, four and control are 0.15 -0.58mm, 0.22-0.65mm, 0.19-0.80mm, 021 -0.82mm and 0.11 -0.52mm respectively (Table 3.4) The ranges are comparable to those obtained for the mass gain.

3.1.5 SHELL WIDTH INCREASE.

The ranges observed for treatments one, two, three, four and control are 0.14

- 0.47mm, 0.16 - 0.25mm, 0.17 -0.54mm, 0.15 -0.58mm and 0.13 -0.35mm respectively (Table3.5).

These ranges are also in agreement with ranges got for the shell length increase. The control has reduced mass gain shell length and shell width, This may be due to the fact that the control diet contains limited amount of vitamins and minerals.

3.1.6 PROXIMATE COMPOSITION OF THE EDIBLE PORTION OF THE EXPERIMENTAL SNAIL (% DRY WEIGHT BASIS).

It was observed that the edible portion of the snails in treatment four have the highest crude protein, while the edible portion of the snails in treatment five (control) have the lowest crude protein. The crude protein of snails in treatment 1, 2, and 3 are 79.97%, 82.01%, and 83.68% respectively. There is an indication that the crude protein percentage of the snails in all the treatment are relatively the same. It is however notable that the crude protein percentage discovered here is favourably comparable with that of Imevbore and Ademosun (1988).

The ash content ranges from 0.60% to 0.64% with control having the least and treatment four have the highest percentage. The fat content of the edible portion in all treatment was relatively low, range from 1.59 - 1.63%. These ranges was corrolate with Asibey and Eyeson 1975. The edible portion of the snails in the control have the highest percentage of moisture content while snails in treatment

one have the least moisture content (Table 3.6)

3.1.7 MINERAL CONTENT OF THE EDIBLE PORTION OF THE EXPERIMENTAL SNAIL (mg / 100 DRY SAMPLE).

The calcium content of the edible portion of the snails ranges from 184 .92mg /100g to 185.55mg /100g. These ranges was corrolate with Imevbore and Ademosun 1988. The edible portion of the snails in all treatments is relatively low in Copper and Zinc but high in Sodium, Potassium and Calcium. These is in line with Imevbore and Ademosun 1988 (Table 3.7)

3.1.8 CHEMICAL ANALYSIS OF EXPERIMENTAL SOIL.

The soil used to keep snails in this experiment have P^H 6.84 showing that the soil is neutral. The soil is rich in potassium which is good for the snail shell. The base saturation (99mg/100g) showed that the hydroxy level of the soil is high. The organic matter of the soil is low.(Table 3.8)

3.2 DISCUSSION

The result of this experiment revealed that snails consumed more of compounded feeds with high crude protein than conventional feed. This might be because the compounded feed used composed of selected feed stuffs (ingredients) such as maize, brewery dried grains (BDG), Wheat offals, Palm kernel cake (PKC), Groundnut meal, Soya bean meal, Fish meal, Oyster shell, bone meal and growers premix. Each of these feed stuffs performs its individual roles in mass

gain, shell length and shell width of snails.

Fish meal is a good source of methionine, lysine and tryptopham, it is also a good source of vitamine B complex particularly vitamine B_2 (Riboflavin) and vitamine B_{12} (Choline). Likewise Soya bean meal is a good source of indispensable amino acid, calcium and phosphorous. Maize, brewery dried gain and wheat offal gives adequate energy to the snails. The addition of bone meal and oyster shell to the compounded feed provide phosphorous and calcium respectively to the snails.

The control (pawpaw leaf), although it is rich in crude protein but because of its high moisture (75%) and fibre (9.3%). Snail does not able to consume large quantity of it more so it has low methionine and lysine and lack some other essential amino acid. It also has low calcium and phosphorous compare to that of soya bean meal and fish meal included in the compounded feed.

3.3 RECOMMENDATION.

In setting up a snail farm compounded feed should be used to facilitate rapid growth, interms of mass, length of the shell and width of the shell . Though the cost of compounding the feed and the protein level to be used must taken into consideration. Compounded feed of appropriate crude protein level with selected composition of feed stuffs will make snail perform very well especially during the

dry season when it is difficult to get fruits or leaves. Therefore supplementation of compounded feed should be done in snail rearing in order to reduce the length of time required to attain market size and age of maturity.

Further research should be carried out to determine the effect of experimental diets on the attainment of sexual maturity and appropriate protein level for snail.

Finally, from the result of this experiment, compounded feed with crude protein 22% (treatment four) is here by recommended to feed snails, this will facilitate rapid growth and make the snail to attain maturity in time.

Table 3.1 Proximate Composition of Experimental Diets.

