EFFECT OF ENSILED AND SUNDRIED RUMEN DIGESTA FROM CATTLE SHEEP AND GOAT ON THE PERFORMANCE AND CARCASS CHARACTERISTICS OF WEANER RABBIT

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AHMADU BELLO UNIVERSITY, ZARIA.

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A THESIS SUBMITTED TO THE POST-GRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ANIMAL SCIENCE.

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DECLARATION

I hereby declare that the work in this thesis entitled, **"Effect of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat on the Performance and Carcass Characteristics of Weaner Rabbits"** was performed by me in the Department of Animal Science, under the supervision of Prof. J. J. Omage and Prof. A. M. Adamu. The information derived from literature was duly acknowledged in the text and a list of references provided. No part of this Thesis was previously presented for another Degree or Diploma at any University.

_____ _____

Anoh Kevin Usman Date

CERTIFICATION

This Thesis entitled **EFFECT OF ENSILED AND SUNDRIED RUMEN DIGESTA FROM CATTLE, SHEEP AND GOAT ON THE PERFORMANCE AND CARCASS CHARACTERISTICS OF WEANER RABBITS** by Anoh Kevin Usman, meets the regulations governing the award of degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Prof. J. J. Omage — Date

Chairman, Supervisory Committee

Prof. A. M. Adamu — Date

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DEDICATION

I humbly dedicate this work to God Almighty who gave me the strength to complete this work, my parents, Mr. and Mrs.Stanislaus O. Anoh and to the blessed memory of my uncle Mr. Alphonsus O. Agbe who died in 2001.

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ABSTRACT

Two feeding trials were conducted using a total of 35 weaner rabbits to evaluate the effects of ensiled and sundried rumen digesta from cattle sheep and goat on the performance of weaner rabbits. In experiment 1, the ensiled and sundried rumen digesta were included in the weaner rabbit diets at 20% dietary level in a completely randomized design. There were seven (7) treatments group including the control and each replicated 5 times with each rabbits as a replicate. The rabbits were randomly allotted to the treatment groups and housed individually in a cage. The experimental diets were designated T_1, T_2, T_3, T_4, T_5, T_6 and T_7, formulated to be iso-carloric and iso-nitrogenous. The feeding trial lasted for 8 weeks during which experimental feed and water were given *ad libitum*. Parameters monitored were daily feed intake, daily body gain, daily water intake, feed to gain ratio, feed coat/kg gain, carcass and haemtology such as pack cell volume (PCV), red blood cells count (RBC), white blood count (WBC), haemoglobin (HB) total protein (TP) and the differentials. Average daily feed intake and weight gain were significantly higher ($P<0.05$) and similar in rabbits fed the control and 20% inclusion of sundried sheep rumen digesta (SSRD) (69.21g, 59.99g and 18.5 12.8g) respectively. The feed to gain ratio and feed/kg gain also followed the same trend. The daily water intake was significantly higher ($P<0.50$) in SSRD than the others. All the nutrients in the control diets were better utilized ($P<0.05$) by rabbits than the rumen digetsa of the cattle, sheep and goat. SSRD was better utilized than that of cattle and goats. All the carcass parts and internal organs were significantly influenced ($P<0.05$) except the lungs, loin, forelimb and length of small intestine. All the haematology indices except PCV, RBC, TP, monocytes and eosinophils were significantly ($P<0.05$) affected by treatments. In experiment 2, SSRD was included in rabbit diets at graded levels of 10, 20, 30, 40 and 50% to make 6 treatments. Thirty (30) weaner rabbits were randomly allotted to the treatments in a

completely randomized design having 5 animals per treatments replicated 5 times. Water and feed were given *ad libitum* parameters monitored were the same as in experiment 1. Average feed intake, weight gain, feed to gain ratio and feed cost/kg gain were similar to the rabbits fed the control and 30% dietary inclusion of SSRD but were significantly higher than others. Water intake was consume more ($P<0.05$) by rabbits on 50% SSRD. All the carcass part and internal organs were significantly affected ($P<0.05$) except slaughtered weight, lungs, hearts, kidney, thigh, forelimb, stomach and small intestine. All the haematological indices were significantly ($P<0.05$) influenced. The result indicated that SSRD can be included optimally in rabbit diets at 30% without any adverse effects.

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CHAPTER ONE

1.0 INTRODUCTION

Nigeria is richly endowed with a variety of animal protein sources with livestock population of 13.8 million cattle, 34.4 million Sheep and goats, 22 million exotic poultry, 1.7 million domestic rabbit (RIM, 1992). Despite this, Nigeria has not been able to provide animal protein in sufficient quantity to meet the requirements of the citizenry. Many Nigerians consume less than 10 grams of animal protein daily as against the minimum requirement of 54 g/person/day considered consistent with a balance diet (FAO, 2007). However, increasing the dietary animal protein intake at a reasonable cost using micro livestock has been part of the National Agricultural Policy (Sabayo *et al*., 2007).

A lot of effort is therefore required in popularizing the raising of rabbits among the rural populace and other low income groups. Rabbits hold a lot of promise for increasing the supply and intake of animal protein among these classes of people. This is because they multiply and grow rapidly producing an average of 6-8 kittens and kindle 3-4 times yearly as a result of their short gestation period of 28-30 days. Rabbits produces high quality meat and can utilize very cheap feed materials (Aduku, 1992).

The type of feed provided for the rabbits must be given special attention to ensure it meets the requirements for energy, protein, vitamins, minerals and other micro nutrients necessary for optimum growth and development. The key to abundant animal production is the availability of cheap and balanced feed. Feed cost and quality determines the growth rate and the population of the animals that can be kept on the farm (Aduku, 1992). There is therefore, the need to intensify research into alternative feed sources that are affordable and available to cut down cost of

production. There is presently global concern for the proper disposal of waste hence the conversion of agro waste to flesh as a means of reducing environmental hazard have been suggested (Teguia *et al.,* 1993). Studies on the utilization of agro-industrial by products in animal feed have increased in the last two decades in order to reduce the high price of feed stuffs (Alawa and Umuna, 1993; Onimisi, 2005; Onimisi and Omage, 2006). Rumen digesta is one of these wastes that pose a problem to the environment. It is an abattoir by product obtained from cattle sheep and goat as well as camal (Maigandi *et al*., 2004). Magaindi and Tukur (2002) reported the proximate analysis of rumen digesta for carmel, cattle sheep and goat slaughtered at the sokoto abattoir. In their studies, camel rumen digesta was reported to have 8.39% crude protein (CP), 11.98% ether extract (EE), and 36.74% (CF) while 8.18% CP, 2.68 EE and 33.31% CF were documented for cattle. Sheep rumen digesta had 9.18% CP, 5.57% EE and 33.31% CF while 8.03 % CP, 5.57% EE and 30.83% CF were values for goat. A range of 9.20-20% Crude protein has been reported for rumen digesta (Ekwuoma, 1992; Adeniji, 1996; Whyte and Wadak, 2002; and Odunsi, 2003). Rumen digesta has not been reported to contain any anti nutritional factor therefore it may not only serve as feed, but recycling it will enhance proper disposal and reduce environmental problems.

1.1 Objectives of study

This study was designed to evaluate the effects of rumen digesta from cattle sheep and goats processed by ensiling and sundrying on the performance of rabbits.

The objectives of this study are to

i) determine the proximate composition of ensiled and sundried rumen digesta.

ii) evaluate the growth performance of growing rabbits fed ensiled and sundried rumen digesta from cattle, sheep and goat.

iii) evaluate the effect of graded levels of sundried rumen digesta of sheep on the performance of weaner rabbits.

iv) determine the hematological parameters of the rabbits fed with the experimental diets containing ensiled and sundried rumen digesta.

v) evaluate the economic advantage of using rumen digesta in rabbit diets.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 FEEDING OF RABBITS

The performance of a good and healthy rabbit can become poor when inadequately fed while low producing ones can be improved on with good feed, because an animal which is not well fed cannot give its best (Sandford, 1979). Rabbits can be maintained on ration consisting of roughages, home grown vegetables and cereal grains. These feeds are generally supplemented with additives such as lysine, methionine, vitamin-premixes and a source of calcium such as limestone or bone meal. Concentrate can be fed in a mash form when it is home produced or in pelleted form as in most commercial operations.

Anyanwu *et al*., (1982) reported that succulent forages can be offered to rabbits. The digestion of these green forages according to the authors is as a result of the nature of their simple stomach that has a large caecum in their digestive tract. They further stated that this large caecum contains a few microorganisms, which are involved in the conversion of cellulose in the forages to the digestible glucose.

2.1.2 Feeding Behavior of the Growing and Adult Rabbit

From weaning (classically between 4 and 5 weeks), the daily feed intake of the domestic rabbits fed a complete pelleted feed increases in relation to metabolic Live weight (LW) and stabilizes at about 5 months of age. It was observed that at 4 weeks, a young rabbit eats 0.25% of the amount an adult rabbits eats, but its LW is only 0.14% of that of the adult (Gidenne and Lebas, 1987).

Like other mammals, the rabbit regulates its feed intake according to its energy requirements (Gidenne and Lebas, 1987). Chemostatic mechanisms are involved, by means of the nervous system and blood level of compounds used in energy metabolism (Gidenne and Lebas, 1987). In non-ruminants, however, blood glucose level plays a key role in the regulation of food intake; while in ruminants the plasma level of volatile fatty acids have a major role. Since the rabbit is a non-ruminant herbivore, the main blood component regulating feed intake is not clear, but it is probably the blood level of glucose (Lebas, 1983). Voluntary intake, proportional to metabolic Live weight ($LW^{0.75}$), is about 900–1000 kJ DE day/ kg $LW^{0.75}$ (Gidenne and Lebas, 1987).

2.2 ENERGY, PROTEIN AND WATER REQUIREMENTS OF RABBITS

2.2.1 Energy Requirements for Growth

An increase in the level of dietary energy intake also affects body gain composition and the partition of energy retained as protein and fat. The body composition changes are not linearly correlated with dietary energy (DE) intake, because some constituents such as fat tend not to increase in proportion to the dietary energy intake. The efficiency of energy utilization for growth is clearly influenced by the levels of growth, because energy retained from protein sources are less efficiently utilizedthan that of fat (Blaxter, 1989; Close, 1990). Lebas, (1983) stated that a growing rabbit is able to adjust its voluntary feed intake according to the energy concentration of the diet in order to maintain constant daily intakes of 920 -1000/KJ/$kgW^{0.75}$ DE per day.

Energy required by rabbits is within 9.6-9.64 MJ/kg metabolizable energy, depending on the physiological state of the animals (i.e maintenance, pregnancy, growth, lactation) and this energy can be supplied mainly from carbohydrates and fats (Lebas, 1980; Aduku and Olukosi 1990).

Lang (1988) reported that energy requirements in rabbits are greater for lactation than for other productive functions. Feed intake for rabbits is primarily to satisfy their energy requirement (Lebas, 1980). Like any other monogastrict animals, the rabbit enzymes cannot digest cellulose, rather it is broken by the bacteria in their caeca (Fielding, 1991).

