THE EFFECT OF OXYTETRACYCLINE ON THE PERFORMANCE AND SERUM MINERAL LEVELS OF KIDS REARED WITH OR WITHOUT THEIR DAMS

By

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ABSTRACT

Investigations were conducted to assess the effect of supplemental oxytetracycline-HCl at various levels on performance and serum mineral levels of kids reared on two different systems of management, namely, kids reared with their dams and those reared artifically on cow's milk, with a view to determine the optimal level at which the best performance could be achieved. Forty-eight three-day-old goat kids weighing between 1.25 and 2.05kg with a mean weight of 1.79kg were used in this study.

A group of animals assigned to a specific rearing method were randomly alloted to four treatment groups (0, 13.2, 19.8 and 26.4mg of oxytetracycline-HCl daily). The experiment lasted for 84 days.

The results on performance showed that the voluntary milk intake and liveweight gain of kids reared with their dams were comparable with their counterparts on cow's milk for the first two weeks of the experiment. Thereafter, the milk intake of kids reared with their dams diminished due to fall in dam's milk yield, resulting in lower weekly liveweight gain. At the end of the experiment, the mean weekly

liveweight gain of kids reared on cow's milk were higher (241.90 vs 295.20g). However, kids reared with their dams exhibited better feed efficiency than their counterparts on cow's milk, indicating that the observed higher weekly liveweight gain was as a result of the higher milk intake.

Oxytetracycline-HCl supplement enhanced weekly liveweight gain of kids reared with their dams. The overall mean weekly liveweight gain for kids on treatment levels (0, 13.2, 19.8, and 26.4mg of oxytetracylne-HCl daily) were 171.70, 216.56, 216.39 and 333.80g, respectively, for kids reared with their dams. The corresponding values for kids reared on cow's milk were 330.56, 315.31, 289.59 and 246.34g, respectively.

Oxytetracycline-HCl supplement did not depress the serum levels of Ca, Na, K, Cu, and Fe, particularly when fed between 13.2 and 19.8mg/day. Slight decrease in the serum levels of P and Mn compared to the control were observed, although the differences were not significant. However, oxytetracycline significantly depressed the serum Mg levels, particularly in kids reared with their dams.

Results obtained with the two systems of management suggested that oxytetracycline-HCl was capable of improving the performance of kids reared with their dams. Oxytetracycline-HCl fed as supplement to kids already adequate in milk intake was not encouraging, since no apparent improvement in performance over the unsupplemented kids was produced. Oxytetracycline-HCl supplement at level of 26.4mg/day is recommended for adequate liveweight gain and optimal feed efficiency without adverse effect on the serum mineral status of the pre-weaned kids.

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wonderful children. Your roles are distinct. I pray we all live to reap the fruit of his labour.

Finally, to God, the alpha and the omega, the author and finisher of faith, be glory, for His Mercy endureth forever!

CERTIFICATION BY SUPERVISOR

I certify that this work was carried out and presented by Bernice Olufunmilayo ADELEYE in the Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

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DEDICATION

Dedicated to my family - my husband, Niyi, and my lovely children, Adebanke, Oluwaseun and Adeola.

---------- some on boards, and some on the broken pieces of the ship. And so it came to pass, that they escaped all safe to land.

PRAISE GOD! Act 27[44]

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CHAPTER ONE

1.1: INTRODUCTION

The geometrical increase in world population and the arithmetical increase in world food production has left the World with an imbalanced food sheet. Statistics showed that Nigerian population increased from 66.356 million in 1971 to 75 million in 1980 (FAO, 1980). The continuous population growth, the accompanying accelerated urban migration of rural population coupled with the rise in living standards as well as the failure of food production to keep pace with population growth, have brought about enormous increases in food demand and a sharp increase in food prices (Lamorde, *et al*, 1981) particularly meat and meat products.

For centuries, Nigerian agricultural focus has been in the area of crop production with limited effort directed to livestock production. This has been expressed in the planning and implementation of various agricultural development programmes instituted in recent years. An agricultural expert observed that as much as 80 percent of Nigeria's agricultural output is crop, while about 20 percent is livestock (Oyenuga, 1973). The low animal production in the country reflects the total animal available for slaughtering and the over-all animal protein consumption of the Nigerian population. The estimated protein daily requirement per normal adult Nigeria for 1975, 1980, and 1985 were approximately 65, 66 and 68 grams, respectively (Atanda, 1983). Out of each recommended value, 35 grams is expected to be derived from animal sources (FAO, 1965). However, animal protein intake stood at 8.4 grams per person per day (FOS, 1972). A further decrease in protein intake of Nigerians by 1980 has also been predicted.

The present level of Nigerian meat and meat product consumption should be of serious concern to nutrition experts as well as agricultural policy makers. Thus genuine efforts must be made to increase livestock production in the country.

1.2: DIETARY IMPORTANCE OF MEAT AND MEAT PRODUCTS

The animal is one of the food resources of man. Animals provide appetizing, highly relished foods, which are important parts of human diet with unique characteristic tastes (Cunha, 1982). Animal products, particularly meat, is regarded as part of a higher standard of living and the demand for meat and meat products has been on the increase in many parts of the world. Except for the vegetarians, majority of humans in the world would desire animal products in their diet (Cunha, 1982).

Any adequate human diet in terms of optimum nutrition requirements is one that contains sufficient animals products (Cunha, 1982). Animal proteins are known to have higher net body utilization, protein efficiency ratio and balanced essential amino acids for man than the protein of plant origin. Most cereals are deficient in lysine, tryptophan while pulses are low in sulfur animo acids such as methionine, cystine, and some other amino acids such as threonine and tryptophan (Awah, 1981). The relative biological value of the various animal protein foods have been estimated at between 60 and 100 percent when compared with the reference protein. Most plant foods have a biological value of less than 60 percent (Oyenuga, 1973). The nutritive importance of animal protein could be better appreciated when one considers the prevalence of protein calorie malnutrition in children in many developing countries where inadequate protein intake is a common problem. The significance of animal as a source of food supply is not limited to the quality protein it supplies but also for its richness in vitamins and minerals. Animal protein is the major source of vitamin B-12, a vitamin known to be present in limited amounts in plant foods and known to be very essential for physiological process.

1.3: PROBLEMS OF LIVESTOCK PRODUCTION IN NIGERIA

FAO (1980) livestock figures showed that there were (in millions) 12.3 cattle, 11.7 sheep, 24.0 goats, 1.1 pigs, 0.017 camels, 0.25 horses and 120 poultry in Nigeria. When the total animal figure was considered with the estimated human population for the same time period, it was observed that local livestock production could hardly meet 20 percent of the national livestock supplies (Lamorde, *et al*., 1981). In addition, the output of the existing livestock industries in Nigeria is inevitably low, when compared with the productivity of animals in advanced countries. This adversely affects the overall animal protein supply in the diet of the Nigerian population. Animal production, like other agricultural production, is beset with series of problems, which grossly limit its scope and outputs.

The more important of these problems are: the traditional husbandry practices in the major animal producing areas of the country, prevalence of animal diseases, and provision of inadequate foods.

1.3.1: TRADITIONAL ANIMAL HUSBANDRY PRACTICES

Majority of Nigerian ruminants (approximately 80 percent) exist in the northern parts of the country (FAO, 1966) where traditional animal husbandry is much in practice with slow integration into modern animal husbandry sysem. This area is seasonally dry, less humid and the conditions are too arid for tsetse flies. The Fulani herdsmen are known to graze their animals to the north of the tsetse fly belt in the wet season and move them southwards at the onset of the dry season (FAO, 1966). The migratory system, the lack of grazing and the low nutritive quality of matured dry-season herbage adversely affect animal growth and productivity.

Until recently, the traditional pasturalists regard their flocks as personal wealth and hardly geared production towards commercialization. These herdsmen accumulate stock as an insurance against deaths from disease, drought and starvation catastrophes, which are understandable because they have decimated livstock since time immemorial (FAO, 1966). In addition, modern livestock management and feeding practices are not easily adopted by the nomadic herdsmen (Lamorde, et al., 1981).

1.3.2: DISEASE PROBLEM

Efficient disease control is an integral part of livestock production. In Nigeria, Livestock production is still being hampered by diseases. The prevailing diseases differ from one livestock species to another. For example, disease like rinderpest is known to be peculiar to cattle. Although efforts have been made to eliminate or control this disease from many parts of the country through international vaccination campaigns, the disease still threatens cattle production in Nigeria. In 1984, a serious outbreak of rinderpest wiped out thousands of cattle herds at different parts of the country. Contagious bovine pleuro-pneumonia, foot-mouth disease and mycotic skin disease strepto-thricosis are a few other diseases common with cattle.

Diseases posing threat to expansion of poultry production include New-castle, Gumboro, Coccidiosis, infectious bronchitis and fowl-pox. Mange afflicts cattle, sheep and goats while ticks can result in high calf mortality, particularly when exacerbated by mal-nutrition (FAO, 1966).

Trypanosomiasis is one of the major factors limiting the expansion of cattle production in the south. The disease transmitted by the various flies seriously interfere with animal health and productivity and takes an annual toll of the animals that migrate southwards from the north (FAO, 1966). Animal health problems have recently been compounded by shortages and prohibitive prices of vaccines and other veterinary drugs due to inadequate foreign exchange earnings for the importation of these drugs. Inadequate veterinary personnel to man veterinary centres as well as lack of access to veterinary services by a number of small-scale farmers have been cited as another factor militating against animal production in Nigeria (Sansi, 1975).

1.3.3: PROVISION OF ADEQUATE FEEDS

The four facets of animal production are breeding, feeding, management and disease control (Ranjhan, 1980). Of these, animal feeding and its practical application is of utmost importance. Livestock feeds constitute about 75 to 80 percent of the total recurrent expenditure in poultry and pig livestock production (Lamorde, *et al*., 1981). The inadequate local grains production coupled with restriction on importation of grains and other poultry feed ingredients have caused unprecedented high increase in the prices of poultry feeds.

The ruminants on the other hand either graze the natural pasture or browse on weeds, shrubs and trees. Since they are in larger number in the seasonally dry regions of the north, they are subjected to seasonal subsistence intervals when serious liveweight losses occur, coupled with high rate of abortion, mortality of the immature stock and growth retardation of the young (FAO, 1966).

1.3.4: TOWARDS AUGEMENTING LIVESTOCK PRODUCTION IN THE TSETSE-FLY ZONE OF NIGERIA

In the tsetse infested southern area of the country, meat consumption is low compared to the traditional pastoralist areas of the north (Awah, 1981). The low meat consumption in the south is occasioned by the physical difficulties and expenses of getting livestock from the north (FAO, 1966). To alleviate this problem and ensure adequate animal protein sufficiency in the diet of the southerners, livestock adapted to the geographical and environmental condition of the south needs to be considered and efforts made to improve their productivity and performance.

Non-ruminant such as poultry and pigs offered the most rapid opportunity for increased livestock production in these regions because ruminants take longer to show results. Unfortunately pigs and poultry depend for their energy supplies on almost the same nutrients as man. Therefore these groups of domestic animals are in direct competition on an energetic basis with humans (Van Soest, 1981).

Small ruminants such as sheep and goats are known to be less competitive with humans in terms of limited available food crops. They have the ability to process the structural carbohydrates of plants into a form utilizable by man. "Energy sinks" in the form of plant cellulose are "irretrievable" not only to the plant but to man. The ruminant renders this energy available to man through fermentation process. In today's changing agricultural economy, the margin between supply and demand of retrievable energy sources is narrowing, thus there is need to consider the less energy dependent livestock system, such as goat raising, as one of the possible alternatives to augment high protein-rich food supplies to the Nigerian populace. Goat is a traditional livestock of many nations (Brown and Johnson, 1984), particularly the southern part of Nigeria.

1.4 GOATS

The domestic goat belongs to the genus Capra, a probable descendant of the Species Caegagrus (Williamson and Payne, 1965). As one of the oldest farm animal to be domesticated, goats' association with man has been put at well over 10,000 years (Zeuner, 1963). This animal specie has been described as the first of man's domestic animals to colonise the wilderness and the last to abandon the desert that man leaves behind (Mackenzie, 1970). As a result of its unique physiological-anatomical features, goat is tolerant to different environmental conditions and various ecological systems, which make goat rearing to cover a wider geographical area than any other domesticated animals.

Goat is one of the most important agricultural animals in the tropics (Zeuner, 1963). Goat, particularly the West African Dwarf (WAD), possesses a tolerance to certain local diseases and parasitic conditions (FAO, 1966). Goats are better adapted to hot regions than cattle or sheep, and less dependent on regular supply of water (FAO, 1966).

On account of their wide dietary preference, goats survive droughts better than either cattle or sheep (Wilson, 1982). They have preference for shoots, buds, leaves, and pungent herbs as well as fibre-rich twigs and bark with a high tannin content. They are even capable of eating the tiny leaves of thorny bushes, which no other ruminant can do (Peter and Horst, 1981). Along with the fact that goats feed on any available substance, their ability to digest fibre-rich fodder is an important factor in considering improving goat production to augment animal protein supply in many developing countries of the world.

1.5: DISTRIBUTION OF GOATS

The precise world's goat population is not known as the reported figure varies from one author to the other. In Seller's (1981) view, this problem is envisaged since a greater proportion of goat population exists in developing countries, where well coordinated livestock data collection methods are lacking and the statistics suffer from the usual defects of large-scale operations, response bias, variation in definition and enumerator interpretation, added to which are editing, transcription and casting errors. The above constraints not withstanding, a total world goat population of between 400 and 450 million (Cunha, 1982; Raun, 1982) could be accepted as a workable figure, amounting to approximately 15 percent of the total world domestic animals (FAO, 1966).

The majority of the world's goats exist in the developing countries where they contribute immensely to the social and economic well-being of subsistent farmers. Report (FAO, 1979) indicates that 30 percent of the total world's goats exist in Africa, 23 percent in India and Pakistan, 17 percent in Mainland China and 7 percent in Latin America. The remaining 23 percent are found primarily in Asia. The estimated goat population in Africa stood at 143.3 million (Wilson, 1982) in 1978. Within the African continent, the distribution of goat is uneven. The greatest concentration of goat abound in the semi-arid arc with approximately 22 percent of the world's goat density as well as the highest number of goats per head of the rural population.

In Nigeria, goat is more important numerically than other ruminants. Livestock production data indicated that an estimated 24.0 million goats exist in Nigeria. This was followed by 12.3 million for cattle and 11.7 million for sheep (FAO-WHO-OIE, 1970). Approximately 60 percent of Nigerian households keep goats, compared to 40 percent that keep sheep (Seller, 1981). The percentage distribution showed that the largest goat population is found in the north with nearly 65 percent of the total goat population. The remaining 35 percent are scattered throughout the southern states of the country (FAO, 1966).

1.6: MANAGEMENT

Goat management in Nigeria comes under extensive traditional system of management. No deliberate effort is made by majority of goat owners to provide feedstuffs. Except for experimental research stations, goats scavenge for their living, subsisting largely on browse, kitchen wastes, and refuse. In some homes, they receive small or erratic quantities of household scraps of crop residues.

No elaborate housing is provided as the majority wander at will around villages and market places. Provisions are often made for their security at night to guide against predators.

Veterinary care for goats is non-existent. Instead a majority of goat owners engage in arbitrary medication of their animals. Despite the great concentration of goats in Africa, lack of both preventive and adequate curative measures coupled with poor management practices have led to the underutilization of goat's potential to augment food production from livestock.

1.7: SOCIAL AND ECONOMIC IMPORTANCE OF GOAT

Considering the distribution pattern of goats in the world, goats can be described as the characteristic livestock of the poorer nations. The meat, milk and leather produced serve an economic and sociological purpose for the rural dwellers. World-wide, goats produce more than 4.5 million tons of milk and 1.2 million tons of meat for human consumption (FAO, 1977), not to mention the production of hair and goat leather.

Goat meat production assumes a siginficant importance in the tropical zone than the temperate region (Peter and Horst, 1981). In many developing countries, goat meat is prized at premium (McDowell and Bove, 1977) probably for its unique characteristic flavour and texture. The consumption of goat meat is not subject to any religious taboos. In various regions in Africa and Asia where there are predominantly islamic populations, preference for goat meat has been reported (Peter and Horst, 1981).

Adu (1980) depicted comparative slaughtering figures for Nigeria which showed that 180,000 goats were slaughtered in 1980 as compared to 300,000 cattle and 70,000 sheep. The figures could not be regarded as absolute since most of these small ruminants (sheep and goats) are slaughtered far away from markets where no statistical records are kept. Some estimates indicate that for every goat and sheep "officially" slaughtered, ten are slaughtered without any record (Wilson, 1982). Another interesting aspect of goat contribution to meat production is their ability to continue producing meat through stress periods such as drought, and to recover very rapidly afterwards, thus avoiding too drastic drop in total meat production (Wilson, 1982).