Nutrient %	T_1	T_2	T_3	T_4	T_5
Moisture	8.82	9.13	9.41	9.43	75.21
Crude Protein	16.07	18.16	19.98	22.05	32.46
Crude Fibre	6.72	6.10	4.91	4.28	9.31
Ether Extract	3.43	4.67	4.86	4.98	1.01
Ash	5.18	5.23	5.41	4.49	8.61
Total Carbohydrate	59.78	56.71	56.43	54.77	48.61

Table 3.2 Mean weekly Feed Intake of snail Fed Experimental Diets (g)

(g\week)

Mass gain (g)[a]

Duration week	T_1	T_2	T_3	T_4	T_5
1	13.48±0.83	14.83±0.86	15.81±0.86	14.93±0.91	14.84±0.84
2	15.61±0.55	17.73±0.84	18.21±0.87	15.21±0.88	19.58±0.86
3	18.28±0.87	19.18±0.87	20.91±0.89	16.92±0.89	18.98±0.85
4	19.98±0.86	21.29±0.88	23.02±0.90	18.61±0.87	21.48±0.82
5	23.14±0.88	22.96±0.90	24.93±0.88	22.16±0.90	29.01±0.81
6	26.01±0.87	25.28±0.89	27.13±0.86	28.98±0.87	29.91±0.86
7	27.99±0.86	27.83±0.86	29.58±0.90	30.73±0.91	34.28±0.87
8	30.33±0.85	30.33±0.89	33.15±0.91	36.88±0.89	35.73±0.84
9	32.79±0.88	33.93±0.88	36.13±0.90	41.21±0.90	37.11±0.87
10	35.67±0.87	36.13±0.89	38.79±0.89	47.83±0.88	40.73±0.84
11	38.82±0.88	39.42±0.90	43.52±0.90	53.52±0.87	42.73±0.84
12	40.31±0.89	44.28±0.89	48.21±0.91	59.73±0.90	47.91±0.86

[a]Mean of Five Measurements

Table 3.2 Mean weekly mass gain of snail Fed experimental diet (g \ week)[a]

Mass gain (g)

Duration (week)	T_1	T_2	T_3	T_4	T_5
1	3.23 ± 0.2	3.79 ± 0.1	3.37± 0.02	3.08±0.03	1.58± 0.05
2	3.76±0.04	3.52±0.01	4.47±0.01	3.81±0.01	2.36 ±0.06
3	4.0 ± 0.05	4.12±0.02	4.56±0.01	4.39±0.01	2.46± 0.08
4	3.16 ± 0.04	4.76±0.02	4.99±0.02	5.63±0.02	2.79± 0.04
5	3.09± 0.03	5.29±0.02	5.72±0.02	7.35± 0.03	2.98± 0.07
6	4.19± 0.02	5.83±0.03	7.08±0.03	7.92±0.04	3.28± 0.08
7	5.97± 0.03	6.29±0.02	8.81±0.02	8.61±0.03	3.72± 0.06
8	6.38± 0.05	6.96±0.02	8.42± 0.02	9.03±0.03	3.82± 0.08
9	6.79± 0.03	7.88± 0.03	8.61±0.03	9.68 ±0.02	3.89± 0.03
10	7.08±0.03	8.57± 0.02	9.77± 0.03	9.81± 0.02	3.96± 0.06
11	7.23± 0.05	8.68 ± 0.03	9.86±0.04	10.11±0.04	4.18± 0.08
12	7.81± 0.06	9.00± 0.04	9.99± 0.05	10.32±0.04	4.32± 0.09

Mean of Five measurement[a]

Table 3.3 Mean weekly shell length increase of snail fed experimental diet (mm \ week)

Shell length (mm)[a]

Duration (week)	T_1	T_2	T_3	T_4	T_5
1	0.15±0.06	0.22±0.09	0.19±0.02	0.21±0.04	0.11±0.07
2	0.17±0.03	0.29±0.08	0.21±0.08	0.25±0.08	0.17±0.09
3	0.21±0.08	0.31±0.09	0.22±0.09	0.27±0.07	0.22±0.04
4	0.24±0.05	0.35±0.07	0.26±0.07	0.30±0.09	0.23±0.06
5	0.27±0.07	0.38±0.08	0.28±0.4	0.37±0.08	0.24±0.14
6	0.29±0.06	0.42±0.07	0.33±0.08	0.43±0.12	0.27±0.08
7	0.32±0.04	0.44±0.06	0.39±0.09	0.50±0.10	0.33±0.05
8	0.35±0.09	0.47±0.09	0.46±0.09	0.57±0.06	0.36±0.12
9	0.39±0.07	0.50±0.04	0.53±0.12	0.63±0.05	0.39±0.11
10	0.47±0.08	0.54±0.07	0.63±0.09	0.70±0.04	0.41±0.13
11	0.54±0.06	0.57±0.03	0.73±0.10	0.81±0.09	0.49±0.08
12	0.58±0.09	0.65±0.05	0.80±0.08	0.82±0.08	0.52±0.07