2.2.1.1 Voluntary Feed and Energy Intake

Appetite in rabbit is mostly regulated by a chemostatic mechanism; hence, the total quantity of energy ingested daily tends to be constant (Lebas, 1980). The author further stated that growing rabbits in good sanitary conditions naturally consume sufficient feed to meet their energy requirements. However, reproducing does have high energy requirements for pregnancy, lactation and concurrent pregnancy and lactation that are often not covered by an adequate voluntary energy intake. Voluntary energy intake is proportional to metabolic live weight ($LW^{0.75}$). In growing rabbits, voluntary intake is about 900–1000 kJ DE/ day/ kg $LW^{0.75}$ and chemostatic regulation appears only with a DE concentration greater than 9 MJ/ kg in the diet (Cheeke, 1987; Parigi-Bini, 1988; Santoma *et al*., 1989). Below this level a physical type regulation is prevalent, which is linked to the filling of the gut with dietary material (Cheeke, 1987).

Reproducing females can ingest on average 1100–1300 kJ DE/ day/ kg $LW^{0.75}$ during lactation, with the lowest value recorded by primiparous females (Maertens and DeGroote, 1988; Parigi Bini *et al*., 1990, 1992; Xiccato *et al*., 1992, 1995, 2004; Pascual *et al*., 1998), that have a different energetic limit of chemostatic regulation compared to growing rabbits. An increase in

DE concentration greater than or above 9–9.5 MJ/ kg permits a further increase in the daily energy intake of lactating females (Maertens and De Groote, 1988; Fraga *et al*., 1989; Castellini and Battaglini, 1991; Xiccato *et al*., 1995; Pascual *et al*., 1998, 1999). In these animals, the regulation limit probably varies by around 10.5– 11 MJ/ kg which equally depend on the dietary energy source, tending to be higher in added fat diets than in high-starch diets (Fraga *et al*., 1989; Castellini and Battaglini, 1991; Xiccato *et al*., 1995; Fortun-Lamothe and Lebas, 1996; Pascual *et al*., 1998, 1999).

2.2.2 PROTEIN REQUIREMENT OF RABBITS

Many attempts have been made to determine the exact protein requirement of rabbits. Reports obtained so far have shown a dietary requirement for ten amino acids (Adamson and Fisher, 1971; NRC, 1995). Aduku and Olukosi (1990) stated that the quantity and quality of these amino acids are not critical in rabbits as in other animals such as poultry because rabbits practice coprophagy and can adapt to low or poor protein situation, except that the production will not be optimal. With high and good protein quality however, optimum production can be achieved.

de Blas and Mateos (1998) had reported that the amino acid supply through caecotrophy was for a long time been considered adequate to support essential amino acid requirements in rabbits. In reality, rabbits fed conventional diets, have crude protein contribution from soft faeces to be about 0.15–0.18% (Fraga, 1998; Carabano *et al*., 2000); with limited information available on the different amino acids. In lactating does, the contribution of caecotrophy was 0.17% of the supplied sulphur amino acid, 0.18% of lysine and 0.21% of threonine (Nicodemus *et al*., 1999).

The most limiting essential amino acids in rabbit diets are methionine, lysine and threonine (Taboada *et al*., 1996). A minimum level of 5.4 g total sulphur-containing amino acid /kg (4.0g

digestible amino acid/ kg) is required to obtain adequate productivity in growing and non-reproducing rabbits. A higher level (6.3 g total amino acid/ kg and 4.9 g digestible sulphur-containing amino acid/ kg) was recommended for reproducing females to increase milk production, reduce the interval between parturitions and improve feed utilization efficiency (Taboada *et al*., 1996). Recommended levels of lysine (for lactation diets with 10.5–11 MJ DE/ kg) was 6.8 g total lysine/ kg (5.2 g digestible lysine/ kg) for maximum reproductive performance; and 7.6–8.0 g total lysine (6.0–6.4 g/ kg digestible lysine) /kg for maximum milk production and litter growth (Taboada *et al*., 1996).

Various units are available for expressing protein requirements (de Blas and Mateos, 1998; Fraga, 1998; Carabano *et al*., 2000; 2008). Crude protein (CP) and apparent dietary protein (DP) are the most commonly used available description for both requirements and raw material composition (Villamide *et al*., 1998; Maertens *et al*., 2002).

In reality, rabbits have specific amino acid requirements and apparent faecal and true ileal digestible amino acids would be more reliable units. All the same, even if increasing information is given on the amino acid concentrations of the most common raw materials, digestible amino acid requirements and concentration in feeds are barely known; and even less information exist on ileal digestible amino acid (Carabano *et al*., 2008).

In practice, due to the chemostatic regulation of appetite in rabbits, nitrogen requirements are expressed in relation to dietary energy by the dietary protein (DP) to the dietary energy (DE) ratio, which is directly correlated to body nitrogen retention and excretion (Carabano *et al*., 2000).

2.2.2.1 Protein Requirements for Growth

In growing rabbits, dietary protein (DP) is estimated to be 2.9 g DP/ day/ kg $LW^{0.75}$ (Partridge *et al*., 1989; Fernandez and Fraga, 1996; Motta Ferreira *et al*., 1996; Fraga, 1998). Lower DP has been found in a new strain of laboratory rabbits (2.11–2.14 DP/ day/ kg $LW^{0.75}$), which was attributed to a lower basic metabolic rate (Lv *et al*., 2009). In non-reproducing adult rabbits, there is no specific information on DP hence, the same figures is assured as for growing rabbits. Dietary protein requirements vary according to the growth rate.

The efficiency of utilization of dietary protein intake for growth is estimated to be 0.56% (Partridge *et al*., 1989; Fernandez and Fraga, 1996; Motta Ferreira *et al*., 1996; Fraga, 1998). Overall DP retention (RP/DPI) decreases linearly from 0.40% to 0.10% with increasing live weight, due to the increase in dietary protein used for maintenance (Xiccato and Cinetto, 1988; Trocino *et al*., 2000; 2001). Lebas (1980) and NRC (1995) have recommended 12-13% crude protein for maintenance, 15-16 % for growth, 15-18 % for gestation and 17-18 % for lactation.

2.2.3 WATER REQUIREMENT OF RABBITS

Water is essential as a constituent of all part of the body and without it, food can rarely be digested. The maintenance of effective elimination of harmful products via the urine is dependent upon available water, as it is also important in the maintenance of almost all other physiological processes.

Gillespie, (1992) observed that rabbits need good supply of cool clean water at all times for the maintenance of health and that rabbits usually consume 2-3 times more water than dry matter. Sanford, (1979) reported that water intake in rabbits is variable; it is higher in the young rabbits than in the old, thus a shortage of water in early life has much more serious effect. Restricted amount of water may seriously retard growth even though their water requirement can

sometimes be satisfied by highly succulent rations (which is not generally desirable). It is preferable to supply fresh drinking water (Sanford, 1979).

Water consumption is affected by both hot and cool weather as well as salt content of the feed (Stephen, 1980). Under hot conditions feed intake is reduced and water is increased while under cool condition feed intake increased and water intake is reduced (Stephen, 1980). It could also reduce milk supply of suckling doe's and may predispose the rabbits to digestive disorders.

In a review by Akpet *et al*., (2007), it was reported that low quality water normally results in reduced or low water intake, and hence low feed consumption and production in birds. Stephen, (1980) also stated that water intake in rabbits increased when the diet contained higher levels of fibre.

2.3 ROLE OF FIBER IN RABBIT NUTRITION

Available data indicate that fiber is necessary in rabbit diets for normal functioning of the digestive tract (Champe and Maurice, 1983). Rabbits require a level of crude fiber in excess of 9% for normal growth and to reduce the incidence of enteritis and diarrhea (Champe and Maurice, 1983). Low fiber levels predispose the animal to diarrhea (Champe and Maurice, 1983). Crude fiber levels of between 10-17% were found to support weight gain, the optimum level at 14.8% for a live weight gain of 41.3g/day/animal (Check and Amberg, 1972). The workers reported further that a crude fiber level exceeding 17% reduced performance by limiting energy intake of the animal.

It has been reported that rabbits were able to digest fiber relatively well, due to the presence of the caecum (Laplace, 1978). The author further stated that rabbits were able to separate fibre and non-fibre components in the hind-gut with the rapid excretion of the fibre hard faeces and that,

the non-fibre components were digested because of re-ingestion as caecotropes and thus subjected to more than one passage through the digestive track. It was also reported that with hind gut fermentation a high intake of high fiber diet can be achieved with nutrient requirement met as a result of high digestibility of non-fiber component (Laplace, 1978).

Of the factor that affect the digestibility of any feeding stuff, the most important is the amount of fiber it contains (Sandford, 1979). Furthermore as the proportion of the fibre constituent rises, the total digestibility and the individual digestibility of the various constituent of the feed decreased. The reason advanced is that the fiber tends to protect the more digestible constituents from the digestive juices.

Rabbits eat hair from their body when fed low fibre diets in attempt to satisfy crave for fiber (Aduku and Olukosi, 1990). Increase in dietary fiber help to reduce hair ball problem which reduces feed consumption. Feeding hay or other coarse roughages, also help to "sweep" hair from the stomach hence prevention of hair ball disease. This can block the opening of the stomach and ultimately leads to death due to starvation (Sanford, 1979).

2.3.1 Fibre Digestion and Degradation by Rabbits

Traditionally, fermentation of dietary fiber (DF) has been considered to be a post-ileal activity of the endogenous microbiota. However, there is evidence that some components of structural carbohydrates are degraded prior to entering the caecum of rabbits (Yu *et al*., 1987). This has also been observed in other non-ruminant species such as pigs and poultry (Yu *et al*., 1987). The extent of pre-caecal fibre digestion in rabbits varied from 0.07 to 0.19% for crude fibre (Yu *et al*., 1987), from 0.05 to 0.43% for NDF (Gidenne and Ruckebusch, 1989; Merino and Carabano, 1992) and from 0 to 0.37% for Non Soluble Polysaccharides (NSP) (Gidenne, 1992). It must be

pointed out that the values obtained using NDF and crude fibre with respect to those obtained with NSP might be overestimated due to solubilization and filtration of cell wall components that would be considered digested. When NSPs have been analysed, arabinose and uronic acids, typical monomers of pectic substances, have been found to be largely digested before the ileum (from 0.2 to 0.5%). On the other hand, glucose and xylose, the major monomers in most fibre sources, showed a much lower ileal digestibility (0–0.2%) (Bach Knudsen, 2001). These results implied that around 0.4% (from 0.2 to 0.8%) of total digestible fibre (including water-soluble NSP) is degraded before the caecum, which is similar to that observed in pigs (Bach Knudsen, 2001). This could be explained by the 'remaining' fibrolytic activity from microbiota (Gomez-Conde *et al*., 2007, 2009) supplied by soft faeces, and observed in the stomach and small intestine (Marounek *et al*., 1995) by the established microbiota.

2.4 PROCESSES OF ENSILING FEED MATERIALS

Ensiling processes are the changes which take place when a feed material with sufficient moisture that can cause fermentation is ensiled in a silo in absence of air. These processes take place between 2 to 3 weeks of ensiling (Amodu and Abubakar, 2004). Ensiling processes are broadly divided into three (3) phases;

Phase1: Aerobic phase

This phase begins from the time of harvesting crop to the time oxygen is depleted in the sealed silo (Adesogan and Newman, 2008). Amodu and Abubakar (2004) reported that during this period, the living plant cells continue to respire, consuming the entrapped air, producing carbondioxide and water and releasing heat as energy. The heat produced by respiration raises the temperature of silage which may reach up to 46^{o}C in forages with moisture content of 50 to

70% (Barnhart, 2008). Furthermore, plant enzymes such as proteases and carbohydrases are active during this phase, provided the pH is within the normal range of 6.0-6.5. Plant enzymes convert complex carbohydrates to water soluble carbohydrates (WSCs) and proteolysis also occurs (McDonald *et al.,* 1998). Piltz and Kaiser (2004) stated that respiration is undesirable because it results in loss of DM, energy and available WSCs required by the lactic acid bacteria (LAB) for fermentation. Harvesting at the correct plant maturity, chopping to the right particle length, packing the silo tightly and sealing properly are the keys to minimizing nutrient losses during the aerobic phase (Adesogan and Newman, 2008).