The value and contribution of goat as a dairy animal in the tropics is of secondary importance, since the indigenous goats are reared mainly for meat production. Nevertheless, the quality of goat milk is one of the special attributes of this animal specie. Goat milk has a high digestibility, distinct alkalinity and its therapeutic uses in medicine are of particular significance in human nutrition (Walker, 1965; Devendra Burns, 1970). Goat milk has a peculiar flavour and taste which is very different from that of sheep or cow (Williamson and Payne, 1965).

In some countries, skin, wool and hair of the goat strengthen their economic base and boost their foreign exchange earnings (Williamson and Payne, 1965). In Nigeria, although there has been little effort to promote the improvement and commercialization of goat skins, the skin, particularly the skin of Maradi (Red Sokoto), is known for its superior quality and the premium it commands in the world market (FAO, 1966).

Other economic aspects of goat husbandry include the role they play as an economic blanet for the subsistent farmer as well as their economic advantage of reducing pastoralist risk in case of heavy losses due to drought or other mishaps (Stanford, 1982). Goat production is economically viable due to the higher prolificacy of the animal (Swain, et al., 1982). As a multi-purpose animal, goat is slaughtered more often in ceremonial occasions like weddings, namings, and birthdays compared to other domestic ruminants. In various cultural circles, the goat is in greater demand as a sacrifical animal for religious purposes, as a meat provider for the family feasts, or as fine or pledge and as a mark of honour to guests.

CHAPTER TWO

REVIEW OF LITERATURE

2.1: RUMINANT

The ruminant mammals include all animals that have complex forestomach and chew the curd. Like non-ruminants these species do not secrete enzymes capable of hydrolyzing cellulose and related carbohydrates. However, by virtue of the microflora in the first section of the complex stomach, they can degrade large quantities of such materials, to the extent of being able to depend on them for their entire energy needs. Preston (1975) reported that nearly 80 percent of the total energy of the diet is made available to the ruminant through the fermentative activity of its microflora.

The ability of ruminants to recycle nitrogen for re-utilization and synthesis of protein from cheaper nitrogen sources, such as ammonia, has been attributed to the unique gastro-intestinal architect of ruminant stomach (Chalmers, et al., 1976). Physiologically, ruminants' stomach is partitioned into different functional compartments designated as rumen, reticulum, omasum and abomasum.

Annison and Lewis (1959) observed that the modification of digestive tract of ruminant is necessary for physiological, biochemical and nutritional purpose. In the rumen, there exists a mixed population of micro-organisms, bacteria and protozoa, which are of the order of 10^{10} for protozoas per gram of the rumen content (Hungate, 1966). These micro-organisms are responsible for the digestion of bulky and fibrous foods retained in the first ruminant stomach compartment. The injested food is retained in the rumen and reticulum until it attains a fine constituency. By means of alternate contraction of rumen and reticulum, smaller particles are separated from the mass and later transversed into the omasum.

The omasum functions mainly to grind or triturate food material entering it from the rumen (Duke, 1955). Abomasum's digestive function resembles that of simple stomach except that digestive function of abomasum is continuous in ruminants and relatively independent of feed pattern (Bueno and Fioramonti, 1979).

2.2: DEVELOPMENT OF DIGESTIVE SYSTEM IN RUMINANT

Pre-weaned ruminant digestive tract is not well developed but undergoes progressive changes as the animal develops. Thivend, *et al.*, (1979) observed that the total weight of the digestive tract of pre-weaned calf (as a percentage of empty body weight) is always lower compared to adult at any given age. A progressive change in pre-weaned calf digestive tract over a period of one year has been reported (Session, 1949). Wandrope and Coombe (1960) categorized the physical and functional development of rumen of pre-ruminant into three phases:

1. 0 - 3 weeks of age--as the non-ruminant phase
2. 3 - 8 weeks of age--as the transition phase
3. 8 weeks of age onward--the adult phase

In the first three weeks of life, young ruminant digestive system is anatomically similar to that of non-ruminants since the forestomach does not function yet and only the abomasum is functional (Walker, 1969).

Ramsey (1962) investigation revealed that the only nutrient that can be satisfactorily utilized when given in liquid form are milk proteins, butterfat, and lactose. Milk fed reaching the stomach is channeled through the oesophageal groove directly into the omasum and abomasum (McDonald, _et al_., 1969). Other investigators reported that the reflex of oesophageal groove closure can be used to transport liquid feed directly from oesophagus to the abomasum (Qrskov, _et al_., 1970).

McCarthy and Kesler (1956) reported that at birth, and for a short time afterwards, the calf relies on glucose for its major energy needs. Later the glucose levels in the blood begins to fall while the concentration of blood volatile fatty acids increases. Hibbs, et al. (1953) noted that plasma glucose level declined markedly only after withdrawal of milk feed from the diet. They further noted that administration of antibiotics influenced the level of plasma glucose, by its ability to alter fermentation in the rumen and depressing the activity of certain bacteria.

At weaning, there is a notable shift in animal's digestive process (Thivend, et al., 1979). Dry feeds pass into the rumen where carbohydrates and protein and all others undergo ruminal fermentation by the activities of the microbes.

2.3: ANTIBIOTICS

Some plants secrete from roots or leaves compounds which are capable of blocking the growth of other plants while many organisms produce chemical substances which are toxic to other organisms. Of specific interest is antibiotics.

Different authors define antibiotics in various ways. Some describe it as a substance directed against life or destructive of life, while others define it as a substance, synthesized by a living organism, which inhibits the growth of others (Kuthe, 1975). Antibiotics as it applies today can best be described as chemical substances produced by a micro-organism, or identical substances produced by chemical synthesis which have the capacity to inhibit the growth of other micro-organisms or to destroy them (FTC, 1958).

The use of antibiotics as an anti-bacteria substance dated back to pre-Islamic days when the Arabs utilized the antibactericidal effect of moulds without knowing its "Modus Operandi." Even today the Bedouin are known to blow the greenish dust off mouldy bread into a sick person's throat as a cure for throat infection (Kuthe, 1975).

Although the concept of growth inhibition of one kind of organism upon another has been formed many decades ago, modern interst in the phenomenon began in 1929 when Alexander Fleming observed the inhibition of growth of Staphylococci by Peniccilium notatum (Metzler, 1977). This observation led directly to the discovery of penicillium, and the subsequent isolation of actinomycin and streptomycin from soil actinocycetes (Streptomyces). The name antibiotics was coined for these compounds (Metzler, 1977).

Antibiotics may be either bacteriostatic or bactericidal, depending to a large extent on dosage. Since they act primarily through interference with bacterial growth, these agents are mostly effective in acute infections when bacteria are in a rapid growth stage. In animal, they are primarily applied against bacteria infections; however, some of the large viruses and several protozoa and fungi are also sensitive to these drugs (The Veterinary Manual, 1967).

Antibiotics are somewhat selective in their anti-bacteria actions. Streptomycin for example is mainly effective against gram-positive bacteria while penicillin is more active against gram-negative organisms. Others such as chlortetracycline and oxytetracycline have wider range of activity; they are effective against both gram-positive and gram-negative bacteria. These are called broad-spectrum antibiotics to distinguish them from the more selective ones, such as penicillin.

Since their discovery, antibiotics have proved to be wonder drugs for medicine and have been nothing short of miracle agents in agriculture over the past quarter of a century (Time, 1984). To date, approximately 6.8 million kilograms, nearly half the United States annual production of antibiotics, are fed yearly to farm animals, primarily cattle, poultry and pigs (Time, 1984).

There are hundreds of known antibiotics which have been isolated, produced, and sold under different brand names. These include Aureomycin (Chlortetracycline), Terramycin (Oxytetracycline), Penicillin, Bacitracin, Streptomycin, Tylosin, and Oleandoymcin. Other feed addictives which have been used experimentally are Arsenicals, Nitrofurans, Sulfonamides and Copper compounds (Kisser, 1976). Of these antibiotics, Chlortetracycline and Oxytetracycline have been used extensively as feed additives in ruminants and their efficacy in improving animal performances have been established (NRC, 1971).

2.3.1: CHLORTETRACYCLINE (AUREOMYCIN)

Chlortetracycline is the first tetracycline to be isolated. This antiobiotic was prepared from the strain of Streptomyces Aureofaciens (Florey, 1957).

Chlortetracycline is a yellow crystalline material, almost insoluble in water at pH 7.0 and remarkably stable at room temperature. The crystalline hydrochloride salt is more soluble than the primary substance at a concentration of 2 percent weight by volume (W/V) at a high pH (Florey, 1957).

The trade name "Aureomycin" has recently been replaced in pharmacopodia by 'Chlortetracycline', a name which indicates its structural configuration with a molecular weight (MW) of 515.36.

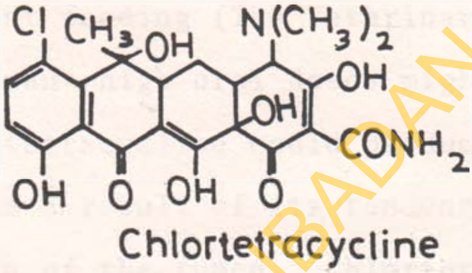


Figure 1: Chemical Structure of Chlortetracycline (Source: Maynard, et al., 1979. Animal Nutrition. 7th ed., 361).

Chlortetracycline is well absorbed when administered orally. Its main route of excretion is though the urine. Experimental studies indicate that the toxicity of chloretetracycline is low and there appears to be no clinical reports on serious toxicity in animals at a dosage that would be suitable for clinical work (The Veterinary Manual, 1967). When administered to a nursing cattle, studies have shown that appreciable amounts are excreted into the milk.

When chlortetracycline was administered to mice, dogs, rats and rabbits, result showed that most animals tolerated an intravenous injection of 50mg per kg of body weight (Bryer, et al., 1948).

When chlortetracycline was added to the diet of young pigs, chicks and rats in very small amounts, it was found to increase the rapidity of growth. Later it was demonstrated to be beneficial in pre-weaned ruminant feeding (The Veterinary Manual, 1967). In adult ruminant high oral doses might be a problem, because chlortetracycline could produce digestive disturbance as a result of its tendency to disturb the microflora of the rumen. Chlortetracycline is active against the many gram-positive and gram-negative bacteria as well as large viruses and rickettsiae (The Veterinary Manual, 1967). This drug has been used for therapeutic purposes in treating streptolococii and staphylococci mastitis in cattle, pneumonia, urinary tract infections and coccidosis in dogs, various enteric infections in swine, as well as a valuable drug in controlling infectious synovitis (The Veterinary Manual, 1967).

2.3.2: OXYTETRACYCLINE (TERRAMYCIN)

Oxytetracycline is the second in the series of antibiotics used as feed additives in young ruminants. This anti-bacteriacidal agent was first isolated by members of the Biochemical Research Laboratories of Messrs. Chase Pfizer and Co., Inc., in the United States, from cultures of actinomyceta, "Streptomyces rimosus" (FTC, 1958). In dry form, oxytetracycline is yellow in colour and crystalline in nature. The active substance was found to be amphoteric; both acid and basic salt were crystallized and found to be readily soluble in water and moderately so in organic solvents (Regna and Solomon, 1950). Investigation about the metabolism and safety revealed that it is rapidly absorbed from the gastrointestinal tract and excreted in relatively large amounts in the urine (Welch, 1950).

Oxytetracycline acts promptly upon sensitive cells and exerts a bacteriacidal effect, when the ratio of the concentration to the initial number of organisms is high (Hobby, et al., 1950).

According to X-ray difraction studies, oxytetracycline shares a remarkable similarity with chlortetracycline. The two antiobiotics may differ chemically in the replacement of a hydroxyl-group in oxtetracycline by chlorine in chlotetracycline (Regina and Solomon, 1950).

Figure 2. Chemical Structure of Oxytetracycline (Source: Maynard, et al., 1979. Animal Nutrition, 7th ed., 361).

Oxytetracycline possesses a broad antibacteria spectrum, being effective in the treatment of a wide range of diseases caused by susceptible gram-positive and gram-negative bacteria, both aerobic and anaerobic, as well as some rickettsia and certain viruses. In cattle, oxytetracycline is used by intramammary infusion to treat mastitis. Systematically, it has been employed to treat a variety of diseases including shipping fever, foot rot, calf scours, and anthrax for poultry. Oxytetracycline administered in feed is of value in the control of infectious synovitis, bluecomb and chronic respiratory disease. Oxytetracycline added to small ruminants' feed serves to control diarrhea and enterotoximia (The Veterinary Manual, 1967).

Oxytetracycline, like chlortetracycline, has a low degree of toxicity in both man and animal. It may be administered orally to all species of livestock except adult ruminants, where it is likely to exert an unfavorable influence on the ruminal microflora (The Veterinary Manual, 1967).

2.4: ANTIBIOTICS IN ANIMAL HUSBANDRY

Antiobiotics are not nutrients, neither are they dietary essentials for animals but their use in animal husbandary is growing. Observers believed that wide use of antiobitics has played a significant role economically in controlling losses due to infectious diseases and in helping to meet the ever growing demands for animal protein food (Maynard, et al., 1979).

At higher levels, antibiotics are used to treat specific infections of digestive tract in animals. Outside the normal therapy substantial amounts of antibiotics are used for prophylatic purpose. The inclusion of sub-clinical levels of antiobiotics in the rations of experimental animals, especially young ones, has been widely embraced because of their immense benefits which include:

1. Improved growth rate (as measured by liveweight change).
2. Improved feed consumption and feed efficiency (as measured by kilogram of feed required to produce a kilogram of (liveweight (LW) gain).
3. Reduction in mortality and morbidity from clinical or sub-clinical infections.

2.5: ANTIBIOTICS AS GROWTH STIMULANT

Growth increase due to antibiotics is expressed as the percentage increase in liveweight of antibiotic supplemented group over the control group (Stokstad, *et al*., 1949). Numerous experiments had demonstrated the efficacy of antibiotics in increasing the growth rate of young animals when their feed is supplemented with sub-clinical levels of antibiotics.

Most of the early information on the ability of antibiotics to stimulate the growth of animals was obtained from the study conducted with monogastrics such as piglets, chicks and turkey. Moore, *et al*. (1946) reported that sulphasudine and Streptomycin stimulated the growth of chicks on purified diet. Harned, *et al*., (1948) observed that Duomycin (Aureomycin) have noticeable effect on the growth rate and well-being of chicks. These early findings were followed by reports (Stockstad, *et al*., 1949;

Whitehill, _et al_., 1950; Horvath and Vander, 1954) which further confirmed the stimulatory effect of antibiotics on the growth rate of chicks and pigs. This knowledge was quickly applied to the rearing of other farm animals and further experimental work was done to demonstrate these properties.

Ruminants unlike monogastrics depend on intestinal micro-flora synthesis of some essential nutrients needed for proper nutrition. Thus scientists interested in ruminant nutrition were skeptical about introducing antibiotics to this group of livestock. Some feared that the inclusion of antibiotic in ruminant feed may possibly interfere with the normal intestinal microflora of the ruminants by paralyzing the active rumen micro-organisms (Bartley, _et al_., 1953). Further information on monogastric research motivated ruminant nutritionists and physiologists to exploit the unique characteristics of antibiotics in feeding of young ruminants.

Bartlet, _et al_. (1950) reported increase in the average weight gain and reduction in the incidence of scours when calves' feed were supplemented with sub-clinical levels of aureomycin. Loosli and Wallace (1950) reported an average daily gain of

20 percent over the control calves when various milk substitutes with grain and hay were supplemented with 2.8 percent level or 0.5gm of pure aureomycin per 45kg of dry matter intake.

Rusoff, et al (1954) obtained approximately 17 percent weight gain in the aureomycin-fed group compared to the control, when 30 Holstein and Jersey male calves were fed with 50mg daily in milk and 0.5 percent level of Aurofac 2A in calf starter. Jordan and Bell (1951) in their own study reported higher rates of gain than control on suckling and fattening lambs fed with ration supplemented with 5 to 15mg aureomycin per head daily. Hatfield (1954) in three feeding trials involving 190 suckling and feeder lambs to study the influence of ration supplemented with antibiotics on growth, feed efficiency and carcass grade, discovered consistently higher average daily gains, almost reaching the 5 percent significant level, in all the trials.

Contrary to the above report, it was observed by Colby, et al (1950) that young lambs, which received 9mg aureomycin and supplied with an APF supplement per kilogram of concentrate, gained less than their control both before and after weaning. Kinsman and

Riddell (1953) reported no difference in the rate of gain when creep ration was supplemented with 15mg aureomycin, terramycin and penicillin per kilogram of ration. Luce, et al. (1953) observed that lambs supplemented with 10mg aureomycin per day from one week of age to weaning gained less than the controls.