[a] Mean of five measurements

Table 3.4 Mean weekly width increase of snails shell fed experimental diet (mm \ week)

Width increase (mm)

Duration (week)	T_1	T_2	T_3	T_4	T_5
1	0.14±0.10	0.16±0.4	0.17±0.07	0.15±0.10	0.13±0.09
2	0.17±0.05	0.21±0.06	0.19±0.04	0.20±0.09	0.14±0.06
3	0.24±0.09	0.26±0.09	0.23±0.08	0.24±0.03	0.17±0.03
4	0.29±0.13	0.30±0.11	0.29±0.12	0.28±0.08	0.15±0.12
5	0.30±0.08	0.33±0.07	0.31±0.09	0.34±0.06	0.19±0.09
6	0.31±0.07	0.34±0.08	0.34±0.06	0.37±0.12	0.20±0.06
7	0.34±0.04	0.36±0.09	0.37±0.05	0.40±0.09	0.22±0.08
8	0.38±0.11	0.39±0.96	0.41±0.04	0.43±0.06	0.24±0.07
9	0.41±0.09	0.41±0.08	0.44±0.03	0.46±0.07	0.25±0.08
10	0.43±0.07	0.45±0.09	0.46±0.02	0.49±0.09	0.28±0.09
11	0.47±0.07	0.49±0.12	0.51±0.06	0.52±0.07	0.33±0.11
12	0.50±0.08	0.52±0.08	0.54±0.08	0.58±0.13	0.35±0.04

[a] Mean of five measurement

Table 3.6 Proximate composition of the edible portion of the experimental Snails (% dry mass basis)

Parameter (%)	T_1	T_2	T_3	T_4	T_5
Moisture	7.96	7.98	8.11	7.98	8.20
Crude protein	79.97	82.01	83.68	85.89	84.58
Ether extract	1.61	1.6	1.61	1.63	1.59
Ash	0.60	0.62	0.61	0.64	0.61
Total carbohydrate	9.86	92.21	5.99	3.86	5.02

Table 3.7 Mineral contents of edible portion of the experimental snail (mg / 100 dry sample)

Sample	Ca	P	Na	K	Mg	Fe	Cu	Zn
T1	184.92	61.18	26.18	63.21	24.02	1.35	0.59	1.78
T2	184.88	61.19	26.17	63.23	24.03	1.34	0.58	1.72
T3	185.48	61.21	26.19	63.24	24.02	1.34	0.55	1.76
T4	185.56	61.20	26.18	63.24	24.06	1.33	0.53	1.74
T5	185.60	61.17	26.21	63.22	24.04	1.35	0.52	1.68

Table 3.8 Chemical analysis of experimental soil.

Parameters	Mg/100
Calcium (Ca)	6.02
Magnesium (Mg)	3.63
Cation exchange capacity	0.07
Potasium (K)	1.33
% Base saturation	99.00
% Carbon (C)	0.88
% Nitrogen (N)	0.09
PH	6.84
Soil type	Sandy loam

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Picture 2: The Picture of Snails (*Achachatina marginata*) at the begining of the experiment

Picture 3: The Picture of Snails (*Archachatina Marginata*) at the end of the experiment.

Picture 4: The picture of the Eggs laid by the Snails during the experiment.

Appendix 1

Anova table for feed intake.

Sv	df	SS	Ms	F cal
Total	14	4691.88	-	
Treatment	4	2738.44	484.61	3.50
Error	10	1953.44	195.34	

f tab 3 84, 05)

f tab { 7.01; 0.01}

f cal< f tab There is no significance among the feeding intake of the treatment.

Appendix 2

Anova table for mass gain

Sv	df	SS	Ms	F cal
Total	14	1672.40	-	-
Treatment	4	8605.76	2151.44	2.64
Error	10	8156.64	815.66	

f tab {3.84; 0.05}

f tab {7.01;0.0}

f cal < f tab ; there is no significant difference among the mass gain of the snail in the treatments Duncan Multiple Range test

T_4	T_3	T_2	T_1	T5
89.74^a	83.42^a	74.69^a	62.61^b	35.89^c

Mean with the same superscript are not significantly different.

Appendix 3

Anova table for shell length increase

Sv	df	SS	Ms	F cal
Total	14	4691.88	--	
Treatment	4	2738.44	68461	3.50
Error	10	1953.42		

f tab { 3.84;0.05}

f tab { 7.01;0.01)

f cal < f tab hence there is no significant among the treatment means.

Appendix 4

Anova table for shell width increase.

Sv	df	SS	Ms	Fcal
Total	14	2.76	-	
Treatment	4	1.43	0.36	2.77
Error	10	1.33	0.13	

f tab {3.84; 0.05)

f tab { 7.01 ; 0.01}

f cal < f tab hence, there is no significant difference among the treatment means.