Phase 2: Fermentation phase.

The fermentation phase commences once anaerobic conditions are achieved within the silo (Pitz and Kaiser, 2004). This phase starts after the oxygen is used up, when anaerobic bacteria begin to ferment plant sugars into organic acids, alcohols, carbondioxide and nitrogenous compounds (Barnhart, 2008). During this period, acids are produced, that lowers the silage pH below 5 (Lemus, 2010) and prevents further microbial activity, thus preserving the sillage. McDonald *et al.* (1998) stated that the LABs which are facultative anaerobic continue to increase, fermenting the WSCs in crops to organic acids mainly lactic acids which reduces the pH value. The acids produced finally reaches a point where the bacteria themselves are killed, thus completing the silage making process and at later stage, silage in good silo will remain unchanged for a period 10 to 15 years (Amodu *et al*., 2008). This period when silage remain unchanged for long period is also called stable phase. If the population of clostridia bacteria increases, a secondary fermentation can occur, thus fermenting the WSCs, lactic acids and protein to produce butyric,

propionic and acetic acids and ammonia nitrogen plus a number of intermediate compounds releasing strong offensive odours (Piltz and Kaiser, 2004; Adesogan and Newman, 2008).

Phase 3: Feedout phase

This phase begins when silage is opened for animal feeding. The silage is exposed to air where aerobic bacterial, mould and yeast can thrive hence spoil the silage (Barnhart, 2008). These organisms convert remaining plant sugars, lactic acid, or other energy-rich nutrients in the silage to carbon dioxide, water, and heat (Barnhart, 2008) thus increasing the pH. The phase is also called "aerobic deterioration" or "aerobic spoilage". Aerobic organisms that have been dominant during the aerobic phase revive and multiply (Piltz and Kaiser, 2004). The first sign of aerobic spoilage is heating the feed taken or in the feeding trough (Martin *et al*., 2004). Piltz and Kaiser (2004) stated that yeasts, moulds, some fungi and bacteria (Bacillus, LAB, acetobacteria) may produce mycotoxins that can be harmful to animals. The silage should be fed out at a rate of at least 20.5 to 30cm per day and a straight face should be maintained with shavers (Adesogan and Newman, 2008).

2.4.1 Types of Silage.

Silages are classified based mostly on the acids formed after fermentation. Piltz and Kaiser (2004) classified silages into five types as follows;

i Lactic silage

In this silage, fermentation is dominated by lactic acid bacterial (LAB), WSCs are primarily converted to lactic acid and it has pleasant, acidic and sweet smell with a pH of 3.8 to 4.2.

ii Acetate silage.

Fermentation is dominated by enterobacteria, and it occurs when low dry matter DM, unwilted or slightly wilted silage is ensiled, WSCs are primarily converted to acetic acids, and it has sour or vinegar smell, the pH is above 4.2 and the DM as well as energy losses can be significant.

iii Clostridia silages

Fermentation is dominated by clostridia; and it occurs when low DM, unwilted or lightly wilted silage is ensiled. Water soluble carbohydrates and lactic acids are converted to butyric and acetic acids. Clostridia silages have high pH and low lactic acids. Proteins and amino acids levels are extensively degraded. These silages are unpalatable to livestock.

iv Wilted silage

Fermented by LAB, fermentation is restricted by high DM content(>30%), less WSCs, pH values are higher than lactate silages, very dry forages are harder to compact and have higher residual WSCs and mould spore.

v Silages with additives

Additives are normally used to target a particular fermentation/feedlot problem and will only be expected to be having benefits where preservation would have been poor without them. The characteristic and type of fermentation observed varies with the additives.

2.4.3 Silage Storage

Silages are usually stored to ferment in containers called silos. Edoka, (2006) reported that silage can be stored in any container and it must exclude air from the stored material, including entrance of air into the container. The kind of silo and the choice of contraction material should be determined primarily by economics and suitability to the particular needs of the farmer or ranch (Amodu and Abubakar, 2004). The type of silo in which a farmer may choose to ferment his crops are varied, ranging from small plastic bag to large cylindrical towers built of concrete, steel or wood(McDonald, *et al*., 1998).

Edoka, (2006) stated that silos may be classified according to five basic methods as follows;

1 Conventional upright(tower) silos

a- Concrete stave.

b- Galvanized steel.

c- Wood stave.

d- Monolithic concrete(poured in place)

e- Tile block.

f- Brick.

2 Gas-tight(oxygen-limiting) silos

a- Gas lined structures.

b- Galvanized steel.

c- Concrete stave.

d- Monolithic concrete.

3 Pit silos

4 Horizontal silos

a- Trench silos (below ground level).

b- Bunker (above ground level).

5 Temporary silos

a- Enclosed stacks.

b- Open stacks.

c- Modified trench-stack silos.

d- Plastic or polyethylene bag silos.

e- Round bale bagged or wrapped silos.

2.5 Rumen Digesta as Feeding Material

Rumen digesta is an abattoir by product obtained from cattle sheep and goats as well as camels (Maigandi *et al*., 2004). Maigandi and Tukur (2002) reported the average proximate composition of rumen digesta from animals slaughter at the Sokoto abattoir to be crude protein: 8.39%, 8.68%, 9.18% and 8.03% for camel, cattle sheep and goats respectively; ether extract of: 11.98%, 2.68%, 5.57% and 5.17% and crude fiber: 36.74%, 33.31%, 31.88% and 30.83% respectively.

2.5.1 The Rumen Environment

The rumen environment appears to be controlled by the type and quantity of food eaten, periodic mixing through contraction of the rumen, salivation and rumination, diffusion or secretion into the rumen, absorption of nutrients from the rumen, passage of material down the digestive tract (Hungate, 1975). The author further stated that only under abnormal circumstances is this environment drastically perturbed. For instance, if grain is suddenly introduced into the diet, lacticacidaemia may occur because of a drop in ruminal pH, growth of *Streptococcus bovis* and

the accumulation of lactic acid. Saliva is continuously added to the rumen and maintains the contents in a fluid state, to facilitating access of micro-organisms to the plant materials. It has been reported by Allison and Leek (1993) that the volume of saliva secreted by ruminants is dependent on diet. The microbial community also affects salivary flow, which may be reduced by the presence of a population of protozoa. These rapidly assimilate starch and sugars and remove the need for copious salivation to maintain rumen pH (Allison and Leek 1993).

The saliva is a buffered bicarbonate solution of about pH 8 containing high concentrations of sodium and phosphate ions. The saliva and the movement of bicarbonate ions across the rumen epithelium maintain the pH within narrow limits. The buffered rumen liquor is a favourable medium for growth of anaerobic bacteria, fungi and protozoa and allows VFAs to accumulate in the fluid (up to 0.2 molar) (Hungate, 1975).

Neutral conditions in the rumen are maintained by continual adjustment of the pH of the ruminal fluid by the above processes and by absorption of VFAs, thus ensuring continuous fermentation. The biomass of microbes in the rumen is maintained at a constant level by the passage of microbes down the digestive tract, and also by death and lysis of the micro-organisms within the rumen. Methane and carbon dioxide are produced as end products of fermentation. At low rumen pH, carbon dioxide comes out of the fermenting solution and accumulates in a pocket in the dorsal sac. Methane and carbon dioxide are largely eliminated by eructation (Hungate, 1975). At high rumen pH most of the carbon dioxide produced by fermentation or entering in saliva is absorbed and excreted via the lungs.

2.5.2Microbial Fermentation in the Rumen

Food consumed by the ruminant is subjected to the microbes inhabiting the rumen. Microorganism inhabiting the fore stomach includes bacteria, protozoa and fungi. There is

always a symbiotic relationship between the host animal and the microorganisms; because after they have utilized in the nutrient in the feed, the organism themselves will in turn constitute an important source of nutrient to the host animal.

The temperature of the rumen is between 39-40^{o}C, an optimum pH value of 6.0-6.8 and a gas composition with low oxygen content (Allison and Leek, 1993). These medium makes the rumen to be conducive for the microbes to multiply and grow. The advantages of microbial fermentation in the rumen is that it allows digestion and then absorption of fermentation products that are of value to the host (e.g., microbial cells, VFAs, and B vitamins) before the abomasums, change poor quality protein/N compounds to a "good-quality" microbial protein, selective retention of coarse particles extend fermentation time and allows for further mechanical breakdown during rumination (cud chewing), release of fermentation gas mostly Carbon dioxide and methane from the system by eructation, and toxic substances in the diet may be attacked by the microbes before being presented to the small intestine (Allison and Leek, 1993) .

2.5.3 Roles of Bacteria on Fermentation in the Rumen

Bacteria are one of those microbes in the rumen that aids in breaking down of nutrient in the diets consumed by ruminant animals. It has been reported that concentration of bacteria in the rumen is 10^{9}-10^{11}/ml of ruminal liquor (Allison and Leek, 1993). They further reported that the concentration depends on the ration composition. It is higher when animals are fed concentrate and grasses than when animals are fed diet comprising of roughages. The various substrates for microbial growth are provided by the feed. Various microbial species differ in their ability to utilize this substrate and to compete for them. Many bacteria utilize multiple substrates, some of the major groups, each of which contain multiple genera and species, include:

Cellulolytic - Digest cellulose

Hemicellulolytic - Digest hemicellulose

Amylolytic - Digest starch

Proteolytic - Digest proteins

Sugar utilizing - Utilize monosaccharides and disaccharides

Acid utilizing - Utilize lactic, succinic, malic acids, etc.

2.5.4 Roles of Protozoa and Fungi on Fermentation in the Rumen

Protozoa predominantly ciliates seem to contribute substantially to the fermentation process. Several studies have shown that lambs and calves deprived of their ruminal protozoa had depressed growth rates (Swenson and Reece, 1993). Most ciliated protozoa digest starch and they are also proteolytic and cellulolytic on high starch diet. Allison and Leek (1993) reported that protozoa population in the fore stomach is about 10^5-10^7/ml of ruminanl liquor. They further stated that the maximum density of protozoa in the rumen occurs at the pH of 6-7 and they disappear in the fore stomach when the pH is less than 5.5 or above 8.0. When the animal feeds freely on concentrate or highly pelleted fed granules, 4-5 days after starvation, these factors may result in the disappearance of the protozoa in the fore stomach.

Not much is known about the role of fungi in fermentation in the rumen. Although it has been reported that fungi possess cellulolytic activities and also ferment simple sugar they are involved in the synthesis of glycogen (Swenson and Reece, 1993).

2.5.5 Microbial Interactions in the Rumen

Rumen microbial populations vary within an animal, with time after feeding, between days in the same animal and, apparently, in animals in different countries on similar feeds (Hungate 1975).

The end-products of fermentation, however, are virtually the same. For this reason, only the interactions between the major groups of organisms and their involvements in rumen fermentation are discussed.