Mackay, et al. (1953) investigated the growth promoting effect of terramycin on young dairy calves receiving a liberal ration of milk, calf starter and good quality hay. The result showed a significant increase in the growth of terramycin supplemented animal as well as improved appetite and general appearance, when compared with the control animals. Cason and Voelker (1951) reported that feeding of 30mg of terramycin per kg of body weight daily increased the growth rate of calves by 21 percent over the control calves. The terramycin-fed calves gained 28.6kg as compared to 23.6kg for the control. Increasing the terramycin level to 100mg daily stimulated growth responses 28 percent faster than the calves on basal diet.

Murdock, et al (1951) failed to obtain any growth advantage when calves were fed terramycin but when aureomycin was fed, there was a significant increase in the growth rate of the supplemented calves. Lassiter, et al. (1959) reported that crystalline terramycin did not improve the growth rate of Holstein and Jersey calves fed a limited amount of milk and all-plant starter, whereas a terramycin supplement had stimulated growth rate as much as 12 percent in a previous experiment when a similar feeding system was employed. Moddy, et al. (1954) observed sex differences in the level of terramycin effectiveness on the growth rate of calves. It was discovered that terramycin stimulated the growth rate of female calves more than those of males and no evidence was found that low birth weight calves responded more to terramycin supplementation than normal birth weight calves.

Besides, aureomycin and terramycin, other antibiotics or a combination of others had been used as growth stimulant. Hogue, et al. (1954) reported a greater body weight gain (as much as 18 percent) in the streptomycin-fed calves compared to the control. And Rusoff, et al. (1955) observed 15 percent growth increase in calves supplemented with 50mg streptomycin per head, but not in calves supplemented with 30mg of streptomycin per day.

Rusoff and Davis (1952) found that neither tyrothricin nor bacitracin stimulated the growth of calves. Bloom and Knodt (1951) reported that feeding of potassium penicillin lowered the growth rate and appeared to cause an earlier and greater consumption of the calf starter ration.

Aureomycin, terramycin and a few other antibiotics have been found to be effective as a growth stimulant in pre-weaned ruminants, particularly in calves. In cases where aureomycin and terramycin have been found to be ineffective, questions have been raised as to the level of antibiotics used, the quality of feed, the age of the experimental animals as well as management practices.

2.6: INFLUENCE OF VARIOUS FACTORS UPON GROWTH RESPONSE TO ANTIBIOTICS

The increase in weight gains of domestic animals attributed to the feeding of antibiotics varies under different experimental conditions. Published figures ranged between 15 to 30 percent in liveweight gain and in a few cases an increase of up to 70 percent had been reported (Juke and Williams, 1953). Kuthe (1975) examined factors affecting the practical effect of antibiotics on growth and stated thus:

1. The best effect is shown in young and growing animals as the efficacy of antibiotics in promoting growth diminishes markedly with increasing age.

2. Monogastrics react more favourably when their feeds are supplemented with antibiotics over a longer period than do ruminants.

Reid, et al. (1954) also identified those factors that affect the response of animal to antibiotics thus:

1. Effect of dietary component.
2. Level of antibiotic.
3. Mode of administration.
4. Age of the experimental animals.

2.6.1: EFFECT OF DIETARY COMPONENTS

It is common knowledge that the feeding of antibiotics will not substitute for a good feeding program. This means the necessary protein, minerals and vitamins must be supplied in the right proportion in a diet.

It was observed (Branion and Hill, 1951; Heywang, 1952; Briggs, et al. 1951) that the composition of the diet could have marked influence on the response obtained from feeding antibiotics to livestock. Bartley (1954) obtained a better growth stimulation when antibiotic was placed in the milk compared to when it was added to a calf starter. Accardi (1969) found a similar result when 20mg oxytetracycline per kg liveweight was added to milk or solid feed for Red Danish calves. The investigator reported that those given the antibiotic in the milk gained consistently more than those on the solid feed.

Rusoff, et al. (1953) fed three protein sources to three experimental groups. A group received the soybean oil meal, another group, cotton seed meal, and the other group, cotton seed meal degossypolized. The results showed that regardless of the type of protein in the starter, an increase in weight gain was produced. However, aureomycin-fed calves on the soybean oil meal starter showed the greater increase in weight. From this investigation, the authors concluded that the type of protein source in all-vegetable calf starter when fed with limited milk may affect the growth response of calf to antibiotics. A growth advantage was observed for calves on aureomycin when fed 2:1 hay to grain ration during the period 12 to 26 weeks of age compared with calves fed the 4:1 ration (Hibbs, et al., 1954).

2.6.2: LEVEL OF ANTIBIOTICS

The level of antibiotics administered to animals varies from one experiment to another. Bartley, *et al*. (1951) fed aureomycin supplement at two levels of 3 and 9 grams per 45kg body weight daily to dairy calves. The result showed that both levels of antibiotic produced similar improvement in growth. Aureomycin-fed at 15 and 45mg per 45kg body weight daily from birth to 25 weeks of age showed that the higher level of antibiotics feeding reduced the difference between sexes in the growth response. When crystalline aureomycin was supplemented at higher levels (45 and 90mg/day) from birth to 25 weeks of age, report (Bartley, *et al*., 1954) showed that both levels reduced the incidence of infection. However, 45mg level produced significantly greater gains than the 90mg level up to 12 weeks of age. Based on this observation, the investigators proposed that the optimum level of aureomycin feeding should be 45mg per 45kg of body weight daily for the first 12 weeks of life.

Pritchard, *et al*. (1954) observed that terramycin fed to calves at 15mg and 60mg per 45kg of body weight stimulated the growth of calves slightly over that of the control, but the increase was not statistically significant. Rusoff, et al. (1955) fed streptomycin at levels of 30 and 50 mg per calf daily up to 12 weeks of age; the 50mg level improved the growth rate of calves 15 percent but the 30mg level did not have appreciable effect on average daily gain. Sawhney and Bedi (1968) reported that 15mg chlortetracycline in a test diet gave better response compared to 30mg when fed to growing kids. Experiment with different kinds of antibiotics, namely, aureomycin, streptomycin and mixture of bacitracin and penicillin (4:1) at levels of 10, 20 and 40mg per 45kg of body weight showed no growth advantage for any particular level over the other (Hogue, et al., 1954).

Series of experiences have been conducted to test the effect of various levels of antibiotics in milk replacement feed. One of these experiments fed aureomycin at 0, 2, 4, 6 and 10g per 45kg of milk replacement. It was reported that all levels of antibiotics improved the growth rate of the calves at 8 and 12 weeks of age. Aureomycin supplement at 2g per 45kg of milk replacement improved growth more than any other level at 8 weeks of age and was about the second level of antibiotic to improve growth at 12 weeks of age. Based on these data, aureomycin supplement at 2g per 45kg of milk replacer was proposed to be adequate in producing maximum growth response in young calves (Knodt and Ross, 1952). Similar observation was reported when antibiotics were fed at three different levels of 0.5g, 1.0g, and 2.0g per 45kg of milk replacement in both pure and supplemented aureomycin to young calves. At 8 weeks of age, the greatest response was obtained from the feeding of 1.0g in the pure form of aureomycin at 0.5g and 1.0g of aureomycin in crude form. However, at 12 weeks there was no statistically significant difference between the levels of the crude form, but the 1.00g level produced the greatest growth response when aureomycin was fed in the crystalline form (Bloom and Knodt, 1953). Kesler and Knodt (1952) reported a greater growth response with 20mg terramycin HCl per 45kg body weight, compared to 10mg and 40mg.

2.6.3: MODE OF ADMINISTRATION

Oral supplementation versus muscular injection of aureomycin to young calves have been studied. In this experiment, the researchers supplemented the rations of a group of calves with aureomycin in milk and calf starter. A second group of calves were given

400mg of aureomycin by intramuscular injections weekly. The result showed that orally administered aureomycin increased the average daily gain of the calves 24 percent over that of the control calves while the injected antibiotic improved the growth rate by only 15 percent. Kesler and Knodt (1952) observed that administration of terramycin by capsule effect greater growth and was more effective in inhibiting micro-organisms, which attack cellulose in the rumen.

Bartley, et al. (1954) investigated the most effective mode of transport for antibiotics in a study with calves from birth to 8 weeks of age. Various levels of antibiotics were offered in calf starter, in milk or by capsule. The result showed that the control calves gained 176 percent of the starting weight; calves fed 1 percent of aureomycin supplement (Aurofac 2A) in calf starter, 185 percent, calves fed 45mg of aureomycin daily by capsule 191 percent, calves fed 45mg aureomycin daily in milk, 207 percent and those given weekly injection of 125mg of aureomycin, 183 percent. It was concluded that aureomycin given once weekly by intramuscular injection (125mg) was not as effective in improving the growth rate of the calves as daily oral administration of 45mg.

Richardson, et al (1953) applied different treatments to five different groups of animals to study the effect of different methods of antibiotics administration on the growth response in calves. The treatments were 250mg (orally administered) antibiotic weekly, 60mg subcutaneous implantation per week, 70mg per day orally and 60mg intramuscular injected weekly. The result showed that the daily and weekly oral feeding of aureomycin were about equally effective in stimulating the growth rate of calves over the controls, but this was not true of weekly subcutaneous implantations or weekly intramuscular injections of aureomycin.

2.6.4: EFFECT OF AGE

Growth response to sub-clinical levels of antibiotics occurs early during the growth cycle and ceases before growth is completed (MacFadden and Bartley, 1959). Bartley, et al. (1954) observed that the greatest benefits from antibiotic feeding occur when calves were started on antibiotics soon after birth. Thus, some close relationship between the age of animal and the observed growth response to antibiotics have been carefully studied.

Lassiter (1955) observed a maximum growth response to antibiotics supplement before calf was 8 weeks of age. Bloom and Knodt (1953) reported that aureomycin stimulated a greater growth rate during the first four weeks of life than during the later period, while Kesler and Knodt (1972) reported that cessation or initiation of terramycin feeding at 8 weeks of age had very little effect on growth, thus showing that the maximum growth response to antibiotics supplementation occurred before animals attained 8 weeks of age.

Much earlier, Mackay, et al. (1952) had tried rotational experiments to study the age at which appropriate response could be obtained with feed additives. In two experiments, the investigators divided into two groups, eight heifer calves at a time when the rumen is beginning to function (6 to 9 weeks). Group I was maintined as the control lot while Group II received 24 grams terramycin hydrochloride per ton of grain feed. The results showed an initial increase in growth of the supplemented calves over the control but at the end of 8 weeks, there was no appreciable difference in rate of gain of the experimental compared with control group. At this time, the groups were reversed and this phase continued for another 8 weeks. The weight data and average gain per calf showed an initial increase in gain during the first part of the period for the terramycin-fed calves, which eventually declined gradually to the close of the period to control level.

Feeding of antibiotics to mature ruminants could have detrimental effect on digestibility and afford no nutritional advantage. Lassiter et al. (1954) fed yearling dairy steers 500mg of crystalline aureomycin alone and in combination with surfactants, Ethomid/C-15 to study the effect of aureomycin and surfactants on digestion of nutrients. It was reported that crystalline aureomycin decreased dry matter digestibility from 64.0 percent on the basal ration to 60.5 percent, and crude fibre digestibility was reduced from 35.5 to 22.7 percent. Lodge and Jacobson (1954) reported a decrease in cellulose digestion in the artificial rumen from 83 percent for the control to 72 percent for the experimental group when dairy animals were supplemented with 240mg of aureomycin daily from birth to maturity.

2.7: MODE OF ACTION

The spectra of bacteria against which antibiotics are effective and their chemical structures vary widely as their mode of action. From a biochemical point of view, some antibiotics such as penicillin block specific enzymes. The peptide antibiotics often form complexes with metal ions and apparently disrupt the control of ion permeability in bacteria membranes. The polyethylene antibiotics interfere with proton and ion transport in fungal membranes while tetracyclines and many others interfere directly with protein synthesis. Some interchalate into DNA molecules (Metzler, 1977).

The mode of action and metabolic process by which antibiotics improve performances and promote feed efficiency in domestic animals have been a subject of interest. To this effect, investigators have postulated series of hypotheses to explain the mechanism by which antibiotics work (Bartley, _et al._, 1953; and Jacobson, _et al._, 1952). Some investigators concluded that high incidence of scours is most commonly observed during early life when antibiotics have been found to be very effective in stimulating growth, thus possible mode of action of antibiotics must be associated with its effectiveness in reducing the incidence of scours. This hypothesis failed to gain wide acceptance because increased growth rate in domestic animals had been observed when incidence of scours was not a problem (Warner, 1952; Knodt, et al., 1953; Lassiter, et al., 1954).

Another observer believed that part of the accelerated growth in antibiotic-fed calves was due to increased appetities. Radisson, et al. (1956) fail to substantiate this proposal because if antibiotics affected the appetities of calves directly, one would expect calves fed antibiotics to consume more feed per kg of body weight and this was not reflected in their observation.

Stockstad (1954) postulated that the action of antibiotics in increasing the growth rate of domestic animals is apparently confined to its effects on the bacteria within the intestinal tract. Jukes and Williams (1953) indicated that the possible mode of action of antibiotics in effecting growth promotion must be related to the ability of the antimicrobial agent in exerting an influence on the intestinal microflora.

In non-ruminants, investigators have found some relationship between the growth of chicks supplemented with sub-clinical levels of antibiotics and their intestinal microflora (Moore, et al., 1946; Lassiter, 1955). Moore, et al. 1946) reported a rapid increase in the intestinal microflora of certain growth-promoting yeast in chicks when streptomycin supplemented chicks feed were fed. Lassiter (1955) reported that antibiotics in the ration of chicks cause some changes in the intestinal flora of these birds that was responsible for the improvement in the growth rate. Walton (1977) concluded that growth promotion in antibiotics-fed animals, might be associated with a better metabolic performance, which is likely due to some interference with performance of one or more groups of enteric bacteria.

There was a selective increase in intestinal flora of antibiotic-fed chicken based on the nutritive quality of the feed (Anderson, et al., 1952). In such investigation in which intestinal flora of chicken fed diets deficient in some nutrients were supplemented with antibiotics, there was a tendency to have an increase in the categories of certain intestinal coliforms known to synthesize some deficient essential nutrients. Organisms which compete with the host for dietary needs are suppressed by certain additive compounds in chicks and pigs (March and Biely, 1952; Kellog, et al., 1964).

Antibiotics also caused reduction in the number of lactobacilli (Johnson and Sarless, 1949; Kellog, et al., 1966; Kuthe, 1975). March and Biely (1952) observed that the bacteria most affected by chlortetracycline were lactobacilli. Studies by Kellog, et al. (1964) indicated that changes in intestinal counts of lactobacilli, streptococci, total aerobes and total anaerobes in general, paralleled the rate of liveweight gain in response to level and sources of protein. These reports showed that certain organisms, particularly lactobacilli, require amino acids in certain proportion. Kellog, et al. (1966) reported that those antibiotics most effective in reducing the growth of these organisms are the most effective as routine growth promotants.

Contrary to the observation on non-ruminants, very few data have indicated that microflora of the intestinal tract has any significant relationship with the growth response produced by antibiotics in ruminants. An increase in total bacteria count of feed material without any appreciable effect on the total number of streptococci or coliform groups was found when calves were supplemented with 0.5g aureomycin in their feed (Chances, et al., 1953). Loosli, et al. (1951) reported that feeding aureomycin to calves under 16 weeks of age had very little effect on the total bacteria count of the rumen or the types of bacteria present. Rusoff and Davis (1951) examined 122 rumen smeers from 22 different calves. Their results failed to show any effect on the usual microscopic appearance of the rumen.

Voelker and Cason (1957) in their bacteriological studies compared the colon bacteria of terramycin-fed and control calves; the result showed no consistent difference in bacteria population of the experimental and control groups. Radisson, *et al*. (1956) proposed that physiology of bacteria rather than the number of intestinal bacteria is affected by antibiotics in ruminants. In a two-part experiment to determine the effect of aureomycin administered orally on young calves' sensitivity to intestinal bacteria, salmonella species and coliform bacilli were isolated from the faeces of calves receiving aureomycin and those receiving the unsupplemented diet. The sensitivity of the organisms to phagocytosis *in vitro* were measured. Observation revealed that the oral administration of aureomycin did not affect phagocytic activity of the leucocytes in the blood of the calves; however, bacteria isolated from faeces of calves receiving aureomycin were more sensitive to phagocytosis than bacteria isolated from the faeces of the control calves. Phagocytic activity of the leucocytes from young calves (from birth to two weeks) were lower compared to leucocytes from older calves (5 to 7 weeks). From these observations, it was concluded that the failure of various researchers to find a relationship between the growth-promoting action of antibiotics and the changes in number and type of intestinal bacteria in ruminants might be due to the fact that "at least a part of the effect of antibiotics on growth is due to the effect on the physiology of bacteria, rather than on the number of intestinal bacteria, in such a manner as to make them susceptible to the body defense mechanism and thereby less detrimental to the host."