2.5.5.1 Bacteria-bacteria interactions

Bacteria associate with related organisms and function as a consortiumon particulate digesta and on rumen epithelial tissue, one organism growing on the end-products of metabolism of another (Hungate 1975). The sequential fermentation process involving different species of organisms converting cellulose to VFAs is well recognised, as are the interrelationships between hydrogen-producing and hydrogen-utilising organisms (Hungate 1975). Within the rumen there are often very close associations of bacterial species, dependent on simple materials liberated by each to the mutual benefit of both (syntropic associations). These interactions of rumen bacteria appear to be highly beneficial and there appears to be little that can be done to manipulate these associations, other than inhibition of methanogenesis.

2.5.5.2 Protozoa-bacteria interactions

There is conclusive evidence that there are marked interactions between protozoa and bacteria. Protozoa ingest and digest bacteria and reduce the bacterial biomass floating free in solution in the rumen (Hungate 1966; Coleman 1975), and thus they may reduce the rate at which bacteria colonise ingested food particles. With readily digestible feeds this may not be significant but with refractory feeds, predation may increase the lag phase of degradation of particles.

Protozoa effectively compete with bacteria for the soluble sugars and starches, storing these carbohydrates within their cells. In this way the protozoa reduce the severity of acidosis on some diets. On sugar-based diets (eg. sugarcane) the protozoal biomass is probably larger than the bacterial biomass.

2.5.5.3 Interactions of bacteria, fungi and protozoa

Eadie and Gill (1971) found that the number of flagellate protozoa (motile zoospores) increased following defaunation of the rumen. If these flagellates were zoospores, then it suggests that protozoa either `compete' for nutrients with fungi or reduce fungal growth in other ways. For instance Orpin (1975) observed predation by protozoa on the non-motile flagellates (zoospores).

To investigate these interactions, studies have been made on the effects of defaunation on fungal growth and digestibility of feed in the rumen. The digestibility of fibrous feeds in nylon bags in the rumen of sheep that were faunated, then defaunate (and remained unfaunated) and then refaunated showed that the unfaunated state of the rumen resulted in an increased rate of disappearance of straw dry matter (by 6-10 units/24 h). This was associated with more zoospores in rumen fluid and a greater growth of fungi as indicated by the numbers of sporangia on fibre that had been incubated in the rumen in nylon bags for 6-12 hours (Bird and Leng, 1985).

2.5.6 Degradation of dietary protein in the rumen

Between 20 and 100% of the protein in many diets based on high-protein forages, protein meals and grains may be soluble. It is assumed, for practical purposes, that the solubility of protein-N in buffer solution indicates the degradability of the protein of a meal in the rumen. However, soluble proteins such as serum albumin, ovalbumin, chloroplast protein extract and soluble proteins from soya bean meal and rapeseed meal have variable resistance to degradation in the rumen (Mahadevan *et al*., 1980). The chemical form of protein and the presence of disulphide bonds and perhaps phenolics (tannins) have major influences on degradability of proteins in the rumen.

Degradation of protein to peptides and amino acids is by bacterial (usually surface) proteases and peptidases. Nugent and Mangan (1981) reported that lysis of leaf protein in the rumen was high

but affected by diet and that soluble protein was adsorbed rapidly onto the bacterial cell prior to lysis. Small particles such as chloroplasts were engulfed directly by protozoa and then degraded only slowly.

Factors affecting the extent of ruminal degradation of the less-fermentable proteins in food particles have received little study. Fermentation of particulate proteins depends on the length of time that they are in the rumen, and factors such as their rates of solubilisation and enzymatic degradation. In addition to chemical factors affecting rates of degradation of soluble proteins (ie. cross-linking and number of accessible hydrolysable sites in the protein molecules, enzyme concentration, and pH), physical characteristics of particles also affect accessibility of proteins to enzymatic action (Nugent and Mangan, 1981). The authors went further to state that surface area of the protein that is accessible to microbial proteases may be reduced by formation of fibrous proteins by treatment with formaldehyde and by lipids or other water-insoluble substances used to encapsulate the protein. Rates of disruption of these substances are major factors that affect the rate of breakdown of such protected proteins.

2.5.7 Peptides and amino acids in rumen fluid

In animals fed high-protein diets, a high proportion of the nitrogen in the rumen may be derived from peptides and amino acids in the feed protein. Peptides or amino acids are degraded rapidly by bacterial peptidases and deaminases, and peptides are present in the rumen in significant quantities only when the protein is fermented at high rates (Mahadevan *et al*., 1980).

Amino acids are absorbed from the rumen but probably only in small amounts as the majority of free amino acids are probably deaminated to give rise to branched-chain volatile fatty acids

(VFAs), carbon dioxide and methane. The level of branched-chain VFAs in the rumen fluid is an index of amino-acid degradation in the rumen, as these generally arise from the fermentation of valine, leucine, isoleucine and proline.

2.6 UTILIZATION OF ANIMAL WASTE/BY-PRODUCTS BY MONOGASTRICTS

Several animal waste/by-products; rumen digesta, poultry litter, blood meal etc have been explored in trials with monogastrics (Alawa and Umuna, 1993; Onimisi, 2005; Onimisi and Omage, 2006; Esonu *et al*., 2002), to cut down cost of production due to the high cost of feed raw materials. Brewers dry grain, cassava and yam peals including cocoa pod husks have also been tested, (Teguia *et al*., 1993; Teguia *et al*., 2002). In the various studies, the dietary energy and protein source were replaced on a weight to weight basis. Thus, the nutrient composition and digestibility of the test diets differed from that of the control diet.

2.6.1 Utilization of Rumen Digesta

It has been reported that rumen digesta contain no anti-nutritional factor (Adeniji and Balogun, 2002). This has prompted some researchers to use the material to replace one protein source or the other. Odunsi (2003) combined rumen digesta with blood meal to replace groundnut cake (GNC) or fish meal in layers diet and reported low values for parameters monitored namely; feed intake, weight gain, hen day egg production, egg weight and shell thickness in the laying birds that were fed the test diet. He attributed this to the un-palatable nature of the diet due to the influence of the blood meal which agreed with the findings of Adeniji (1996) in a study carried out on pullets.

Okpanachi *et al*., (2010) and Mohammed *et al.,* (2010) used rumen digesta as replacement for soy bean in rabbit diet, and reported that there was a linear increase in feed intake and weight gain of rabbits as the level of rumen digesta increased in the diet. Feed intake was reported to increase up to 40% level of inclusion of rumen digesta. Their findings were similar to those of Whyte and Wadak (2002) and Mohammed *et al.,* (2005) when a similar diet was fed to rabbits.

Rabbits fed diets containing rumen digesta compare well in terms of performance with those on conversional feeds (Omekem, 1994; Opera, 1996; Esonu *et al*., 2002). Esonu *et al*., (2002) suggested that the improved performance could be attributed to the higher protein of the undigested starchy and fibrous carbohydrates, long chain fatty acids and partially digested diet protein material due to the influence of the microbial protein in the digesta.

On carcass characteristics evaluation, Esonu *et al*., (2006) reported that the values of the dressed weight, gizzard, and heart were similar to those of the control group, and the values indicated that the material was well utilized by the birds. The reasons advanced was that the improved performance could probably be due to adequate dietary crude fiber level, which may have activated the intestine and more occurrence of peristallic movement, more enzyme production resulting in efficient digestion and utilization of the nutrients.

Ensiling of rumen digeta was found to improve the nutrient in the rumen digesta (Maigandi *et al*., 2004) although they further stated that if the process exceeds four weeks, the protein in the material may be converted to non-protein nitrogen and could hinder the supply of the needed protein to the animal for normal growth.

2.6.2 Utilization of Poultry Litter

The use of poultry litter as feed components for livestock has been established (Onimisi and Omage 2006 and Adeyemo and Oyejola 2004). These authurs reported that poultry litter could replace up to 32% of maize – soyabeans and 40% of blood meal in rabbit and guinea fowl diets respectively without detrimental effects on growth performance. Ensiled and sundried broiler litter was also reported to support performance and haematological parameters of weaner pigs when fed at 20% inclusion in their diets (Akinfala and Komolafe, 2011). In separate researches conducted on the utilization of poultry litter, it was observed that feed intake increased as the levels of poultry litter in the diet increased. However, weight gain was reported to decrease with increase in the dietary levels of poultry litter (Garder and Shmeller 1986; Adeyemo and Oyejola, 2004; Onimisi and Omage 2006). Alawa and Umunna (1993) stated that the inclusion of most agro-industrial by products in livestock rations often result in increased feed intake as a compensation for the reduced energy concentration of such diets.

Poultry litter is not injurious to animal's health (Raviondran *et al*., 1982). About 5000 tons are produce annually in Nigeria poultry industry (Olusi and Agbasi, 2000), a continuous accumulation of this products is dangerous as it releases ammonia into the atmosphere there by polluting the environment.

On the health implication of feeding poultry litter to rabbits, Owen and Amakiri (2012) reported that feeding poultry litter at 10-15% levels of dietary inclusion had no pathological effects on the heart, pancreas and spleen as these organs did not show any pathological lessons when poultry litter was used to replace soy bean meal in weaner rabbit diet in their experiment. They reported that these organs were normal as that of the control. However, the authors further reported that

the kidney and liver were mostly affected; inclusion levels were also characterized by enlarged hepetocystes degednerated chords of hepatocystes and compression of sinusoids. The authors attributed their findings to be related to the various level of pollution of poultry litter by pesticides, feed additives, medicine, trace minerals, bacterial and uric acids.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1Experimental Site

This study was carried out at the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University Zaria. Zaria is located in the northern Guinea savannah, about 650m above sea level. It lies between latitude 10^{o}N and longitude 7^{o}E, with an average rain fall of 1100mm which starts from late April and early May to mid-October (Meteorological unit, IAR).

3.2 Source of Rumen digesta

Rumen digesta was collected from cattle, sheep and goats in separate containers from abattoirs within Zaria. Each of the materials were divided into two parts, one part was placed inside air-tight containers and placed inside a pit for 21 days, the other part was sundried for 4-5 days depending on the intensity of the sun.

3.3 Laboratory analysis

Samples of ensiled and sundried rumen digesta from cattle sheep and goats were taken to the laboratory for proximate analysis in the Biochemical Laboratory unit of the Department of Animal science A.B.U. Zaria. The proximate composition such as dry matter, crude protein, crude fire, ether extract and ash were determined (A.O.A.C, 2000). Nitrogen free extact (NFE) was calculated by differences as shown below NFE = 100-%CP + %CF + %EE +Ash.

3.4 Experiment 1

Effect of Ensiled and Sundried Rumen digesta from Cattle, Sheep and Goats on the Performance, Carcass Characteristics, Digestibility and Heamatology of Weaner Rabbits.

3.4.1 Experimental diets:

Ensiled and Sundried rumen digesta from cattle, sheep and goat rumen were used at 20% dietary level in weaner rabbits' diet. The three different source of rumen digesta and the two processing methods were used in a completely randomized design feeding trial to give seven (7) experimental diets including a control. The diets were designated T_1, T_2, T_3, T_4, T_5, T_6 and T_7. They were formulated to meet the rabbits nutrient requirement according to NRC (1995). Treatments T_2, T_3, and T_4 contained ensiled rumen digesta from cattle, sheep and goat, respectively while T_5, T_6 and T_7 had sundried rumen digesta from cattle, sheep and goats in the same order. (Table 3.1)

3.4.2 Experimental Animals

A total of 35 mixed breeds, unsexed weaner rabbits were used in this study. The rabbits were individually caged and fed the seven experimental diets. Each treatment was replicated five times in a completely randomized design. Treatment 1 was the control diet, and rabbits on treatments 2, 3 and 4 were fed diets containing ensiled rumen digesta from cattle, sheep and goat respectively while rabbits in treatments 5, 6, and 7 were fed diets containing sundried rumen digesta from cattle, sheep and goats respectively. Prior to the commencement of the study, the cages were disinfected, and the animals were dewormed with piperazine. The animals were also given the respective experimental diets three days to the commencement of the trial to get adjusted to the feed. Feed and water were given *ad libitum*.