Maynard, et al. (1979) stated that "most reports on rumen bacteria of cattle receiving antibiotics support the view that low levels do not modify the normal development of rumen function in calves and that they effect little or no changes in major type of micro-organisms present in the rumen of either calves or older cattle but higher levels do cause changes."

Rusoff, et al. (1953) conducted a bacteriological examination on 62 faecal samples collected from calves supplemented with aureomycin. There was no indication of aureomycin affecting the rumen microflora. Thus the authors concluded that aureomycin stimulating calf growth apparently is not due to selective bacteria inhibition of the common bacteria groups of the intestines, namely: coliforms, enterococci and clostridium perfigens types; rather, it might be concerned with a more rapid or complete absorption of nutrients passing through the gastro-intestinal tracts, or that certain biochemical reaction are influenced, resulting in increasing synthesis of essential nutrients without necessarily altering the character of the microflora.

Other publications have related the mode of action of antibiotics to their nutrient-sparing effect. Evidence in literature (Braude, et al., 1955; Coats, 1953; Rusoff, et al., 1954) substantiates the fact that antibiotics-fed animals have thinner intestinal walls. This phenomenon has been reported in pigs, chicks and calves. The implication is that organisms causing damage or thickening of the wall are suppressed or inhibited by antibiotics and an improved absorption capability result from feeding of antibiotics.

The bulk of evidence in literature showed that the mechanism by which antibiotics exert their influence could be categorized under three broad headings, which include:

1. A disease control effect through suppression of specific pathogens micro-organisms causing clinical and sub-clinical diseases.
2. Metabolic effect at cellular level.
3. A nutrient sparing effect.

To a large extent however, none of those observations have fully explained the specific method by which antibiotics exert their influence. It could therefore be assumed that one or a combination of these factors could be responsible for the observed beneficial effect of feeding sub-clinical levels of antibiotics to domestic animals.

2.8: EFFECT OF ANTIBIOTICS ON NUTRIENT METABOLISM

Part of the beneficial effects of dietary antibiotics in domestic animals have been attributed to their nutrient sparing effect, either by stimulating the growth of desirable organisms that synthesize vitamin and amino acids, and/or by enhancing the absorbability of nutrients from the gastro-intestinal tract (Kuthe, 1975). Maynard, *et al.* (1979)

observed that animals grow well on lower levels of protein or amino acids and certain B-vitamins with antibiotics in the diet than without them. Findings (Ahuja, et al., 1972) have shown that aureomycin supplement tends to increase nitrogen retention at the lower protein levels (20.3 and 23.6 percent) but decreases it at the highest level (30.6 percent).

Rashidov and Mamatkulov (1972) reported a better digestibiilty and utilization of N, Ca, and P with antibiotics-fed sheep compared with the control, when culled karakal sheep, 3.5 to 4 years old, were given a ration of cotton seeds husks. Stockstad (1954) observed that antibiotics facilitate the utilization of certain inorganic elements in livestock. The metabolism of some minerals is favourably affected by antibiotics. This is particularly so in the case of Ca, Mg, and P (Kuthe, 1975).

Maynard, et al. (1979) indicated that vitamins and minerals may be better absorbed with addition of antibiotics to feed. When Migicovsky, et al. (1951) measured the incorporation of orally administered doses of radio-active Ca into the tibia of the chicks, they observed that feeding of 30ppm penicillin increased the incorporation of Ca by an average of 70 percent.

Similarly (Common, et al., 1950) had earlier found that Ca and riboflavin in the serum of animals injected with estrogen were enhanced by feeding them antibiotics. Manganese forms chelates and coordination compounds with antibiotics such as tetracycline (Albert and Rees, 1956) and aureomycin (Pepper, et al., 1952). Pepper, et al. (1952) postulated that absorption of manganese in chelate form could be more effective than the absorption of this element in ionic form.

On the other hand, chlortetracycline, oxytetracycline and Tetracycline have been reported to cause a decrease in the absorption of some divalent cations such as Ca, Fe, Mg, and Zn as well as xylose, amino acids and fat in humans (March, 1978).

Studies of the effect of antibiotics on blood sugar levels found that aureomycin caused more rapid increase in blood sugar levels in experimental calves, compared to the control, although the differences were not siginficant (Murley, et al., 1951). Significantly higher blood sugar levels (9mg/100ml) in the experimental calves during the 8 to 12 week period compared to the control were reported (Hibbs, et al., 1954). Voelker and Jacobson (1953) on the other hand reported that ureomycin had no effect on the blood glucose level of 1,500 blood samples examined after daily administration of 200 - 240mg aureomycin per calf.

2.9: OBJECTIVE

The most sensitive period in the life of kids is between birth and one month of age when the highest mortality occurs (Nair, *et al*., 1982). Chawla and Bhatnager (1981) reported that over 44 percent of the total death (1,244 goats) in Indian National Dairy Research Institute occurred between birth and one month of age.

The data obtained on the frequency of birth and death in 1983 at the Goat Unit, University of Ibadan Teaching and Research Farm, showed that nearly 37 percent of kids born alive died within the first one month of life; thereafter, mortality tended to decrease with advancing age. With improved nutrition and better management practices, the mortality in the Unit was reduced by nearly 8 percent in 1984. The most common causes of death according to veterinary reports were scouring, enterotoxemia, pneumonia, Catarrh (PPR), nephritis and parasitic hepatitis. It is believed that oxytetracycline-HCL with its broad spectrum activities could drastically reduce the incidence of death related to infectious diseases at the juvenile stage and improve performance.

Kuthe (1975) advocated the use of antibiotics in humid countries since the climate and environmental factors could be disadvantageous to animal husbandry, particularly under the intensive animal management system. Considering the environmental susceptibility of young animals to infection and diseases in Nigeria, the use of antibiotics could open up some of the possibilities for increasing meat production, because of the established fact that these chemical substances are capable of increasing growth, improving feed consumption, and utilization as well as reduced mortality.

Presently, limited information is available in literature as to the possible effect of antibiotics on the general performance of kids supplemented with sub-clinical levels of antibiotics, either when the kids were allowed to subsist on their dams' milk or reared artificially on unrestricted quantity of cow's milk. In addition, published information have shown that antibiotics have some implications in the metabolism of some minerals that are vital to growth and development (March, 1978; Maynard, et al., 1979). Because of the significance of goat meat in improving the animal protein intake of Nigerians and the economic role this livestock specie plays in the life of many peasant farmers, it is pertinent to evaluate the quantitative utilization of oxytetracycline-HCl on the performance and selected serum mineral levels of kids reared with or without their dams.

This experiment was therefore designed to furnish some information on the effect of dietary inclusion of oxytetracycline-HCL fed at varying levels on milk consumption, liveweight gain and feed efficiency of kids reared with their dams or those reared artifically on cow's milk with the view to determine the level of oxytetracylne-HCl supplement to achieve optimum performance. In addition, changes in the serum mineral levels were assessed to determine the effect of oxytetracycline-HCl fed at varying levels, if any, on serum Ca, P, Na, K, Mg, Mn, Cu, and Fe status of kids under study.

CHAPTER THREE

EFFECT OF OXYTETRACYCLINE-HCl ON THE PERFORMANCE OF KIDS REARED WITH OR WITHOUT THEIR DAMS

3.1: INTRODUCTION

Antibiotics have been used to enhance growth, improve feed efficiency and reduced mortality rate in both simple and complex stomach animals. The efficiency of antibiotics as growth promoter during the juvenile stage of development in ruminants, particularly in calves and lambs, has been highlighted by many researchers (Volker and Jacobson, 1953; Loosli and Wallace, 1950).

There is, however, paucity of information on the quantitative utilization and efficacy of antibiotics in improving performance in goat production. Except for occasional use of antibiotics to combat one disease condition or the other, few scientific investigations have been conducted to test the efficacy of antibiotics in improving the performance of goats in general and kids in particular.

Awah (1981) applied terramycin in drinking water of kids every other day for three to four days to control diarrhea in an experiment designed to assess the effects of milk and concentrate feeding on nutrition, utilization and growth of West African dwarf (WAD) goats, without making a deliberate effort to assess the affect of this chemical substance as an independent variable.

This study was therefore conducted to assess the effects of different levels of oxytetracycline-HCl on performance, using weekly liveweight gain and feed efficiency (as measured by volume of milk required to produce a kilogram liveweight gain as parameters) in kids reared with or without their dams.

3.2: MATERIALS AND METHODS

3.2.1: ANIMALS AND THEIR MANAGEMENT

A total of 48-newborn kids weighing between 1.25 and 2.05kg with an average weight of 1.79kg were used in this experiment.

Shortly after parturition, the kids and their dams were withdrawn from the general pen. They were penned together for the first three days after parturition. The initial penning of the kids with their dams was important to enable the kids to receive colostrum and adjust between the sterile intra-uterus environment to a non-sterile extra-uterus environment of the pen. Colostric antibodies is of significant importance in the life of the newborn because kids depend on this maternal antibodies for most of their defense against infection early in life. In addition, penning of the kids with their dams for this time period would enable them to adapt to suckling reflex.

On the fourth day, the kids were separated from their dams and each of them was given an identification number. They were randomly assigned to the two test diets. In a situation where there were twins, each kid was assigned to a different rearing method. Thus, each nursing dam had a kid each. A total of twenty-four kids assigned to a rearing method were introduced to their test diets without quantifying their milk intake for the first four days after separation from their dams. This period was regarded as the adjustment period to the experimental diets. Kids which refused to suckle at this stage were withdrawn from the experiment and substituted with another. On the seventh day after parturition, the kids were weighed. A group of kids assigned to a rearing method was randomly allotted to four treatment levels to give a 2 x 4 factorial arrangement in a randomized complete block design. Each treatment comprised of a total of six animals. Care was taken to balance for sex.

Eight kids were housed together in a pen consisting of one animal from every treatment from each of the rearing methods. The pens were made of solid-wall littered with clean wood shavings which were changed weekly. During harmattan, a 200-watt electric bulb was suspended in each pen to keep the kids warm.

The animals were dipped fortnightly in a solution of 15g 'asuntol 50' to 15 litres of water (W/V) to protect them against ectoparasite. They were dewormed monthly with a solution of 6g of panacur to 100ml of water (W/V). One millilitre of this solution was administered orally per kg body weight. The health of the kids was carefully monitored. When they were sick, they were treated by a member of staff of the University of Ibadan Veterinary Science. Apart from medication given by these health personnel, no other drug was administered to the kids throughout the experimental period besides oxytetracycline-HCl, the experimental treatment.

3.2.2: PLAN OF THE EXPERIMENT AND DIET

The two rearing methods employed in this experiment were rearing the kids on their natural dams' milk (Factor A) and artificial rearing on cow milk (Factor B). The kids on goat milk suckled their dams directly three times a day, during the hours of 08.00, 13.00 and 18.00. The milk intake was estimated by modified method of Awah (1981):

1. All feeds, water and salt licks were withdrawn from the dams.
2. The weight of the kids were taken.
3. To account for faeces and urine voided during suckling, an already weighed jute bag was placed in the position of the suckling kids after the position of the dams had been adjusted to reduce movement to the bearest minimum.
4. The kids were allowed to suckle for a maximum of 15 minutes at every suckling period.
5. They were removed, weighed and restricted back in their pens.
6. The jute bags were examined for urine and faeces and weighed.

The record of milk intake at every feeding was computed by difference between the weight prior to suckling and after suckling. The faeces and urine voided during suckling were taken into consideration.

The milk fed to the kids reared artificially was fresh cow milk collected daily from the dairy unit of the University of Ibadan Teaching and Research Farm. The milk was warmed to a temperature of about 37.5°C at the time of feeding. The kids in this group were all bottle-fed three times daily at the hours of 08.00, 13.00 and 18.00. They were then allowed to drink to the point of satiety except when there was an incidence of scouring. The milk intake was on such occasion restricted. After the morning feeding, the milk reserved for other subsequent feedings was refrigerated and warmed to the specified temperature at feeding time.

The treatments consisted of the control and three levels of oxytetracycline-HCl. To the oxytetracycline supplemented groups, oxytetracycline-HCl was furnished by terramycin soluble powder. According to the manufacturer's information, each kilogram of terramycin contains 55g of oxytetracyclne-HCl. The control groups were offered each of the basal diet while the supplemented treatment groups received terramycin soluble powder dissolved in known quantity of deionized water and offered to supply 13.2, 19.8, and 26.4mg of oxytetracycline-HCl per head daily. Individual treatment's daily dosage was offered in two equal parts by withdrawing a volume equivalent to each treatment level with clean syringe and drenching the kids prior to morning and afternoon feeding. The experimental design is shown in Table 3.1.

All kids had free access to clean fresh distilled water. No salt lick was provided. At eighth week, fresh gliricidia was offered _ad-libitum_ to the kids to stimulate rumen development. Since the kids were group-fed with _Gliricidia Sepium_, the intake of this browse was not quantified. This browse plant was the choice of this experiment because it is available all the year round and it is less affected by drought, unlike other browse plants. It was the plan of this experiment not to introduce concentrate ration to the experimental animals so as to minimize the variability which might be introduced by such supplementary feeding.

3.2.3: LIVEWEIGHT RECORD AND MILK SAMPLING

The body weights of the kids were taken at birth and on the seventh day after birth. The weights taken on the seventh day prior to the introduction to the treatments were regarded as the initial weight of the animals. Thereafter, the kids were weighed at weekly intervals before morning feeding to compute the weekly liveweight gain.

TABLE 3.1: EXPERIMENTAL DESIGN AND DIET

TREATMENT LEVELS	REARING METHODS (FACTORS) A	B
1	A1	B1
2	A2	B2
3	A3	B3
4	A4	B4

A = Goat Milk B = Cow Milk

A1 = Goat milk + 0mg Oxytetracycline

A2 = Goat milk + 13.2mg Oxytetracycline

A3 = Goat milk + 19.8mg Oxytetracycline

A4 = Goat milk + 26.4mg Oxytetracycline

B1 = Cow milk + 0mg Oxytetracycline

B2 = Cow milk + 13.2mg Oxytetracycline

B3 = Cow milk + 19.8mg Oxytetracycline

B4 = Cow milk + 26.4mg Oxytetracycline

The milk from dams rearing their kids were collected by hand-milking each dam once weekly. Twenty millilitres of the total milk collected from each doe was properly mixed, and stored in a plastic container. Samples of cow milk were obtained by taking 10ml from freshly collected milk daily and bulked on weekly basis. The bulked milk samples were stored in plastic containers in the deep freezer at temperature below 0°C until required for chemical analysis.

3.2.4: ANALYTICAL PROCEDURE

The milk samples were warmed to a temperature of 40°C to disperse the milk fat and cooled to a temperature of 20°C before chemical analyses were carried out on the samples. The milk samples were analyzed for total solids by drying 10ml sample to constant weight at 105°C for 24 hours. Fat was estimated by Gerber Method (British Standard Institution, 1955), crude protein and total Ash by AOAC (1970) Method and lactose by Bernet and Tawab (1957) method.

Two grams of milled Gliricidia Sepium was dried to constant weight for residual moisture determination. The milled samples were analyzed for the proximate composition (AOAC, 1970).

3.2.5: STATISTICAL ANALYSIS

The data on the overall performance highlighting the average daily milk intake, average daily weight gain, and milk required per kilogram liveweight (kgLw) gain were partitioned into three 4-week intervals comprising of weeks 2 to 5, 6 to 9, and 10 to 13 of the experiment. The partitioning of these data was done to highlight the performance of these kids at different phases of the physiological development.

Two kids among the control reared with their dams (treatment A1) died before the expiration of the experiment. One died at the age of two weeks from enterotoxemia and the second from an unknown cause at the age of four weeks. Missing values were obtained for the dead animals using Genstat Computer program. All data were analyzed statistically, assuming factorial design.

3.3: RESULTS

3.3.1: MILK COMPOSITION AND INTAKE

The chemical composition of goat and cow milk are presented in Table 3.2. Table 3.3 depicts the proximate chemical composition of Gliricidia Sepium.

TABLE 3.2: MEAN* CHEMICAL COMPOSITION OF MILK FED TO THE KIDS

Constituents	Goat Milk**	Cow Milk
Total solid %	16.56±1.10	14.12±1.02
Milk fat %	5.03±0.58	4.69±0.14
Crude protein (Nx6.38)	4.191±0.53	3.64±0.37
Lactose %	6.24±0.21	5.18±0.64
Ash %	0.79±0.12	0.76±0.05

*Each value represents average of 12 determinations.

**Each value represents average of 24 determinations.

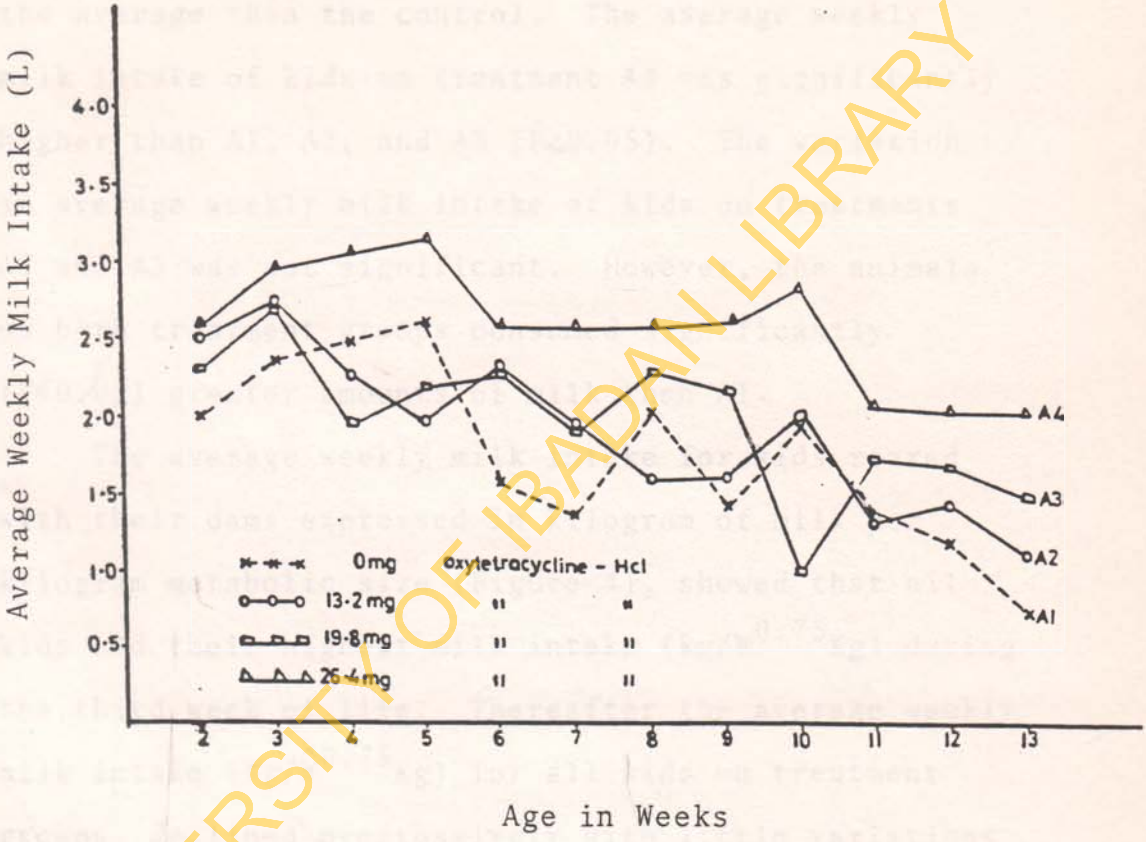
TABLE 3.3: PROXIMATE CHEMICAL COMPOSITION OF GLIRICIDIA SEPIUM LEAVES (g/100g DM)

Constituents	Value
Fresh Dry Matter	34.50
Crude protein	20.69
Crude fibre	23.08
Ether extract	4.95
Ash	7.69

The average weekly milk intake of kids reared with or without their dams (Factors A and B), expressed in litres per week and kg of milk intake per kg metabolic size (kg/$W^{0.75}$Kg) are shown in Figures 3 to 6. Details are presented in Appendix Tables 1 and 2. The average weekly milk intake of kids on treatment groups reared on factor A varied between 0.71 and 3.15 litres.

It is evident from the graph that the average weekly milk intake of kids on treatments A1 and A4 increased progressively between week 2 and 5 with the highest average weekly milk intake being recorded at week 5 after parturition. The corresponding optimum mean weekly milk intake period for kids on treatments A2 and A3 occurred during the third week. After these periods, there were fluctuations in the average weekly milk intake, but the pattern generally tended to decline with increasing age of the kids and advancing lactation. The average weekly milk intake for kids on control and those supplemented with 13.2, 19.8 and 26.4mg of oxytetracycline-HCl daily reared on factor A were (litres) 1.74, 1.90, 1.94, and 2.58, respectively (S.E. of mean = 0.02). The overall mean weekly milk intake (l) for these treatment groups was 2.17 ± 0.04 for the entire experimental period. Observation

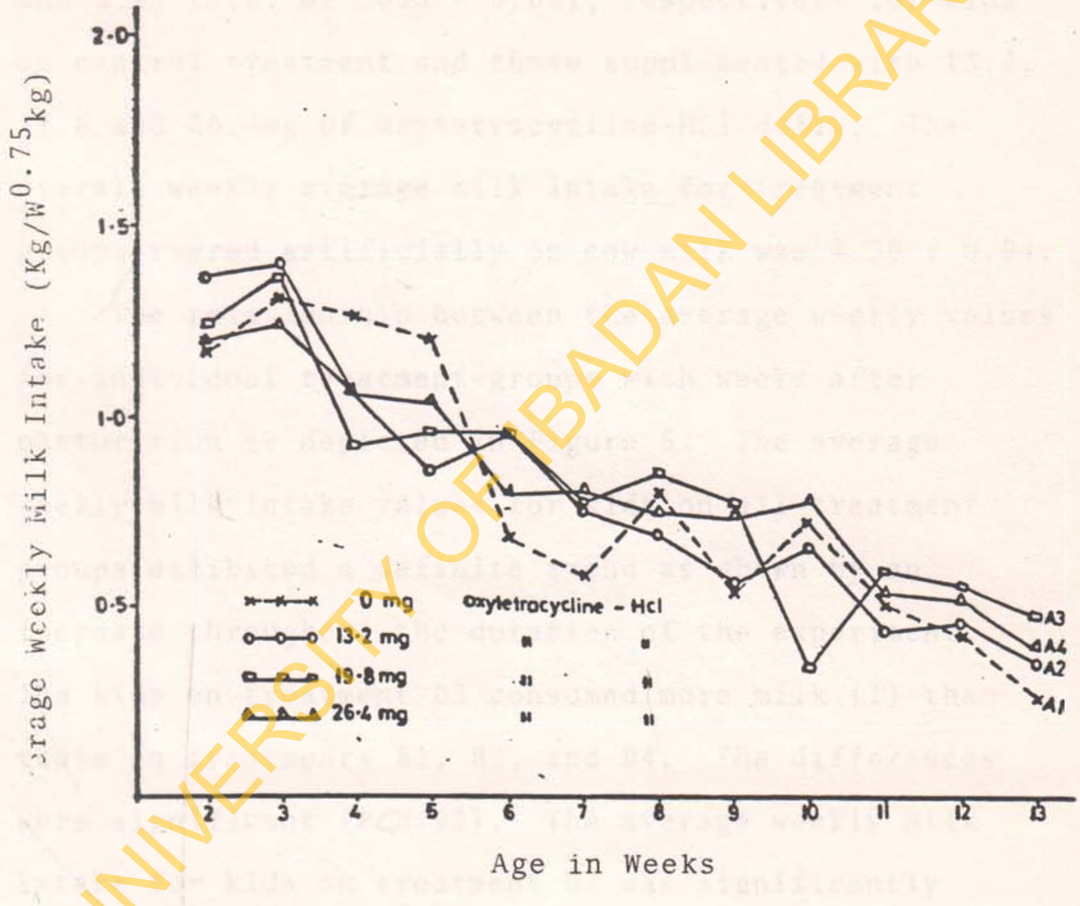
FIGURE 3. AVERAGE WEEKLY MILK INTAKE (L) OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl REARED WITH THEIR DAMS



revealed that all the oxytetracycline supplemented treatment groups consumed greater volume of milk compared to the control. Kids on treatments A2, A3 and A4 consumed between 9 to 48 percent more milk on the average than the control. The average weekly milk intake of kids on treatment A4 was significantly higher than A1, A2, and A3 ($P<0.05$). The variation in average weekly milk intake of kids on treatments A2 and A3 was not significant. However, the animals on both treatment groups consumed significantly ($P<0.05$) greater amounts of milk than A1.

The average weekly milk intake for kids reared with their dams expressed in kilogram of milk per kilogram metabolic size (Figure 4), showed that all kids had their highest milk intake (kg/$W^{0.75}$Kg) during the third week of life. Thereafter the average weekly milk intake (Kg/$W^{0.75}$Kg) for all kids on treatment groups, declined progressively with little variations until the end of the experiment. The average weekly milk consumed (Kg/$W^{0.75}$Kg) were 0.78, 0.79, 0.82, and 0.84 (S.E. of mean = 0.07) respectively, for kids on control group and those supplemented with 13.2, 19.8, and 26.4mg of oxytetracycline-HCl daily. The variations observed between the mean values were not appreciable ($P>0.05$).

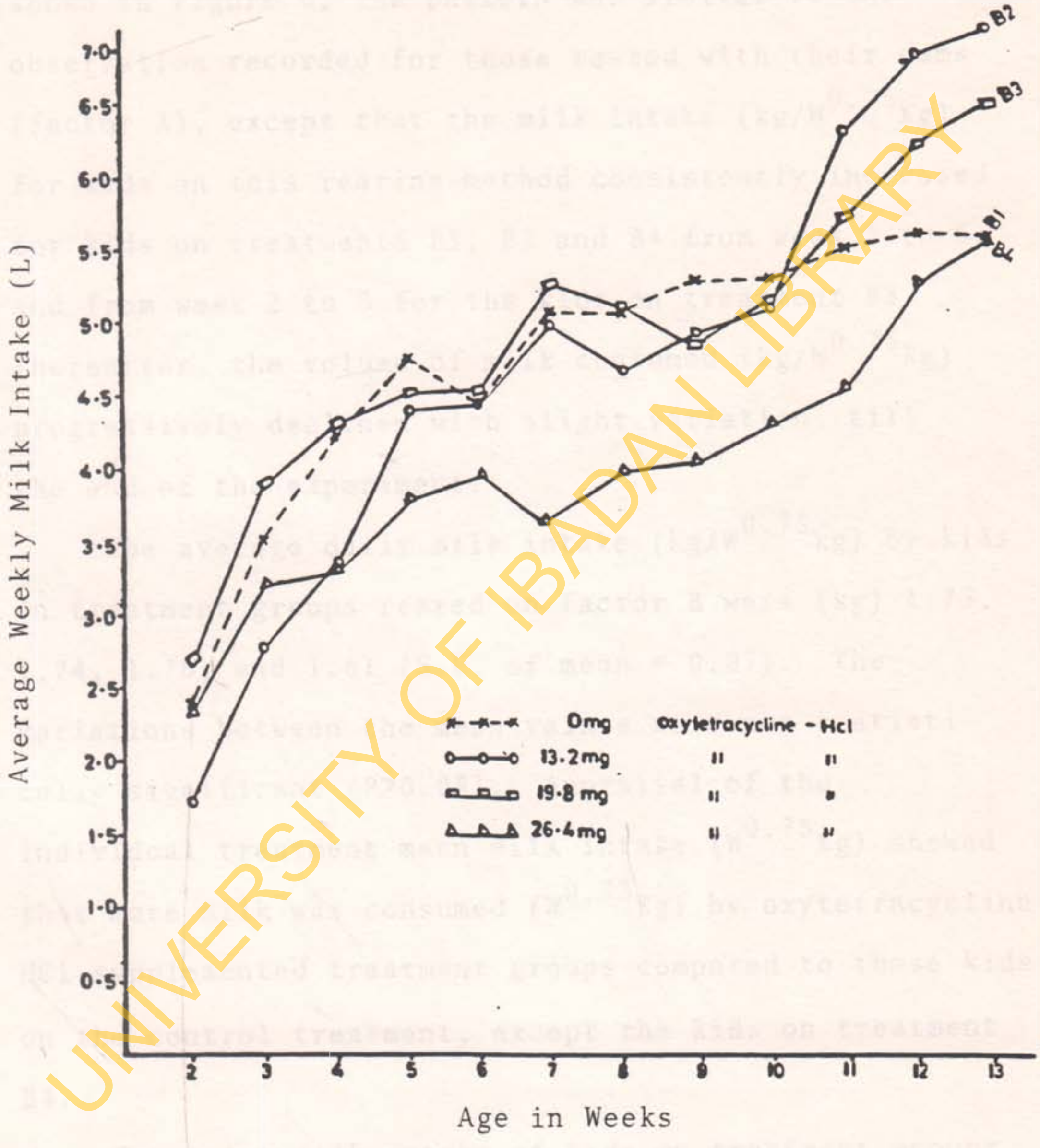
FIGURE 4. AVERAGE WEEKLY MILK INTAKE ($Kg/W^{0.75}kg$) OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl WHEN REARED WITH THEIR DAMS



The average weekly milk intake for kids on treatment groups reared on cow milk (Factor B) ranged from 1.73 to 6.98. The mean weekly milk intakes obtained for kids on different treatment groups for the entire experimental period were (litres) 4.71, 4.73, 4.85, and 3.92 (S.E. of mean = 0.02), respectively for kids on control treatment and those supplemented with 13.2, 19.8 and 26.4mg of oxytetracycline-HCl daily. The overall weekly average milk intake for treatment groups reared artificially on cow milk was 4.50 ± 0.04.

The relationship between the average weekly values for individual treatment groups with weeks after parturition is depicted in Figure 5. The average weekly milk intake values for kids on all treatment groups exhibited a definite trend as shown by an increase throughout the duration of the experiment. The kids on treatment B3 consumed more milk (1) than those on treatments B1, B2, and B4. The differences were significant ($P < 0.05$). The average weekly milk intake for kids on treatment B2 was significantly ($p < 0.05$) higher than the values obtained for kids on treatments B1 and B4, while the intake of B1 was significantly ($P < 0.05$) higher than B4.

FIGURE 5. AVERAGE WEEKLY MILK INTAKE OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl WHEN REARED WITHOUT THEIR DAMS

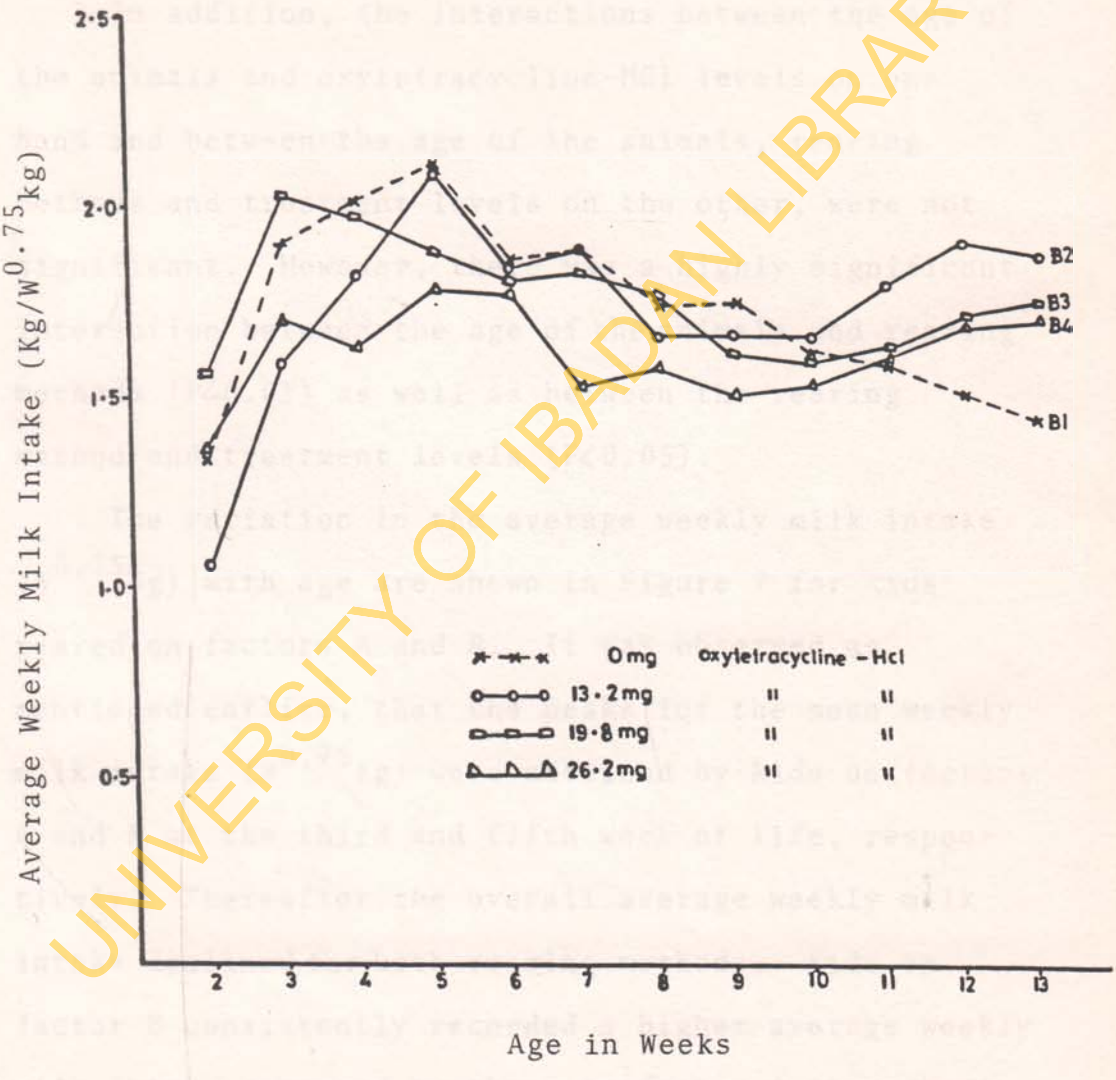


When the average weekly milk intakes for each of the treatment groups were expressed (kg/$W^{0.75}$Kg) as shown in Figure 6, the pattern was similar to the observation recorded for those reared with their dams (factor A), except that the milk intake (kg/$W^{0.75}$Kg) for kids on this rearing method consistently increased for kids on treatments B1, B2 and B4 from week 2 to 5, and from week 2 to 3 for the kids on treatment B3. Thereafter, the volume of milk consumed (kg/$W^{0.75}$Kg) progressively declined with slight variation, till the end of the experiment.