3.4.3 Parameters monitored

Parameters monitored and measured on weekly basis were weight gain, feed intake; water intake and mortality were recorded as it occurred. Feed conversion ratio and feed cost per kg gain were calculated as secondary data.

3.4.4 Digestibility Study

A digestibility study was carried out on the 7^{th} week of the experiment. Three rabbits from each treatment were used. The rabbits were housed in individual cages for faecal collection after given a known quantity of feed. Faecal sample and urine was collected for five days; the urine was preserved in a refrigerator before the day of the analysis, while the fecal samples were oven dried at $60^{o}C$. The faecal samples were subjected to proximate analysis. Nutrient retention was determined for crude protein, ether extract, crude fiber, ash and nitrogen free extract using the following formula:

$$\frac{\text{Nutrient in Feed - Nutrient in Faeces}}{\text{Nutrient in Feed}} \times 100$$

3.4.5 Carcass characteristics evaluation:

Three rabbits from each treatment were selected based on the average weight per treatment on the eight (8) week of the experiment, fasted overnight and thereafter slaughtered and weighed to obtain the slaughter weight. The head, heart, liver, kidney, thigh, loin, back limb and fore limb were weighed and expressed as percentage of the live weight.

3.4.5 Haematological evaluation:

On the last day of the experiment, 1.5ml of blood sample was obtained through the neck vein from three rabbits per treatment into a bottle containing anticoagulant (EDTA) and taken to the Pathological Laboratory of the Department of Veterinary Medicine for analysis of pack cell

volume, haemoglobine, total protein as well as red and white blood cell. Differential blood parameters such as eosinophils, monocytes, lymphosytes and neutrophils were also analyzed.

Table 3.1 Composition of experimental Diets containing 20% each of Sundried and Ensiled Rumen Digesta from Cattle, Sheep and Goats

Feed Ingredients	Treatments						
	T1 (CD)	T2 (ECRD)	T3 (ESRD)	T4 (EGRD)	T5 (SCRD)	T6 (SSRD)	T7 (SGRD)
Maize	45.00	35.00	35.00	35.00	35.00	35.00	35.00
RumenDigesta	-	20.00	20.00	20.00	20.00	20.00	20.00
Soy bean	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Groundnut cake	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Rice Bran	26. 10	16. 10	16. 10	16. 10	16. 10	16. 10	16. 10
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35
□Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis							
M.E. (Kcal/kg)	2677.5	2627.3	2627.3	2627.3	2627.3	2627.3	2627.3
Crude Protein (%)	18.60	17.73	18.23	18.08	17.93	18.31	18. 10
Crude Fiber (%)	7.40	9.32	8.92	9.81	9.32	10.52	10.95
Lysine (%)	0.83	0.80	0.80	0.80	0.80	0.80	0.80
Methionine (%)	0.57	0.52	0.52	0.52	0.52	0.52	0.52
Calcium (%)	1.36	1.34	1.34	1.34	1.34	1.34	1.34
Phosphorus (%)	0.78	0.67	0.67	0.67	0.67	0.67	0.67

□Vit. Premix supplied per kg diet : Mg, 300mg; Mn, 80mg; Fe, 80mg; ZN, 50mg; Cu, 3.5mg; I, 04mg; retinal acetate, 2.27mg; menaphtone, 1.3mg; riboflavin, 4mg; niacin, 25mg; pantothenic acid, 10mg; biotin, 50ug; cyancobalamin, 10ug.

M.E: Metabolizable energy

ECRD-Ensiled Cattle Rumen Digesta,

ESRD- Ensiled Sheep Rumen Digesta,

EGRD- Ensiled Goat Rumen Digesta,

SCRD-Sundried Cattle Rumen Digesta,

SSRD- Sundried Sheep Rumen DIgesta,

SGRD- Sundried Goat Rumen Digest

3.5 Experiment 2:

Effects of Graded Levels of Sundried Rumen digesta on the performance, carcass characteristics, digestibility and heamatology of weaner's rabbits:

3.5.1 Experimental Diets and Animals:

A total of 30 rabbits were used for this study. The rabbits were individually caged and allocated into six treatments each treatment was replicated five times with one rabbit per replicate in a completely randomized design. Treatment 1 was served the control diet; treatments 2 to 6 had animals fed with diets containing 10, 20, 30, 40 and 50% levels of inclusion of sundried Sheep rumen digesta (Table 3.2).

3.5.2 Parameters monitored:

Parameters measured from performance to heamatological evaluation were the same as in experiment 1.

3.5.4 Statistical Analysis:

Data generated from the study were analyzed using the general linear model of SAS software (SAS, 2002). Significant differences in means were separated using the Duncan's multiple range test in the SAS package.

Table3.2 Composition of experimental Diets containing Graded levels of Sundried Sheep Rumen Digesta

	Treatments					
Feed Ingredients	**T1 (0%)**	**T2 (0%)**	**T3 (20%)**	**T4 (30%)**	**T5 (40%)**	**T6 (50%)**
Maize	45.00	45.00	35.00	35.00	35.00	25.00
SSRD	-	10.00	20.00	30.00	40.00	50.00
Soy bean	10.00	10.00	10.00	10.00	10.00	10.00
Groundnut cake	15.00	15.00	15.00	10.00	10.00	10.00
Rice Brand	26. 10	16. 10	16. 10	11. 10	1. 10	1. 10
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.35	0.35	0.35	0.35	0.35	0.35
□□ Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15	0.15	0. 15
Total	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis						
M.E. (Kcal/kg)	2637.50	2628.30	2600.63	2517.30	2501.3	2497.3
Crude Protein (%)	18.43	18.23	18.63	18.41	18.39	18.30
Crude Fiber (%)	7.68	9.38	10. 18	10.32	10.82	12.52
Lysine (%)	0.83	0.80	0.77	0.70	0.67	0.64
Methionine (%)	0.55	0.53	0.53	0.50	0.50	0.46
Calcium (%)	1.36	1.32	1.32	1.30	1.30	1.27
Phosphorus (%)	0.78	0.67	0.67	0.64	0.64	0.61

□Vit. Premix supplied per kg diet : Mg, 300mg; Mn, 80mg; Fe, 80mg; ZN, 50mg; Cu, 3.5mg; I, 04mg; retinal acetate, 2.27mg; menaphtone, 1.3mg; riboflavin, 4mg; niacin, 25mg; pantothenic acid, 10mg; biotin, 50ug; cyancobalamin, 10ug.
M. E.: Metabolizable energy,
SSRD- Sundried Sheep Rumen Digesta.

CHAPTER FOUR

4.0 RESULTS

Experiment 1:

4.1 Proximate composition of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat. (%DM)

The proximate composition of ensiled and sundried rumen digesta from cattle, sheep and goats is shown in Table 4.0. The results show that the dry matter, crude protein, ether extract and nitrogen free extract of the ensiled digesta was higher than those of the sundried digesta. However, the crude fiber content of the sundried digesta was higher than those of the ensiled. The ash content of sundried cattle rumen digesta was higher than both the ensiled digesta from cattle sheep and goats and sundried digesta from sheep and goats.

4.2 Effect of Ensiled and Sundried Rumen digesta from Cattle Sheep and Goat on the Performance of Weaner Rabbit.

Data on the performance of weaner rabbit is shown in Table 4.2 Feed intake of rabbits on the control diet was significantly ($P<0.05$) higher than the rest of the treatments. This was closely followed by rabbits in treatment 3, 4, 6 and 7. Treatment 2 and 5 had the least feed intake. Apart from the control, rabbits in treatment 6 that were fed diet containing sundried sheep digesta had significantly ($P<0.05$) higher weight gain than the rest of the treatment that had rumen digesta. Generally, rabbits that were fed diets with digesta from sheep and goat performed better than animals that were fed digesta from cattle.

Table4.1 Proximate composition of Ensiled and Sundried Rumen Digesta of Cattle, Sheep and Goat. (% D M basis)

Parameters (%)	ECRD	ESRD	EGRD	SCRD	SSRD	SGRD
Dry Matter	91.25	92.30	93.01	90.86	88.48	88.82
Crude Protein	9.82	11.86	10.50	10.94	12.50	10.13
Ether extract	5.07	2.62	3.21	0.43	0.29	0.38
Crude Fiber	21.87	27.07	29.00	24.52	30.17	31.78
Ash	10.00	10.21	10.25	12.50	8.33	8.33
NFE	53.24	48.27	47.05	51.61	48.71	49.38

ECRD-Ensiled Cattle Rumen Digesta,

ESRD- Ensiled Sheep Rumen Digesta,

EGRD- Ensiled Goat Rumen Digesta,

SCRD-Sundried Cattle Rumen Digesta,

SSRD- Sundried Sheep Rumen Digesta,

SGRD- Sundried Goat Rumen Digesta

NFE-Nitrogen Free Extract

Table 4.2 Performance of weaner rabbits fed diets containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goats

Parameters	Treatments							
	T1 (CD)	T2 (ECRD)	T3 (ESRD)	T4 (EGRD)	T5 (SCRD)	T6 (SSRD)	T7 (SGRD)	SEM
Initial weight (g)	420.00	400.00	410.00	420.00	410.00	400.00	420.00	28.16
Final weight (g)	1400^{a}	800^{b}	1125^{ab}	1150^{a}	815^{b}	1280^{ab}	1125^{ab}	93.15
Average Daily weight gain (g)	18.57^{a}	5.71^{d}	11.43^{c}	13.47^{c}	6.43^{d}	17.86^{ab}	14.29^{b}	0.99
Average Daily feed intake (g)	69.21^{a}	42.64^{bc}	54.92^{ab}	58.65^{ab}	35.50^{c}	59.99^{ab}	54.98^{ab}	4.64
Feed to gain Ratio	3.72^{a}	7.45^{b}	5.00^{a}	4.36^{a}	4.47^{a}	3.34^{a}	3.67^{a}	0.51
Average Daily water intake (ml)	118.8b^{c}	96.46^{c}	165.7^{ab}	114.7^{bc}	89.92^{c}	197.9^{a}	130.0^{b}	14.33
Feed cost/kg gain (N)	196.2^{ab}	240.30^{b}	228.80^{b}	198.9^{ab}	204.06^{ab}	151.35^{a}	167.19^{a}	20.53
Mortality (%)	20.00^{b}	40.00^{a}	20.00^{b}	20.00^{b}	40.00^{a}	20.00^{b}	20.00^{b}	1.56

$^{a, b, c, d=}$ means in the same row with different superscripts are significantly different (P<0.05)
SEM: Standard Error of Mean.
ECRD-Ensiled Cattle Rumen Digesta,
ESRD- Ensiled Sheep Rumen Digesta,
EGRD- Ensiled Goat Rumen Digesta,
SCRD-Sundried Cattle Rumen Digesta,
SSRD- Sundried Sheep Rumen Digesta,
SGRD- Sundried Goat Rumen Digesta.