The average daily milk intake (kg/$W^{0.75}$kg) by kids on treatment groups reared on factor B were (kg) 1.73, 1.74, 1.76, and 1.61 (S.E. of mean = 0.07). The variations between the mean values were not statistically significant ($P>0.05$). Appraisal of the individual treatment mean milk intake ($W^{0.75}$Kg) showed that more milk was consumed ($W^{0.75}$Kg) by oxytetracycline-HCl supplemented treatment groups compared to those kids on the control treatment, except the kids on treatment B4.

Comparing milk intake of kids on treatment groups on both rearing methods, it was evident that the kids on treatment groups reared on factor B consumed more

FIGURE 6. AVERAGE WEEKLY MILK INTAKE ($Kg/W^{0.75}kg$) OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl REARED WITHOUT THEIR DAMS

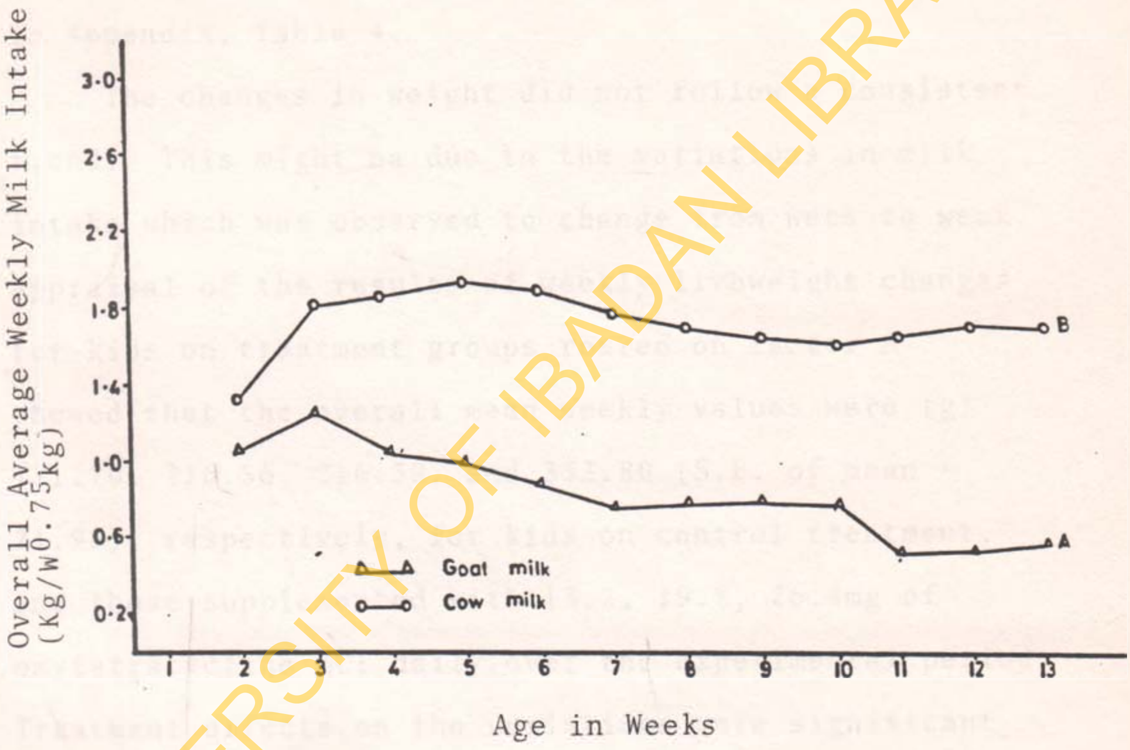


milk than those on factor A. The difference was highly significant ($P<0.01$) (Appendix, Table 3). The effect of age and rearing methods were appreciable ($P<0.01$) on milk intake. The effect of levels of oxytetracycline-HCl on the intake was not significant.

In addition, the interactions between the age of the animals and oxytetracycline-HCl levels on one hand and between the age of the animals, rearing methods and treatment levels on the other, were not significant. However, there was a highly significant interaction between the age of the animals and rearing methods ($P<0.01$) as well as between the rearing method and treatment levels ($P<0.05$).

The variation in the average weekly milk intake ($W^{0.75}$Kg) with age are shown in Figure 7 for kids reared on factors A and B. It was observed as mentioned earlier, that the peaks for the mean weekly milk intake ($W^{0.75}$Kg) were attained by kids on factors A and B at the third and fifth week of life, respectively. Thereafter the overall average weekly milk intake declined for both rearing methods. Kids on factor B consistently recorded a higher average weekly milk intake compared to those on factor A throughout the duration of the experiment.

FIGURE 7. AVERAGE WEEKLY MILK INTAKE ($Kg/W^{0.75}kg$) OF KIDS REARED WITH OR WITHOUT THEIR DAMS



3.3.2 WEIGHT GAIN

Summary of mean weekly change in liveweight of kids on treatment groups reared with their dams and those reared on cow milk (Factors A and B) and supplemented with varying levels of oxytetracycline-HCl are illustrated in Figures 8 and 9. Details are in Appendix, Table 4.

The changes in weight did not follow a consistent trend. This might be due to the variations in milk intake which was observed to change from week to week. Appraisal of the results of weekly liveweight changes for kids on treatment groups reared on factor A showed that the overall mean weekly values were (g) 171.70, 216.56, 216.39, and 333.80 (S.E. of mean = 21.95), respectively, for kids on control treatment, and those supplemented with 13.2, 19.8, 26.4mg of oxytetracycline-HCl daily over the experimental period. Treatment effects on the variations were significant ($P<0.05$). The apparent differences observed among the values (g) 171.70, 216.56, and 216.39 were not significant. The liveweight gain value 333.80g/week for kids on treatment A4 was the highest growth rate and was significantly greater than any of the values for kids on treatments A1, A2, and A3 ($P<0.05$). The

FIGURE 8. AVERAGE WEEKLY CHANGE IN LIVEWEIGHT OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl WHEN REARED WITH THEIR DAMS

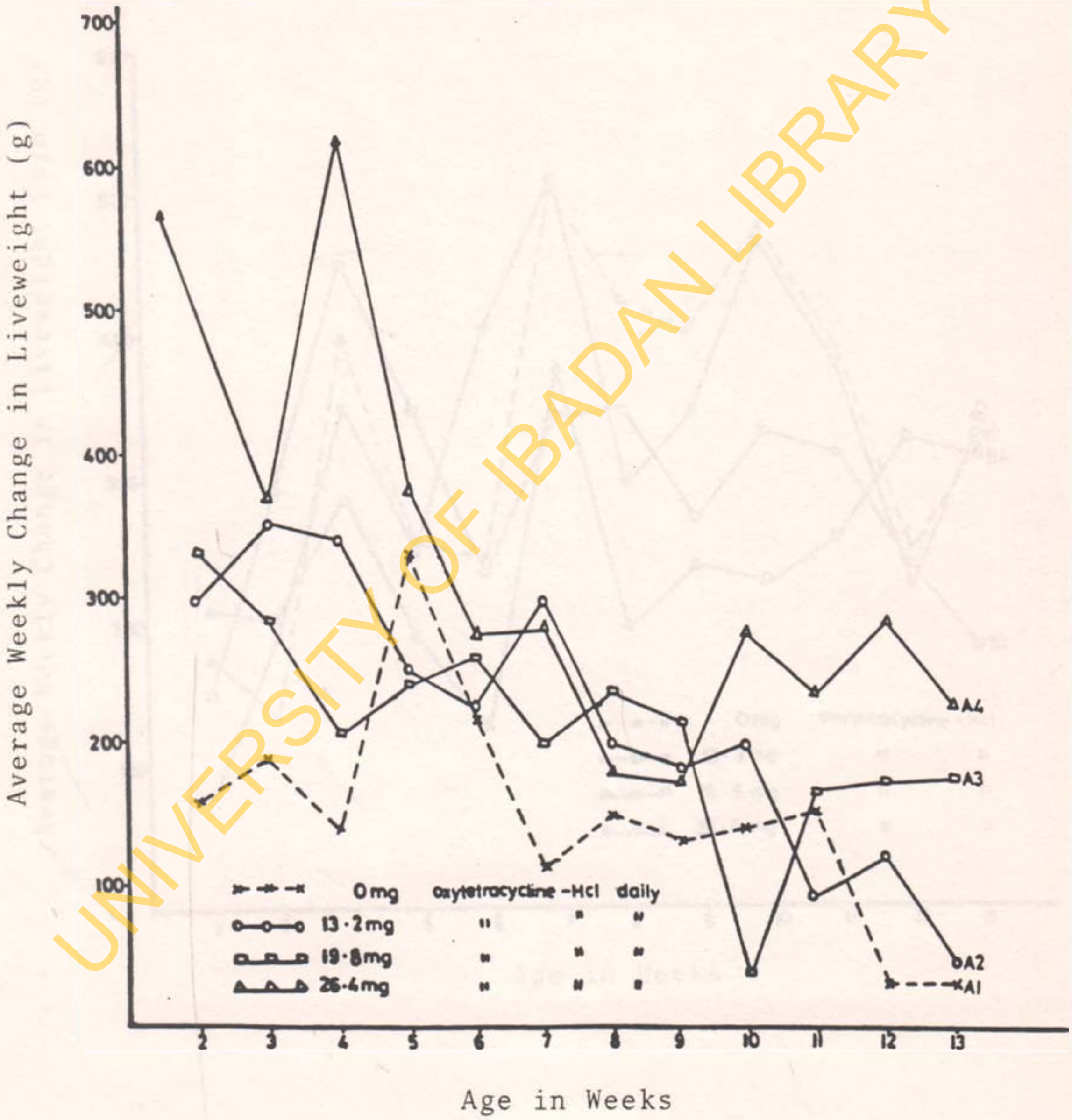
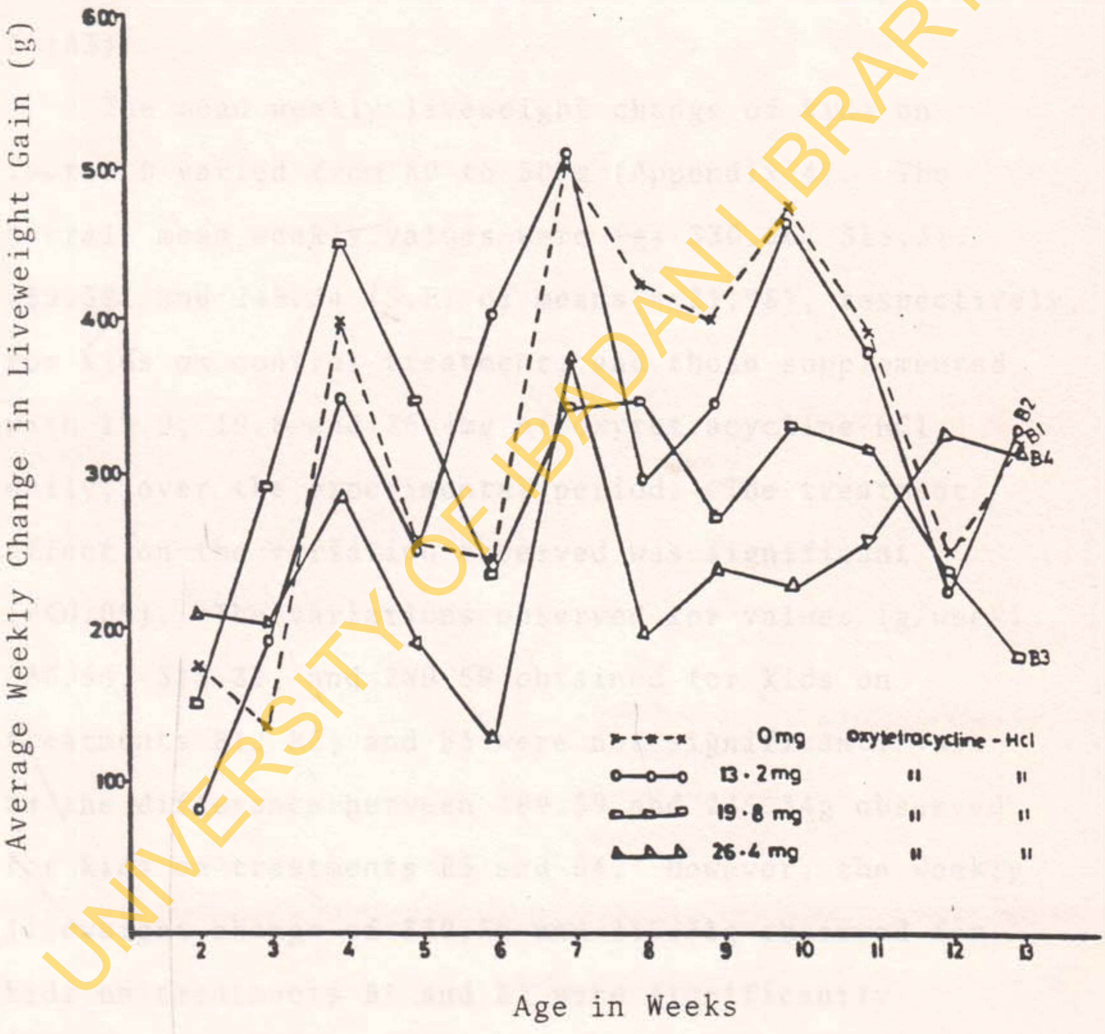


FIGURE 9. AVERAGE WEEKLY CHANGE IN LIVEWEIGHT OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl WHEN REARED WITHOUT THEIR DAMS



oxytetracycline-HCl supplemented groups gained between 26 and 92 percent more than the control groups. The highest weekly weight change occurred early in the experiment between the fourth and fifth week of life with the exception of animals receiving treatment 3 (A3).

The mean weekly liveweight change of kids on factor B varied from 80 to 507g (Appendix 4). The overall mean weekly values were (g) 330.56, 315.31, 289.59, and 245.34 (S.E. of means = 21.95), respectively, for kids on control treatment, and those supplemented with 13.9, 19.8 and 26.4mg of oxytetracycline-HCl daily, over the experimental period. The treatment effect on the variation observed was significant ($P < 0.05$). The variations observed for values (g/week) 330.56, 315.31, and 289.59 obtained for kids on treatments B1, B2, and B3 were not significant, just as the difference between 289.59 and 245.34g observed for kids on treatments B3 and B4. However, the weekly liveweight change of 330.56 and 315.31g observed for kids on treatments B1 and B2 were significantly greater than the value of 245.34g obtained for kids on treatment B4 ($P < 0.05$).

The kids on control group gained between 5 and 26 percent more than the oxytetracycline-HCL supplemented groups. Although the weekly change in liveweight did not follow a consistent pattern, three major growth peaks were prominent, depicting the period of the most accelerated weight change. These occurred between weeks 4 and 10 after parturition, with all treatment groups having their mean highest weekly liveweight change between week 4 and 7.