Rabbits in treatment 6 and the control also had a better feed conversion ratio, which was also followed by treatment 3, 4, and 7. Treatment 2 and 5 had a poor feed conversion ratio. The average daily water intake showed that rabbits in treatment 6 were significantly ($P<0.05$) higher than the rest of the treatments; this was followed by treatment 3 and 7. Treatment 2 and 5 recorded the least values. The feed cost/kg gain in this study showed that there was significant ($P<0.05$) difference across the treatments, rabbits in treatment 6 had lower amount spent on feed per kg gain. This was similar to treatments 4, 7 and the control (treatment1). Treatments 2 and 3 had the highest values for feed cost/kg gain.

4.3 Apparent Digestibility of Weaner Rabbits Fed Diets Containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat

The result of digestibility of rumen digesta is presented in Table 4.3. There were significant ($P<0.05$) differences in digestibility of dry matter, crude protein, crude fibre, ether extract, ash as well as nitrogen free extract. These results showed marked improvement in digestibility of nutrients in all the treatments, hence reflecting efficient utilization of nutrients. Values in Treatment1 were higher than the rest of the treatments and this was closely followed by treatment 6 (SSRD). Generally, the values obtained for crude fiber and nitrogen free extract was lower across the treatments compared with other nutrients.

Table 4.3 Apparent Digestibility evaluation of weaner rabbits fed diets containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat

Parameters	Treatments							
	T1 (CD)	T2 (ECRD)	T3 (ESRD)	T4 (EGRD)	T5 (SCRD)	T6 (SSRD)	T7 (SGRD)	SEM
Dry Matter (%)	84.90^{a}	74.90^{c}	72. 10^{d}	71.30^{d}	70.90^{d}	77.33^{b}	76.63^{b}	0.49
Crude Protein (%)	91.87^{a}	77.54^{d}	83.18^{b}	77.59^{c}	64.45^{e}	87.85^{b}	87.04^{b}	1.02
Ether extract (%)	87.03^{a}	76.78^{c}	68.83^{e}	68.48^{e}	73.28^{d}	79.36^{b}	63.20^{f}	0.79
Crude Fiber (%)	75.07^{a}	64.90^{d}	66.63^{cd}	67.33^{cd}	66.00^{cd}	70.03^{a}	67.70^{cd}	0.73
Ash (%)	77.63^{a}	74.80^{ab}	70.67^{c}	65.81^{d}	73.63^{bc}	72.67^{bc}	71.90^{bc}	1.18
Nitrogen Free Extract (%)	78.14^{a}	68.64^{b}	67.81^{b}	65.70^{b}	65.15^{b}	59.51^{c}	58.68^{c}	1.11

$^{a, b, c, d=}$ means in the same row with different superscripts are significantly different ($P<0.05$)
SEM : Standard Error of Mean
ECRD-Ensiled Cattle Rumen Digesta,
ESRD- Ensiled Sheep Rumen Digesta,
EGRD- Ensiled Goat Rumen Digesta,
SCRD-Sundried Cattle Rumen Digesta,
SSRD- Sundried Sheep Rumen Digesta,
SGRD- Sundried Goat Rumen Digest

4.4 Carcass characteristics of weaner rabbits fed diets containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat.

Results of the carcass evaluation are shown in Table 4.4. There was no significant ($P>0.05$) difference in all the parameters except in the lungs, loin, forelimb, and length of small intestine. The values in rabbits in Treatment 6 (SSRD) and Treatment 7 (SGRD) were similar to those of the control group. Treatment 2 and 3 (ECRD and SCRD) respectively recorded the least values. Values of internal organs recorded in this experiment in Treatment 6 were similar to the control group. However Treatments 2 and 5 recorded the highest values for length of large intestine, this was followed by treatment 3. The rest of the treatments including the control group recorded the least values.

4.5 Heamatological Parameters of Weaner Rabbits Fed Diets Containing 20% each of Ensiled and Sundried Rumen Digesta From Cattle, Sheep and Goat.

The results of the haematological analysis are presented in Table 4.5. The results showed that the full blood count; haemoglobin (Hb) and white blood cell (WBC) were significantly ($P<0.05$) different across the treatments. There were no significant ($P>0.05$) differences in pack cell volume (PCV), red blood cells (RBC) and total protein (TP) across the treatments. Treatment 7 recorded the highest values for Hb and WBC; followed by Treatment 2 for Hb and treatment 5 for WBC. Treatment 5 recorded the least value for Hb.

The differential counts of Monocytes (%) and Eosinophils (%) were not significantly ($P>0.05$) different across the treatment means. There were significant ($P<0.05$) differences in treatment means of Neutrophils and lymphocytes across the treatments. Treatments 2 and 3 recorded the highest values for Neutrophils count and this was followed by the control group. Treatment 5 had

Table 4.4: Carcass characteristics of weaner rabbits fed diets containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle Sheep and Goats

Parameters	Treatments							
	T1 (CD)	T2 (ECRD)	T3 (ESRD)	T4 (EGRD)	T5 (SCRD)	T6 (SSRD)	T7 (SGRD)	SEM
Live weight (g)	1440.00^{a}	800.00^{c}	1250.00^{ab}	1150.00^{b}	815.00^{c}	1285.00^{ab}	1180.00^{ab}	61.43
Slaughtered weight (g)	1375.00^{a}	746.67^{c}	1197.67^{b}	1075.00^{b}	615.00^{d}	1230.00^{ab}	1125.00^{ab}	44.52
Dressed weight (g)	920.00^{a}	465.00^{c}	690.00^{b}	700.00^{b}	435.00^{c}	825.00^{ab}	683.33^{b}	58.07
Dressing (%)	56.81^{a}	44.93^{b}	51.43^{ab}	51.30^{ab}	41.09^{c}	56.64^{a}	53.60^{a}	2.05
Head (%)	8.85^{ab}	8.54^{ab}	8.46^{ab}	8.71^{ab}	8.40^{b}	8.75^{ab}	9.04^{a}	2.05
Liver (%)	2.17^{b}	2.34^{b}	2.40^{b}	2.23^{b}	2.55^{ab}	2.91^{a}	2.63^{ab}	1.14
Lungs (%)	0.89	0.87	0.82	0.84	0.87	0.90	0.88	0.02
Heart (%)	0.14^{d}	0.15^{cd}	0.18^{a}	0.16^{ab}	0.16^{ab}	0.15^{bc}	0.16^{ab}	0.01
Kidney (%)	0.47^{b}	0.46^{b}	0.44^{b}	0.51^{ab}	0.51^{ab}	0.53^{ab}	0.61^{a}	0.03
Thigh (%)	14.89^{ab}	11.50^{c}	14.15^{ab}	13.58^{b}	10.66^{c}	15.75^{a}	13.80^{b}	0.52
Loin (%)	9.81	8.38	8.60	7.97	9.15	9.57	9.31	0.54
Fore limb (%)	0.90	0.94	0.96	0.93	0.87	0.84	0.84	0.04
Hind limb (%)	1.94^{cd}	1.44^{e}	2.36^{b}	2.17^{bc}	1.46^{e}	2.71^{a}	1.87^{d}	0.08
Stomach empty (%)	1.20^{a}	0.94^{c}	1.00^{bc}	1.14^{ab}	1.03^{abc}	1.10^{abc}	1.04^{abc}	0.05
S. Intestine empty (%)	2.75^{a}	1.32^{bc}	2.51^{a}	1.41^{bc}	1.12^{c}	2.70^{a}	1.56^{b}	0.13
L. Intestine empty (%)	2.35^{ab}	2.03^{b}	2.51^{a}	2.54^{a}	2.25^{ab}	2.43^{a}	2.03^{ab}	0.12
Skin (%)	6.76^{d}	4.43^{f}	7.51^{c}	8.76^{a}	5.24^{e}	8.12^{b}	8.41^{ab}	0.19
L.S. Intestine (cm)	231.00	192.00	254.33	257.33	233.00	267.00	242.00	9.15
L.L. Intestine (cm)	136.33^{c}	178.33^{a}	161.33^{b}	142.33^{c}	173.67^{a}	139.00^{c}	143.00^{c}	2.16

$^{a, b, c, d,}$ mean in the same row with different superscript are significantly different ($P<0.05$)

SEM: Standard error of mean, ECRD-Ensiled Cattle Rumen Digesta, ESRD- Ensiled Sheep Rumen Digesta, EGRD-Ensiled Goat Rumen Digesta, SCRD-Sundried Cattle Rumen Digesta, SSRD- Sundried Sheep Rumen Digesta, SGRD- Sundried Goat Rumen Digesta.L : Large, S: Small, L.L : Length of Long, L.S: Length of Small intestine

Table 4.5: Heamatological Parameter of weaner rabbits fed diets containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goats

Parameters	Treatments							
	T1 (CD)	T2 (ECRD)	T3 (ESRD)	T4 (EGRD)	T5 (SCRD)	T6 (SSRD)	T7 (SGRD)	SEM
P C V (%)	40.50	45.50	42.50	42.50	39.50	40.50	48.50	1.54
H b (mg/dl)	13.80^{c}	16.00^{ab}	14.20^{ab}	14.00^{abc}	9.75^{d}	13.80^{bc}	16.15^{a}	0.64
RBC(10^6/ml)	6.37	6.80	6.40	6.60	6.77	6.90	6.85	0.18
WBC(10^3/ml)	7.95^{bc}	8.50^{abc}	8.15^{abc}	7.65^{c}	9.25^{ab}	7.85^{bc}	9.65^{a}	0.43
TBP (mg/dl)	5.60	4.95	6.95	5.40	6.35	6.00	6.10	0.70
Neutrophil (%)	30.50^{ab}	38.00^{a}	34.50^{a}	20.00^{bc}	16.50^{c}	25.50^{abc}	30.00^{abc}	3.89
Lymphocyte (%)	67.00^{ab}	61.00^{b}	61.50^{b}	79.00^{a}	71.50^{ab}	66.50^{ab}	65.00^{ab}	4.33
Monocytes (%)	1.50	1.00	1.00	0.00	1.00	1.00	2.50	0.89
Eosinophil (%)	1.00	1.00	2.50	4.00	3.50	2.00	1.50	0.57

$^{a, b, c, d=}$ means in the same row with different superscripts are significantly different ($P<0.05$)

SEM : Standard Error of Mean

ECRD-Ensiled Cattle Rumen Digesta,

ESRD- Ensiled Sheep Rumen Digesta,

EGRD- Ensiled Goat Rumen Digesta,

SCRD-Sundried Cattle Rumen Digesta,

SSRD- Sundried Sheep Rumen Digesta,

SGRD- Sundried Goat Rumen Digesta

PCV : Packed cell volume, Hb : Heamoglobin,

WBC : White blood cell,

TP :Total Protein

the least value. Treatment 4 recorded the highest value for lymphocyte count which was followed by the control group, treatments 5, 6 and 7. Treatments 2 and 3 had the least values.

4.6 Effect of Graded levels of Sundried Rumen Digesta from Sheep on the Performance of Weaner Rabbit.

Results of the performance parameters of rabbits fed graded levels of sundried rumen digesta are shown in Table 4.6. There were significant ($P<0.05$) differences in all the parameters. The average weight gain of rabbits given rations containing 20% and 30% SSRD were significantly ($P<0.05$) higher than those of treatments 2 (10%), and 6 (50%), but similar to treatment 5. The control group recorded the highest values and treatment 2 recorded the least. Weight gain increased in Treatment 3(20%) as the levels of inclusion of SSRD in the diet increases and started decreasing in treatment 5 (40%) and 6 (50%). The values of the feed intake showed that feed intake increased as the levels of SSRD in the diet increases, with a decline in treatment 6. Treatment 5 recorded the highest value which was followed by treatments 4, 6 and 1. The least value was recorded in treatment 2. There was a linear increase in the volume of water intake as the levels of SSRD increased in the diet. The values obtained for the feed cost/kg gain in this study showed that treatments 3, 4 and the control group were statistically the same and were significantly ($P<0.05$) different from treatments 2, 5 and 6. The highest amount spent on feed per kg gain was recorded in treatment 2 and the least in treatment 4.

4.7 Apparent Digestibility Evaluation of Weaner Rabbits Fed Diets Containing Graded Levels of Sundried Sheep Rumen Digesta

The results of nutrient digestibility of weaner rabbits given graded level of SSRD is presented in Table 4.7. There were significant ($p<0.05$) differences among treatments in digestibility of dry matter, crude protein, crude fibre, ether extract and ash as well as nitrogen free extract. Digestibility values for dry mater, and crude protein, showed marked improvements in

Table 4.6 Performance of weaner rabbits fed diets containing Graded levels of Sundried Sheep Rumen Digesta

Parameters	Treatments						
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
Initial weight (g)	430.00	420.00	420.00	430.00	420.00	430.00	32.01
Final weight (g)	1220^{a}	1005.00^{b}	1015.00^{ab}	1135.0^{a}	1032.50^{a}	1012.50^{ab}	78.80
Average Daily weight gain (g)	16.60^{a}	9.80^{c}	14.50^{ab}	14.28^{ab}	11.85^{b}	9.80^{c}	0.85
Average Daily feed intake (g)	70.41^{ab}	60.91^{c}	67.92^{b}	75.29^{ab}	83.19^{a}	72.32^{ab}	4.11
Feed to gain Ratio	5.06^{a}	6.65^{b}	4.71^{a}	5.29^{a}	6.79^{b}	7.39^{b}	0.25
Average Daily water intake (ml)	79.17^{d}	61.46^{c}	104.42^{bc}	111.38^{c}	120.92^{b}	154.14^{a}	5.41
Feed cost/kg gain (₦)	257.35^{a}	372.56^{c}	301.16^{b}	251.49^{a}	325.40^{c}	$301.\ 16^{b}$	12.63
Mortality (%)	20.00^{b}	40.00^{a}	20.00^{b}	20.00^{b}	20.00^{b}	20.00^{b}	1.45

$^{a,b,c,d=}$ means in the same row with different superscripts are significantly different ($P<0.05$)
SEM : Standard error of mean.

digestibility of nutrients up to 40% SSRD inclusion levels, values reflecting efficient utilization of these nutrients with increasing levels of SSRD. The values for the digestibility of fiber and ash were low in all the treatments compared to other nutrients. Treatment 6 (50%) performed poorly in nutrients digestion compared to the rest of the treatments.

4.8 Carcass Characteristics of Weaner Rabbits Fed Diets Containing Graded Levels of Sundried Sheep Rumen Digesta.

Results of the carcass evaluation are shown in Table 4.8. There were no significant ($P>0.05$) differences in slaughtered weight, heart, kidney, thigh, forelimb, stomach and weight of small intestine across the treatments. The live weight, dressed weight, dressing percentage, head, liver, loin, hind limb, large intestine empty, skin, length of small intestine and length of large intestine showed significant ($P<0.05$) difference among their means for the treatments. The values obtained for dressed weight and dressing % in the control group (treatment 1) was not statistically different from those of treatment 4 (20 % inclusion). This was closely followed by treatment 5 and 6 with 30 % and 40 % inclusion of SSRD. Treatment 2 with 10 % inclusion level, recorded the least value. There was a linear increase in values along the treatment for length of large intestine as the values of SSRD in the diet increased.

4.9 Heamatological Evaluation of Weaner Rabbits Fed Diets Containing Graded Levels of Sundried Sheep Rumen Digesta

The results of the haematological analysis obtained in this study are presented in Table 4.9. The PCV, HB, TP, RBC and WBC were significantly ($P>0.05$) different across the treatments. Treatment 2 recorded higher values for PCV, HB, RBC and WBC than the rest of the treatments. These values were similar to those of treatment 1 for HB, TP and WBC.

Table4.7: Nutrient digestibility evaluation of weaner rabbits fed diets containing Graded levels of Sundried Sheep Rumen Digesta

Parameters	Treatments						
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
Dry Matter (%)	82.05^{a}	79. 14^{ab}	81.85^{a}	79.07^{ab}	76.81^{b}	58.31^{c}	1.05
Crude Protein (%)	91.23^{a}	83.11^{b}	87.36^{ab}	88.02^{a}	83.55^{b}	70.02^{c}	1.36
Ether extract (%)	87.60^{a}	77.24^{d}	80.40^{c}	85.44^{b}	74.33^{e}	73.29^{e}	0.59
Crude Fiber (%)	74.07^{a}	65.71^{d}	71.60^{b}	70.93^{c}	57.05^{e}	54.50^{f}	0.22
Ash (%)	79.57^{a}	78.97^{a}	76.37^{b}	70.93^{b}	59.76^{bc}	56.35^{c}	0.39
Nitrogen free Extract (%)	80.57^{a}	69.37^{b}	60.10^{c}	57.59^{d}	54.22^{e}	52.96^{e}	0.65

$^{a, b, c, d=}$ means in the same row with different superscripts are significantly different ($P<0.05$)

SEM : Standard error of mean.

Table4.8: Carcass characteristics of weaner rabbits fed diets containing Graded levels of Sundried Sheep Rumen Digesta

Parameters	Treatments						
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
Live weight (g)	1293.30^{a}	1005.00^{b}	1018.00^{ab}	1136.00^{ab}	1037.00^{ab}	1012.00^{ab}	94.58
Slaughtered weight (g)	175.0	930.00	987.30	1175.00	1025.00	960.00	106.22
Dressed weight (g)	810.00^{a}	520.0^{b}	600.0^{ab}	790.00^{a}	715.00^{ab}	540.00^{ab}	82.57
Dressing (%)	62.91^{a}	49.93^{b}	51.94^{b}	62.91^{a}	62.58^{a}	52.24^{b}	3.01
Head (%)	8.87^{ab}	9.29^{ab}	8.33^{b}	10.05^{a}	9.51^{ab}	9.75^{ab}	0.43
Liver (%)	2.29^{c}	3.14^{ab}	2.99^{ab}	2.99^{ab}	2.62^{bc}	3.28^{a}	0.17
Lungs (%)	0.89	0.87	0.82	0.84	0.87	0.90	0.88
Heart (%)	0.16	0.21	0.16	0.16	0.18	0.18	0.02
Kidney (%)	0.48	0.62	0.65	0.57	0.55	0.64	0.09
Thigh (%)	13.75	14.76	14.78	11.79	14.72	14.91	1.17
Loin (%)	9.62^{ab}	7.41^{b}	12.49^{a}	8.71^{ab}	8.39^{ab}	9.31^{ab}	1.23
Fore limb (%)	0.93	1.03	1.07	0.90	0.81	0.95	0.09
Hind limb (%)	2.04^{c}	1.96^{c}	2.43^{b}	2.49^{b}	2.45^{b}	3.07^{a}	0.08
Stomach empty (%)	1.14	1.44	1.28	1.33	1.28	1.15	0.10
S. Intestine empty (%)	2.85	2.41	2.20	1.71	2.85	2.61	0.36
L. Intestine empty (%)	2.29^{b}	3.50^{ab}	2.52^{b}	3.23^{ab}	3.05^{b}	4.36^{a}	0.36
Skin (%)	7.38^{ab}	7.58^{ab}	7.01^{ab}	6.72^{ab}	8.06^{a}	6.04^{b}	0.47
L.S. Intestine (cm)	272.67^{ab}	210.00^{d}	228.67^{cd}	286.67^{a}	233.67^{bcd}	251.65^{abc}	12.35
L.L. Intestine (cm)	98.33^{b}	79.00^{b}	95.00^{b}	136.67^{a}	137.33^{a}	141.76^{a}	7.79

$^{a, b, c, d}$=means in the same row with different superscripts are significantly different ($P<0.05$)

SEM : Standard error of mean, L : Large, S: Small, L.L : Length of Long, L.S: Length of Small.

The values were closely followed by those of treatments 4 and 5 while treatment 6 recorded the least values.

The differential counts (%) of neutrophils, lymphocyte, Monocytes and Eosinophils were significantly ($P<0.05$) different across the treatments. Treatment 2 recorded a higher value for lymphocytes than the rest of the treatments and treatment 6 recorded the least for neutrophils. Values recorded by treatment 4 and 5 in all the differential blood parameters were similar to those of the control group.

Table4.9: Heamatological evaluation of weaner rabbits fed diets containing Graded levels of Sundried Sheep Rumen Digesta

Parameters	Treatments						
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
PCV (%)	44.67^{a}	44.67^{a}	35.00^{d}	39.00^{bc}	40.00^{b}	31.00^{e}	1.54
H b (mg/dl)	12.90^{a}	13.40^{a}	12.80^{a}	13.50^{a}	12.93^{a}	10.53^{b}	0.40
RBC(10^{6}/ml)	6.37^{bc}	6.80^{a}	6.00^{c}	6.60^{ab}	6.47^{ab}	4.90^{d}	0.13
WBC(10^{3}/ml)	8.70^{a}	8.77^{a}	7.80^{b}	7.60^{b}	6.80^{d}	4.90^{c}	0.20
TP (mg/dl)	8.37^{a}	7.15^{b}	7.45^{b}	7.47^{b}	6.20^{c}	7.50^{b}	0.07
Neutrophil (%)	25.00^{d}	27.00^{c}	23.83^{d}	41.00^{a}	29.50^{b}	18.50^{e}	0.58
Lymphocyte (%)	67.00^{ab}	79.00^{a}	61.50^{b}	61.00^{b}	71.50^{ab}	66.50^{ab}	4.33
Monocytes (%)	5.33^{bc}	3.00^{d}	3.67^{cd}	7.33^{b}	12.33^{a}	6.00^{b}	0.89
Eosinophil (%)	0.67^{b}	0.00^{b}	1.00^{b}	1.00^{b}	1.00^{b}	2.33^{a}	0.57

$^{a, b, c, d}$=means in the same row with different superscripts are significantly different (P<0.05)
SEM : Standard Error of Mean.
PCV : Packed cell volume,
HB : Heamoglobin,
RBC : Red blood cell,
WBC : White blood cell, TP : Total blood protein.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Proximate composition of Ensiled and Sundried Rumen digesta from Cattle, Sheep and Goat

The values of dry matter (91.25%, 92.30% and 93.01%), crude protein (9.82%, 11.86% and 10.50%) and crude fiber (21.87%, 27.07 and 29.00%) obtained for ensiled rumen digesta from cattle, sheep and goats respectively in this experiment was similar to the values of 91.25%, 90.65 and 91.00% (dry matter) 9.38% 13.65% and 9.35% (crude protein) reported by Maigandi *et al*, (2004) when rumen digesta from cattle, sheep and goats was ensiled for four weeks and was also similar to 29.62% and 29.65% (crude fiber) of ensiled rumen digesta from cattle and sheep respectively (Maigandi *et al*, 2004).