When the average weekly liveweight change of kids on the two treatment groups were tested, Analysis of Variance (Appendix, Table 5) showed that the levels of oxytetracycline-HCl and age did not have an appreciable effect on the variation observed ($P > 0.05$). The main effect of rearing methods was however highly significant ($P < 0.01$). The kids reared on cow milk had greater overall mean weekly liveweight gain (241.90 vs. 291.20g/week).

The interaction between age of the animals and rearing methods on one hand and rearing methods and treatment levels on the other, was highly significant ($P < 0.01$). The interaction between the rearing methods and treatment levels indicated that animals reared on the two different rearing methods responded differently to oxytetracycline-HCl level through their weekly liveweight gain.

As observed earlier, kids on treatment groups reared with their dams showed continuous increase in overall average weekly liveweight change with every successive increase in the level of oxytetracycline-HCl; reverse was however the case for those kids on treatment groups reared on cow milk. The interactions between age and treatment levels were not significant.

The average weekly cummulative liveweight gain of kids on treatment groups reared with and without their dams are shown in Figures 10 and 11, respectively.

3.3.3: FEED EFFICIENCY AS LITRES OF MILK REQUIRED PER KILOGRAM LIVEWEIGHT GAIN

The summaries of the performacne of kids supplemented with varying levels of oxytetracycline-HCl reared with or without their dams, which highlight the average daily liveweight gain, average daily milk intake, average milk required/kg liveweight gain, as well as the overall average of each of these parameters presented in three 4-week intervals are shown in Table 3.4.

The result obtained for the overall mean daily milk intake, daily liveweight gain and the overall averages of these parameters computed for individual

FIGURE 10. AVERAGE WEEKLY CUMMULATIVE LIVEWEIGHT CHANGE OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HC1 WHEN REARED WITH THEIR DAMS

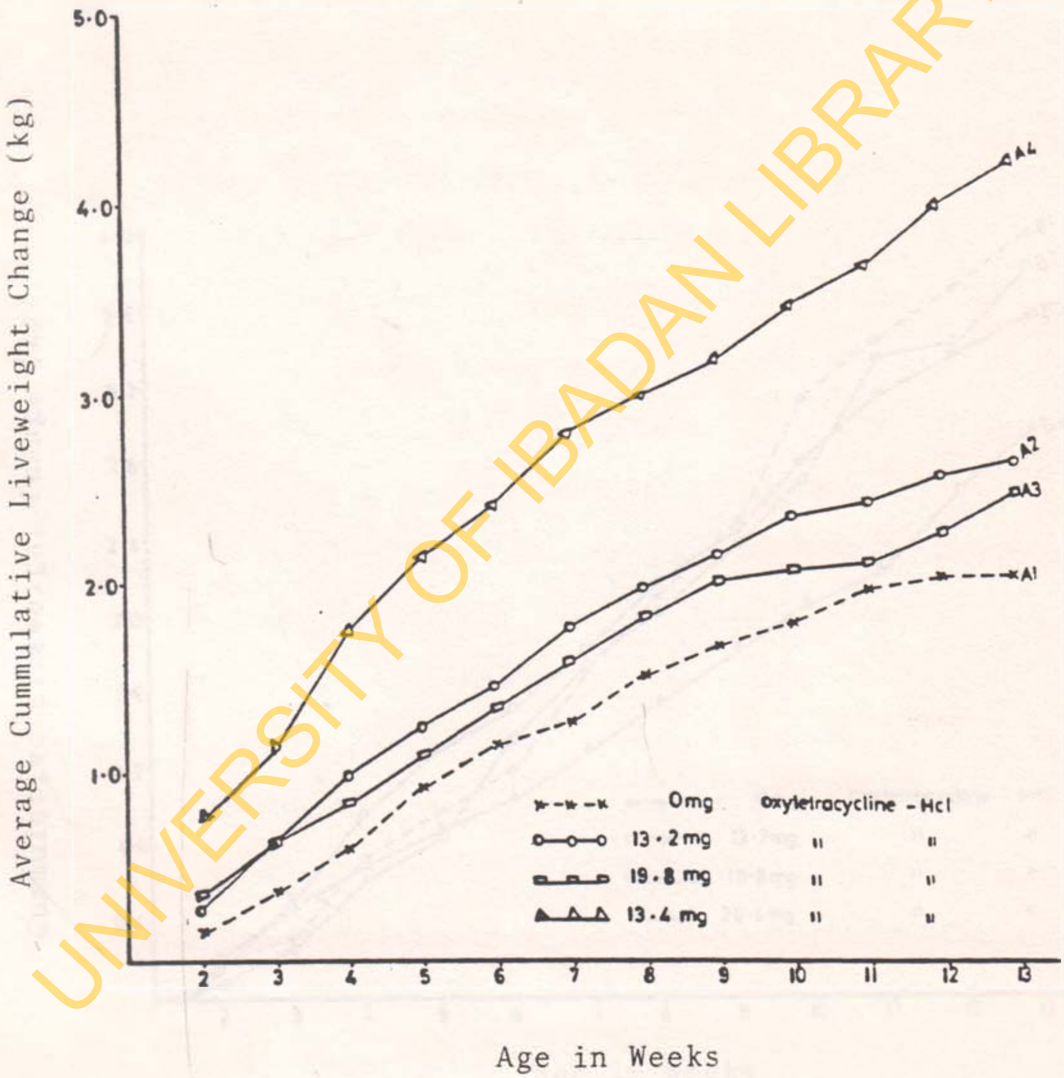
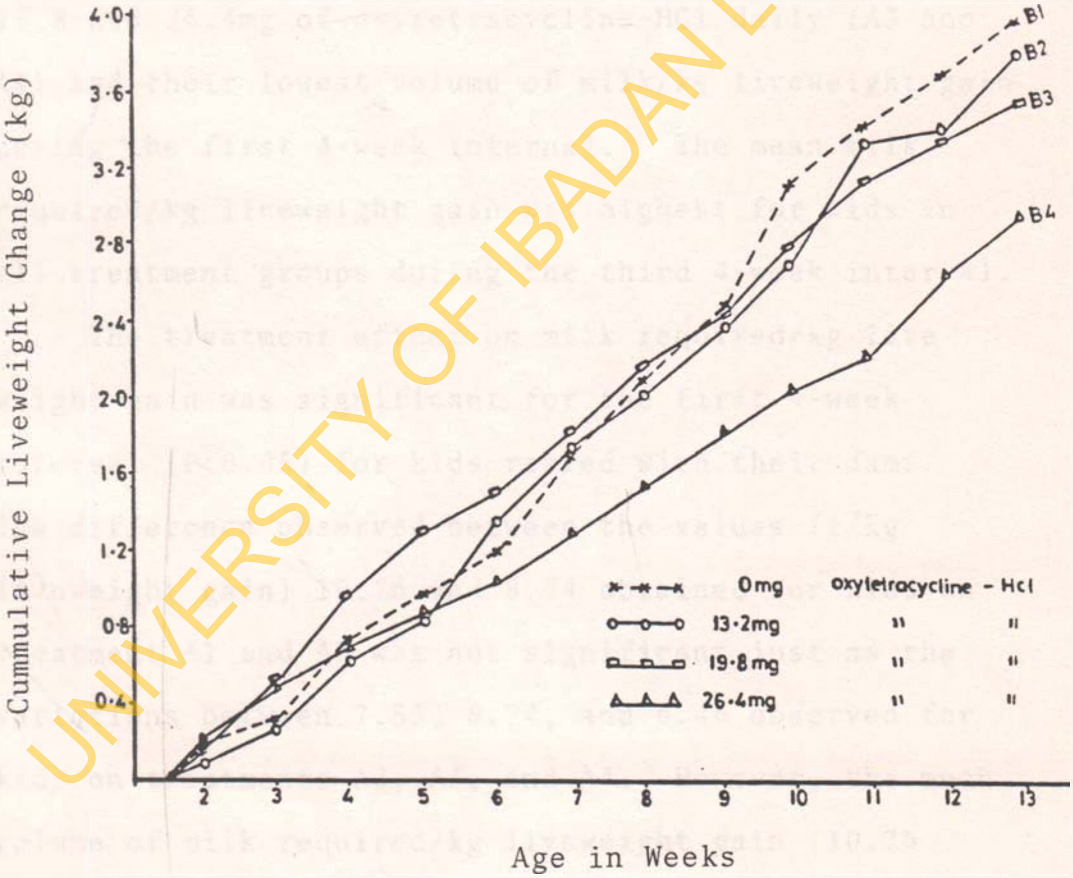


FIGURE 11. AVERAGE WEEKLY CUMMULATIVE LIVEWEIGHT CHANGE OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl WHEN REARED WITHOUT THEIR DAMS



treatment groups, followed similar pattern as those presented earlier (pages 66 to 85).

Table 3.4 shows that kids reared with their dams without any oxytetracycline-HCl supplement (A1) and those on treatment group receiving the lowest level (A2) of antibiotic (13.2mg/day) recorded their lowest volume of milk/kg liveweight gain during the second 4-week internval. While those kids supplemented with 19.8 and 26.4mg of oxytetracycline-HCl daily (A3 and A4) had their lowest volume of milk/kg liveweight gain during the first 4-week internal. The mean milk required/kg liveweight gain was highest for kids in all treatment groups during the third 4-week interval.

The treatment effect on milk required/kg liveweight gain was significant for the first 4-week interval ($P<0.05$) for kids reared with their dams. The difference observed between the values (l/kg liveweight gain) 10.76 and 8.74 obtained for kids on treatment A1 and A3 was not significant just as the variations between 7.53, 8.74, and 6.46 observed for kids on treatments A2, A3, and A4. However, the mean volume of milk required/kg liveweight gain (10.76 l/kg liveweight gain) for kids on treatment A1 was significantly higher than the mean values for those kids on treatments A2 and A4 (P 0.05).

TABLE 3.4: SUMMARY OF THE EFFECTS OF VARIOUS LEVELS OF OXYTETRACYCLINE-HCl ON THE PERFORMANCE OF KIDS REARED WITH OR WITHOUT THEIR DAMS

REARING METHODS	GOAT MILK (FACTOR A)				COW MILK (FACTOR B)				
TREATMENT LEVELS	A1	A2	A3	A4	B1	B2	B3	B4	S.E. of Mean
Number of Animals	6	6	6	6	6	6	6	6	
Average Liveweight (kg)									
Initial	1.87	1.80	1.88	2.02	1.88	1.76	1.78	1.73	0.20
At Week 4	2.79	3.06	2.97	3.78	2.84	2.61	3.10	2.61	0.28
At Week 8	3.49	3.96	3.87	5.01	4.42	4.13	4.23	3.53	0.39
At Week 12	3.88	4.47	4.46	5.90	5.89	5.57	5.33	4.67	0.44
Average Daily Liveweight gain (g)									
Week 2 - 5	32.78	43.78	38.89	63.10	33.70	33.20	36.90	31.20	5.30
Week 6 - 9	25.14	32.14	32.33	43.70	56.20	54.60	40.70	36.70	6.49
Week 10 - 13	13.80	17.21	21.48	32.50	51.20	51.30	38.90	40.50	4.32
Total Experimental Period	23.91	31.54	30.97	46.40	47.10	45.40	42.20	35.10	4.10
Average Daily Milk (1) Intake									
Week 2 - 5	0.33	0.33	0.34	0.41	0.53	0.44	0.55	0.45	0.05
Week 6 - 9	0.19	0.22	0.31	0.39	0.71	0.68	0.71	0.56	0.07
Week 10 - 13	0.18	0.20	0.20	0.31	0.79	0.90	0.83	0.71	0.07
Total Experimental Period	0.23	0.25	0.28	0.38	0.67	0.68	0.70	0.57	0.05
FEED EFFICIENCY									
Average Milk Required Per kg liveweight gain (1)									
Week 2 - 5	10.76	7.53	8.74	6.46	15.70	14.56	14.03	14.36	0.98
Week 6 - 9	7.56	6.85	9.59	8.92	12.76	13.01	17.19	15.25	1.27
Week 10 - 13	13.04	11.76	9.76	9.50	15.89	18.09	19.34	17.43	1.55
Total Experimental Period	10.45	8.66	9.36	8.30	14.61	15.48	16.74	15.68	0.85

A1 = Goat Milk + 0mg Oxytetracycline B1 = Cow Milk + 0mg Oxytetracycline
A2 = Goat Milk + 13.2mg Oxytetracycline B2 = Cow Milk + 13.2mg Oxytetracyline
A3 = Goat Milk + 19.8mg Oxytetracycline B3 = Cow Milk + 19.8mg Oxytetracycline
A4 = Goat Milk + 26.4mg Oxytetracycline B4 = Cow Milk + 26.4mg Oxytetracycline

The treatment effect on milk required/kg liveweight gain for the other two subsequent 4-week intervals (second and third 4-week intervals), as well as the entire experimental period was not significant ($P>0.05$). The overall mean values of 8.23 ± 1.24 and 11.00 ± 1.68 were obtained for the second and third 4-week intervals, respectively. The overall mean value of milk required/kg liveweight gain for animals reared with their dams for the total experimental period was 9.18 ± 0.95.

Appraisal of the results of feed efficiency of kids on treatment groups reared with their dams (Factor A) revealed that all kids on treatment groups supplemented with varying levels of oxytetracycline-HCl utilized their milk intake more efficiently than those kids on control treatment; though the overall effect of treatment on this parameter was not statistically significant ($P>0.05$).

Except during the first 4-week interval when the kids on the control treatment group reared artificially on cow milk (B1) consumed more milk/kg liveweight gain compared to the other treatment groups, for most of the intervals, the kids on control group exhibited greater feed efficiency.

The treatment effect on milk required/kg liveweight gain was not significant for the first 4-week interval. The overall mean value of 14.73 ± 0.52 was obtained for the period. The treatment effect on milk required/kg liveweight gain was however significant during the second 4-week interval ($P<0.05$). The mean treatment values (l/kg liveweight gain) of 12.76, 13.01, 17.19, and 15.25 (S.E. of mean = 1.27) were obtained for kids on control treatment group and those supplemented with 13.2, 19.6, and 26.4mg of oxytetracycline-HCl daily (B1, B2, B3 and B4). The variations observed among kids on treatments B1, B2, and B4 were not significant, just as the difference between the mean values obtained for animals on treatments B3 and B4. However, the mean value of 17.19 l/kg liveweight gain obtained for kids on treatment B3 was the highest for the interval and was significantly higher than the values obtained for kids on treatments B1 and B2 ($P<0.05$).

The effect of treatments on milk required/kg liveweight gain for the third 4-week interval was not significant ($p>0.05$). The overall mean value of 17.65 ± 1.44 l/kg liveweight gain was obtained for all kids in all treatment groups during this experimental interval.

The overall effect of treatment on milk required/ kg liveweight gain for the total experimental period was not significant ($P>0.05$). The overall mean value for all animals in all treatment groups reared on cow milk (Factor B) for the entire experimental period was 15.59 ± 0.87.

Appraisal of the overall individual treatment group mean values for kids reared artifically on cow milk showed that all animals on antibiotic supplement required slightly higher volume of milk/kg liveweight gain; although the variations were not appreciable ($P>0.05$).

Comparison of data obtained on the overall milk required/kg liveweight gain for animals on treatment groups on both rearing methods, it was obvious that animals reared with their dams utilized their milk intake more efficiently than those kids on treatment groups reared on cow milk. Analysis of variance showed that the effect of rearing methods on the overall feed efficiency was highly significant ($P<0.01$). The interaction between rearing methods and treatment levels was appreciable ($P<0.05$).

3.4: DISCUSSION

The milk intake of kids supplemented with various levels of oxytetracycline-HCl and reared artifically on cow milk (Factor B) were greater than the corresponding values for those receiving similar treatments but reared on their dams' milk (Factor A). This was essentially due to the fact that the milk intake of kids reared with their dams was limited by milk production of their dams as compared to the artificially reared kids, which had unrestricted milk intake.

If the weekly milk intake of kids reared on Factor A in this experiment (Figure 1) could be extrapulated to represent the milk production curve of their dams, it is glaring that the optimum milk production levels of the dams were reached between the first 3 to 5 weeks of lactation.

These peaks are comparable to that reported by Loucas, et al. (1975) for the lactation curve of Damascus goats which peaked during the first 5 to 6 weeks of lactation and then decline. The result also agrees with similar observation for WAD goats (Akinsoyinu, et al., 1977) where the highest milk yield for lactation was at the fifth week after paturition.

The higher milk intake by kids reared on cow milk (Factor B) was in harmony with the findings of Newport (1977) who reported that artificially reared pigs required a larger proportion of dried skim milk or other milk products in their diet.