The values of crude protein (10.94%, 12.50% and 10.13%) obtained for sundried rumen digesta from cattle, sheep and goats respectively in this experiment was similar to the values of 8.09%, 8.62%, 9.20% (crude protein) reported by Maigandi and Tukur (2002) for sundried rumen digesta gotten from Sokoto abattoir. However, the values of crude fibre, ether extract, ash and nitrogen free extract was far lower than those reported by Maigandi and Tukur (2002) and White and Wadak, (2002). However a range of 9.20 – 20% crude protein has been reported on the rumen digesta (Ekwuoma, 1992; Adeniji, 1996; Whyte and Wadak, 2002; and Odunsi, 2003).

The high CP in Sheep and Goats digesta may be attributed to fact that sheep and goats are selective feeders and browsers respectively. Maigandi *et al*., (2004) and Maigandi and Tukur (2002) reported a similar results. The higher EE in the ensiled rumen digesta compared to sundried rumen digesta may be due to strong fermentation that may have given rise to high

concentration of volatile fatty acids VFA (Maigandi *et al*. 2004). The high CF in goats digesta could be attributed to the fact that goats feed on wide range of feed materials, browse on foliage and feeds on short grasses avoided by other ruminants. The increase in ash content in the ensiled digesta compared to the sundried digesta may be attributed to the micro-flora and fauna population in the digesta. (Maigandi *et al*, 2004).

5.2 Effect of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat on the performance of Weaner Rabbits.

The increase in feed intake observed in this study could be attributed to the differences in aroma and palatability of the digesta from the various species of animals. Digesta from sheep had a pleasant smell which could be due to the characteristic smell of the sheep and goats gastro-intestinal tract. The digesta from cattle was observed to have an unpleasant smell by me. Abubakar and Yusuph (1991) and Odunsi (2003) had reported a similar observation on the unpleasant smell of cattle rumen digesta. The higher weight gain and better feed conversion ratio observed in animals that were fed diets containing sundried rumen digesta compared to those fed diets containing ensiled digesta could be due to enzymatic changes taking place during ensiling, which may have resulted in a tilt in the nitrogen balance from true protein to Non Protein Nitrogen (NPN) (Church, 1978; Maigandi *et al*., 2004). More so sheep and goat's digesta produced better results than the cattle digseta. This results agrees with those of Maigandi *et al*.,(2004) and Maigandi and Tukur (2002). They reported that sheep and goat digesta have more nutritive value because sheep and goat are selective feeders and browsers, respectively. The daily water intake observed in this study was on the increase which could be attributed to the fact that

water intake increases in rabbits as the levels of protein and fiber in the diet increases (Stephen, 1980).

5.3 Apparent Digestibility of Nutrients by Weaner Rabbits fed Diets Containing 20% each of Ensiled Sundried Rumen Digesta from Cattle Sheep and Goat.

The result of nutrient digestibility studies observed in this study showed that the nutrients in the diets were well utilized with the inclusion of rumen digesta. The improved performance could be due to adequate dietary crude fibre level, which may have activated the intestine and more occurrence of peristaltic movement, more enzyme production resulting in efficient digestion and utilization of the nutrients (Esonu *et al*., 2006).This result is in agreement with the findings of Ajayi *et al.,* (2007) who reported that digestibility values of dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract were significantly different and nutrients were well utilized when diets containing graded levels of a mixture of Blood-wild sunflower leaf meal were fed to male weaner rabbits. The values showed that the nutrients were well utilized.

5.4 Carcass Characteristics of Weaner Rabbits fed Diets Containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat.

The observed differences in the slaughter weight and carcass weight might be due to the differences in the live weight of the rabbits across the treatments. The trend in the slaughter and carcass weight was a reflection of the growth performance. The values of the percentage thigh of ESCRD and SCRD (T2 and T5) compare to the control and SSRD (T6) were a reflection of feed intake of rabbits fed these diets. Rabbits in T2 and T5 had a poor feed intake, which reflected on

their body weight and carcass weight. The range of 41.09-56.81% obtained for dressing % across the treatments is similar to the values of 40.5-52.6 reported by Okpanachi et al., (2010) for rabbits. The value is an indication of better utilization of the materials.

5.5 Heamatological Parameters of Weaner Rabbits Fed Diets Containing 20% each of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat.

All the parameters recorded for full blood count in this study were within the normal range reported by Schalm *et al.,* (1975) and Anon (1990). They were also similar to the values reported by Mohammed *et al.,* (2010) who fed similar diets to growing rabbit. Hacbath *et al.,* (1983) reported that there is a strong influence of diets on the haematological traits with PCV and Hb being very strong indicator of the nutritional status of the animals. Abnormal values might be an indication of aneamia (Bush, 1991; Onifade and Tewe, 1993; Abu *et al.,* 1999).

All values obtained for differential blood count in this study fell within the normal range reported by Mitruka and Rawnsly (1977). Ahamefule *et al.,* (2006) also reported similar results when sundried, ensiled and fermented cassava peal based diets were fed to weaner rabbits. The normal differential counts (%) values portray the nutritional status of the rabbits, as adequate (Church *et al*., 1984).

5.6 Effect of Graded Levels of Sundried Rumen Digesta from Sheep on the Performance of Weaner Rabbits.

The result of weight gain recorded in this study was similar to those of Mohammed *et al.,*(2005) and Okpanachi *et al*., (2010) who fed similar diets to weaner rabbits. The weight gain recorded by rabbits in treatment 2 (9.80g) is a reflection of the feed intake while the decline in weight gain in rabbits in treatments 5 (11.85) and 6 (9.80) could be because of the increased fiber content of

the feed. Results of feed intake of this experiment also agreed with that of Okpanachi *et al*., (2010) who reported that the levels of energy decreased across the treatment as the levels of rumen digesta increased, the fibre content on the other hand increased as the levels of rumen digesta increased in the ration. This was also observed in the ration formulated in this experiment. It is known that rabbits eat to satisfy their energy requirement, and the fiber in the diet tends to dilute other nutrients. According to Lebas (1983) an increased crude fibre would result in increased voluntary feed intake for growing rabbits. This result was similar to the observation of Olorunsanya *et al*., (2007) when sundried cassava peels was used to replace maize in the diet of growing rabbits. Feed to gain ratio followed the trend of weight gain recorded in this study, the values were similar to the values reported by Nokhtar *et al.,* (1997) who fed sundried pigeon droppings to growing rabbits. The linear increase in water intake of rabbits in this study agreed with the fact that water intake in rabbits increase as the levels of fibre in the diet increased (Stephen, 1980). Results of feed cost /kg gain in this study is similar to the reports of Okpanachi *et al.,*(2010) who reported a reduction in the cost of feed at 40% level of inclusion of sundried rumen digesta in growing rabbit diets thus indicating that rumen digesta is economical to use as feeding material up to 40% inclusion level.

5.7 Apparent Digestibility of Nutrients by Weaner Rabbits fed diets containing Sundried Sheep Rumen Digesta at Varying Proportion.

The values obtained for nutrient digestibility in this study showed marked improvement in the digestibility of nutrient up to 40% inclusion level. The digestibility values for crude fibre however were lower in all the treatments than those of other nutrients. This is similar to the findings of Oduguwa (2006). Rabbits are less efficient at digestibility of fibre than sheep and cattle (Slade and Hintz, 1969; Adegbola and Okonkwo, 2002). The lower digestibility could be

due to the type of fibre in the diet, since fibres from different sources could vary in their digestibility depending on the proportions of cellulose, hemicellulose and lignin.

5.8 Carcass Characteristics of Weaner Rabbits fed Graded Levels of Sundried Sheep Rumen Digesta

The observed differences in the slaughter weight and carcass weight might be due to the differences in the live weight of the rabbits across the treatments. The trend in the slaughter and carcass weight was a reflection of the growth performance. Differences in gut weight seem to correlate with feed consumption though not in significant proportion. The kidney, lungs, and heart were not affected by dietary treatments which agrees with the reports of Adeniji and Balogun (2003)who stated that rumen digesta is not known to contain any anti-nutritional factor.The values for dressed weight and dressing % recorded in this experiment was within the range reported by Okpanachi *et al.,* (2010) who fed rumen digesta at graded levels to weaner rabbits.the values were an indication of better utilization of the diets.

5.9 Heamatological Parameters of Weaner Rabbits Fed Diets Containing Graded Levels of Sundried Sheep Rumen Digesta.

The value of red blood cells (RBC), packed cell volume (PCV) and hemoglobin (Hb) of the rabbits on the SSRD diets compared to the control group is an indication that the animals were not anemic. The PCV and Hb values of rabbits on test diets were similar to those of the control group. This is in agreement with the report of Talebi *et al*. (2005) that nutrition affect the blood profiles of animals and this implies that up to 40% inclusion of SSRD had a positive effect on the relative quantity of blood cell as well as total volume of blood. However the values of RBC and

WBC of treatment 6 (50% inclusion of SSRD) were below the recommended values by Schalm *et al.,*(1975) and Anon (1990) which is an indication that the animals were anaemic and sick. This result disagree with Okpanachi *et al.,* (2010) who reported higher values than this at 50% inclusion level of bovine rumen digesta fed to weaner rabbits.

Though blood neutrophil and lymphocyte concentrations showed variation between treatment groups, the values obtained for all groups apart from treatment 2 (lymphocyte) and treatment 6 (neutrophils) were within normal range reported by Mitruka and Rawnsely (1977).

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

Two experiments were conducted with two sets of rabbits. The first experiment was conducted to evaluate the effect of feeding 20% each of ensiled and sundried rumen digesta from Cattle, Sheep and Goat on the performance, digestibility, carcass characteristic, and haematological parameters, while the second experiment was conducted to evaluate the effect of graded levels of sundried sheep rumen digesta on the performance, digestibility carcass characteristic, and haematological parameters.

At the end of the first experiment, it was observed that rabbits fed sundried rumen digesta from sheep performed better in terms of feed intake, weight gain, and feed to gain ratio, carcass characteristic, nutrient utilization, and haematology. In the second experiment, it was observed that rabbits performed well on graded levels of sundried rumen digesta from sheep up to 40% level of inclusion with a decline at 50% inclusion level.

6.2 Conclusion

From the result obtained from the feeding trials conducted, the following were concluded on the use of Ensiled and Sundried Rumen Digesta from Cattle, Sheep and Goat in weaner rabbit diet.

i. Sundried Sheep Rumen Digesta (SSRD) was better than Ensiled Sheep Digesta and both ensiled and sundried rumen digesta from cattle and goats because rabbits fed with diets containing SSRD performed better in all the parameters monitored.

ii. Inclusion of rumen digesta from cattle, sheep and goat in rabbit diet increased water intake in rabbits, water intake increased as the levels of rumen digesta in the diet increased.

iii. Carcass characteristics of rabbits fed sundried rumen digesta from sheep were comparable to the control, indicating that sundried rumen digesta from sheep had no adverse effects on the prime cuts and internal organs of the rabbits.

iv. The use of SSRD as feed stuff up to 40% had no adverse effect on the health of rabbits as values obtained from haematological analysis fell within the normal range for healthy rabbits. This study suggests that the use of rumen digesta will not only serve as feed to livestock, but recycling it will improve the sanitary condition of our environment.

6.3 Recommendations

The following recommendations are made for further study to enhance the utilization of rumen digesta in rabbit's diets.

i. Processing methods other than ensiling and sun drying should be investigated, to reduce or eliminate harmful microorganism in the materials that may affect the growth and wellbeing of the animals.

ii. Appropriate methods of storage of these materials prior to usage should be investigated.

iii. Further investigation into the use of SSRD above 40% should be conducted as there was a decline in performance, carcass characteristics and nutrient digestibility beyond 40% inclusion level of SSRD in this study.

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