Except for kids on treatment B4, all kids on treatment groups receiving oxytetracycline-HCL on both rearing methods, consumed more milk than their control counterparts. This result confirmed the findings of Brisson and Bouchard (1970), who observed higher milk substitute intake by oxytetracycline-HCl-Vitamin-Iron supplemented group, compared with the control when milk substitute was fed ad-libitum from birth till eight weeks of age. Even when the milk intake was restricted, antibiotics had been reported to stimulate concentrate consumption in calves (Bartley, et al., 1953; Loosli, et al., 1951).

The fall in the milk intake of kids on treatment group receiving the highest level of oxytetracycline-HCl and offered unrestricted milk (B4) could be explained by findings (Reid, et al., 1954) which showed that antibiotics exhibited appetite depressing effect when fed at high levels particularly above 14mg per day; although feed consumption was improved when the same antibiotics were fed at low levels. In this experiment, kids on treatment group receiving as high as 19.8mg of oxytetracycline-HCl daily and offered unrestricted amounts of milk, exhibited higher milk intake compared to the kids on lower level of antibiotic supplement. But when the antibiotics were fed at a level of 26.4mg/day, the milk consumed decreased considerably.

The continuous improvement in the milk intake of kids reared on their dams' milk and receiving various levels of oxytetracycline-HCl compared to their control, deserves more explanation. The reason for this observation could not be provided by the scope of this study and may not be apparent until the myth surrounding the mode of action of antibiotics could be completely unraveled. A possible explanation as of now could be that of increased appetite. According to Murley, _et al._ (1952) when improved appetite is observed in antibiotic-fed animals, it may be associated with improved health and vigour. If this assumption is applied in the present study, improved vigour could result in better suckling ability and associated with ability to evacuate the available milk in the udder which could have been responsible for increased milk intake.

The milk production of the lactating dams was adequate for their kids for about the first quarter of the experiment, as shown by the accelerated growth rate of these kids compared to their counterparts reared on cow milk. This observation was short-lived as there was reversal at about the fifth week after parturition, when the drop in the milk intake of suckling kids was accompanied by a decrease in live-weight gain. The trend persisted until the end of the experiment.

The lower liveweight gain of kids in treatment groups reared artifically on cow milk at the early part of the experiment, could not be attributed to improper adjustment to suckling from the feeding bottle. This is because kids reared on this rearing method actually consumed considerably greater amounts of milk than those suckling their dams at this experimental period. A similar report (Murthy, 1974) indicated that dam's milk is considered the best food for their infants, provided that the yield was enough for nursing. This result supports the finding (Loucas, et al., 1975) who noted that any beneficial effects of suckling of the young did not extend much beyond 5 to 6 weeks after parturition.

The overall weight gain of kids reared artificially on cow milk exceeded their naturally reared counterparts at the expiration of the experiment. This present observation seems to agree with Newport (1977) who reported that the growth rate of baby pigs was limited by the supply of milk from the sows and growth rate, could be attained by artificial rearing. Brisson, et al. (1970) observed that lambs reared artifically on milk substitute from third day of life grew faster than their conventionally reared counterparts, though the milk intake of the conventionally reared lambs were not quantified in their experiment.

Although kids reared on cow milk and supplemented with varying levels of oxytetracycline-HCl did not consistently excel their control counterparts in terms of mean weekly liveweight gain for an appreciable number of weeks, observations revealed that at the beginning of the experiment up till sixth week of life, oxytetracycline-HCl supplemented groups showed appreciably higher weekly liveweight gains than the control. Thereafter, the kids in the control group exhibited accelerated weight gain, which was superior to the kids on oxytetracycline, almost till the end of the experiment. At the expiration of the experiment, the overall liveweight gain of the control exceeded that of antibiotic supplemented groups. In addition, the control required less milk per kilogram liveweight gain.

The higher growth rate of kids on oxytetracycline-HCl supplement before the seventh week of life compared to the control could be modified by such a report as that of MacFadded and Bartley (1959) which indicated that the growth promoting effect of antibiotics is more prominent early in the growth cycle and ceases before growth is completed. The result is also consistent with the findings of Hogue et al. (1954) who observed a significant increase in the daily gain of antibiotic-fed calves during the first seven weeks of life and no appreciable differences thereafter.

Other reports (lassiter, 1955; Kesler and Knodt, 1952; MacKay, et al., 1952) also observed maximum growth response to antibiotics feeding at eight weeks, thereafter, the weight gain of the antibiotic supplement group paralleled the control.

In general the bulk of data obtained in this study suggests that oxytetracycline-HCl at the levels of supplement did not enhance the performance of the kids fed unrestricted cow milk. Such was the report (Brisson and Bouchard, 1970) which concluded that antibiotics supplement of a liquid diet had no marked effect on either growth or feed consumption. Jordan (1952) noted that feeding aureomycin to fattening lambs at the rate of approximately 5.50 and 11.00mg/kg of feed, decreased gain as well as feed efficiency.

Colby, et al. (1950) had earlier reported that aureomycin fed at 100mg daily to fattening lambs caused a loss in appetite and lowered body weight gain. Published information (Bridges, et al., 1953) on the other hand reported small but insignificant increase in daily weight gain and feed efficiency of antibiotic supplement groups. Contrary to the finding in this report, using oxytetracycline-HCl Rusoff, et al. (1954) and Cason and Voelker (1951) obtained increase in weight gain of 17 to 28 percent for their antibiotic supplemented group over the control. In addition to an increase in growth rate of terramycin supplemented group, MacKay, et al. (1953) reported an appreciable increase in appetite.

The better performance of kids reared with their dams on antibiotic supplement compared to the control as observed in this study, was consistent with such reports; Hatfield, et al. (1954) and Jordan and Bell (1954) which showed a higher gain and feed efficiency for lambs suckling their dams and receiving antibiotics, compared to the control.

CHAPTER FOUR

THE EFFECTS OF VARIOUS LEVELS OF OXYTETRACYCLINE-HCl ON SERUM MINERAL LEVELS OF KIDS REARED WITH OR WITHOUT THEIR DAMS

4.1 INTRODUCTION

Mineral elements play an important role in the nutrition of both humans and animals. As constituents of the bone and teeth, they give rigidity and strength to the skeletal structures. They serve as components of organic compunds such as protein and lipids, which make up muscles, organs, blood cells and soft tissues of the body. They influence growth and reproduction performance and are important in the activation of many enzymes. Martens and Rayssiguiez (1979) reported that Magnesium, one of the major minerals for livestock, is an activator of nearly 300 enzymes, including most of those utilizing ATP or catalyzing the transfer of phosphate. The diverse functions of individual major and trace mineral elements in human and livestock, as well as specific signs of deficiency, have been extensively reviewed (Pike and Brown, 1975; Underwood, 1977). In ruminent animals, the nutritional significance of mineral elements may be a reflection of its functions in rumen bacteria and of its interactions with other elements present in the rumen (Mathur, et al., 1985).

Antibiotics used in livestock therapeutically to treat a specific infection, prophylatically against a specific organism or group of organisms, or routinely as a growth promotent are known to interact with some nutrients and exert some influence on blood metabolites in general and minerals in particular. These include favorable absorption of Ca, Mg, and P (Kuthe, 1975) and better digestibility of Ca and P in sheep (Rashidov and Mamaticulov, 1972). Kirchgessner, et al., (1961) reported increase in the retention of P, Mg, Cu, Zn, and Fe, while no appreciable effects were apparent in the retention of S, Al, K, Na, Ca, Mi, MO, and Cn when growing pigs were supplemented with 33mg of terramycin per day. Kratzer and Vohra (1986) reported that lonophones antibiotic such as Valinomycin ($C_{54}H_{90}N_6O_{18}$) increase the transport of cations selectively into mitochandria, while March (1978) reported that chlortetracycline, oxytetracycline and tetracycline have depressing effect on metabolism of divalent cations such as Ca, Fe, Mg, and Zn in humans.

Despite the continuous use of antibiotics as feed supplements to livestock and the possible effect on blood metabolites, particularly minerals, limited information is available in he literature as to the effect of these chemical substances on the mineral status of goats, particularly kids.

This study was designed to assess the effect, if any, of feeding different levels of oxytetracycline-HCl on the serum levels of some selected minerals that are vital for growth and development of pre-weaned goats. The minerals of specific interest in this study are Ca, P, Ma, K, Mg, Mn, Cu, and Fe.

4.2: MATERIALS AND METHODS

4.2.1: ANIMALS AND THEIR MANAGEMENT

The experiment involved 48 three-day old kids. Their weight ranged from 1.25 to 2.05kg, with an average weight of 1.79kg. The management of these kids was explained in Chapter 3.2.2.

4.2.2: PLANS OF THE EXPERIMENT AND DIET

The experimental design was shown in Table 3.1 and other details were described in chapter 3.2.3.

4.2.3: MILK AND BLOOD SAMPLING

The milk from dams rearing their kids were collected by handmilking each dam once weekly. Twenty milliliters of the total milk collected from each was taken and stored in a plastic container. Samples of cow milk were collected by taking 10ml from freshly collected milk daily and bulked on weekly basis. The bulked milk samples were stored in plastic containers in the deep freezer at a temperature below 0°C until required for chemical analysis.

Blood samples were taken from the jugular vein of each experimental kid before morning feeding with sterilized disposable syringe fitted with needle. Sample was collected from each kid prior to introduction to the experimental treatments and thereafter at bi-weekly intervals until the animals were thirteen weeks old. The blood samples were allowed to set at room temperature. The serum was harvested and then stored in plastic bottles which were then kept in the deep freezer until required for analysis.

4.2.4: <u>ANALYTICAL PROCEDURE</u>

The mineral content of milk and serum samples as well as dried milled <u>Gliricidia</u> <u>Sepium</u> were determined after wet digestion of 1ml of the liquid samples or 1g of the plant sample, with 20mls of a mixture of perchloric and nitric acid (1:5 v/v) by using Atomic Absorption Spectrophotometer model 403. The total P in the digest was determined using P-Auto Analyzer Model IIA.

4.2.5: STATISTICAL ANALYSIS

The data on the various mineral concentrations in the serum were subjected to statistical analysis of variance using factorial design.

4.3: RESULTS

4.3.1: MINERAL COMPOSITION OF MILK AND INTAKE

The animal effect on the weekly Ca, P, Na, K, Mg, Mn, Cu, and Fe composition of goat milk, was not significant, hence the values of these minerals for the 24 lactating does nursing their kids were pooled together. The mean weekly mineral contents of the goat milk are shown in Table 4.1. The mean weekly mineral contents of cow milk are presented in Table 4.2. Table 4.3 illustrates the mineral composition of Gliricidia Sepium.

The average daily mineral intake calculated on the basis of overall daily milk intake is shown in Table 4.4. The treatment effect on the variations in individual animal mineral intake within the same rearing method was not significant ($P>0.05$). Appraisal of the individual mean intake of each mineral revealed that the kids fed with the highest level (26.4mg/day) of oxytetracycline supplement within the kids reared with their dams (Factor A) recorded the highest intake of all the minerals; kids

TABLE 4.1: SUMMARY OF MEAN* WEEKLY MINERAL CONTENTS OF GOATS' MILK FED TO KIDS

WEEKS	Mg/100 ml				Ug/100 ml			
	Ca	P	Na	K	Mg	Mn	Cu	Fe
2	49.06	130.00	60.50	210.86	19.17	21.98	92.45	90.79
3	68.20	106.20	64.13	207.72	16.38	8.78	94.08	82.20
4	88.32	89.70	61.71	199.33	14.79	5.49	97.32	72.61
5	117.20	134.30	66.55	165.76	14.15	3.20	94.08	64.39
6	136.32	115.70	71.39	162.61	16.35	8.79	68.12	54.80
7	153.60	133.90	75.02	157.36	14.15	6.49	53.53	64.39
8	164.16	140.40	72.60	156.32	12.48	5.50	48.66	60.69
9	156.52	152.30	76.23	157.37	18.15	5.60	43.79	82.33
10	163.20	143.00	78.45	153.17	16.61	4.30	43.79	78.09
11	194.96	134.30	81.00	154.22	12.25	3.30	32.44	54.80
12	203.52	158.60	82.03	155.27	11.46	4.60	29.20	45.21
13	212.20	147.31	78.66	150.02	11.46	4.40	22.71	45.21
Mean ±	142.22	131.60	72.03	169.17	14.79	7.54	60.00	66.00
	±52.60	±20.14	±7.55	±22.71	±2.58	±6.07	±28.01	±15.17

*Each weekly value represents average of 24 determinations.

TABLE 4.2: SUMMARY OF MEAN WEEKLY MINERAL CONTENTS OF COW MILK FED TO THE KIDS

WEEKS	Mg/100 ml				Ug/100 ml			
	Ca	P	Na	K	Mg	Mn	Cu	Fe
2	126.05	82.43	82.32	152.60	13.96	3.00	52.72	41.02
3	130.50	90.99	98.05	149.75	15.00	3.00	60.39	39.40
4	127.01	87.75	86.00	153.09	14.69	4.00	57.20	46.17
5	125.03	92.67	84.01	139.97	14.91	3.00	58.43	40.18
6	113.25	89.94	102.79	160.75	13.99	2.00	60.11	39.29
7	124.20	89.75	86.15	147.43	15.36	3.00	59.78	42.01
8	120.99	90.31	88.53	148.92	14.67	3.00	60.21	42.43
9	123.61	92.97	76.99	151.79	12.89	4.00	54.97	36.98
10	128.32	87.21	93.02	145.32	16.02	3.00	62.61	40.10
11	119.67	91.61	89.56	150.55	14.50	2.00	59.99	38.99
12	125.01	95.75	79.67	141.60	14.33	3.00	58.20	37.89
13	121.75	81.97	91.25	146.43	13.97	3.00	57.75	40.03
Mean ±	123.75	89.35	88.35	148.60	14.50	3.00	58.50	40.00
	±4.56	±4.09	±7.41	±5.70	±0.80	±0.60	±2.58	±2.39

TABLE 4.3: MINERAL CONTENTS OF GLIRICIDIA SEPIUM (per 100g DM)

Minerals	Values
g/100g	
Calcium (Ca)	1.03
Phosphorus (P)	0.30
Sodium (Na)	0.03
Potassium (K)	3.36
Magnesium (Mg)	0.49
ug/100g	
Manganese (Mn)	85.71
Copper (Cu)	5.43
Iron (Fe)	324.97

TABLE 4.4: SUMMARY OF MEAN DAILY MINERAL INTAKE OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

	REARING METHODS							
	GOAT MILK				COW MILK			
	A1	A2	A3	A4	B1	B2	B3	B4
g/day								
Calcium	0.38 ±0.08	0.39 ±0.09	0.38 ±0.05	0.69 ±0.21	0.82 ±0.26	0.81 ±0.19	0.77 ±0.28	0.73 ±0.22
Phosphorus	0.36 ±0.07	0.36 ±0.08	0.36 ±0.05	0.68 ±0.19	0.59 ±0.19	0.59 ±0.13	0.55 ±0.21	0.50 ±0.19
Sodium	0.18 ±0.06	0.20 ±0.04	0.19 ±0.03	0.38 ±0.11	0.58 ±0.19	0.58 ±0.13	0.61 ±0.23	0.52 ±0.16
Potassium	0.45 ±0.10	0.42 ±0.09	0.46 ±0.06	0.87 ±0.26	0.98 ±0.31	0.97 ±0.22	0.93 ±0.34	0.99 ±0.30
mg/day								
Magnesium	39.12 ±9.01	40.72 ±9.13	39.91 ±5.19	76.78 ±21.83	95.97 ±30.41	94.88 ±21.85	90.67 ±32.93	83.94 ±24.35
Copper	0.16 ±0.04	0.17 ±0.04	0.16 ±0.02	0.31 ±0.09	0.39 ±0.12	0.38 ±0.09	0.3 ±0.31	0.34 ±0.10
Iron	0.18 ±0.03	0.18 ±0.04	0.18 ±0.02	0.34 ±0.10	0.27 ±0.08	0.26 ±0.06	0.25 ±0.09	0.23 ±0.07
ug/day								
Manganese	22.71 ±3.45	22.58 ±5.06	22.13 ±2.88	42.57 ±12.10	19.86 ±6.29	19.63 ±4.52	18.76 ±6.81	17.45 ±5.38

A1 = Goat Milk + 0mg Oxytetracycline-HCl B1 = Cow Milk + 0mg Oxytetracycline-HCl
A2 = Goat Milk + 13.2mg Oxytetracycline-HCl B2 = Cow Milk + 13.2mg Oxytetracycline-HCl
A3 = Goat Milk + 19.8mg Oxytetracycline-HCl B3 = Cow Milk + 19.8mg Oxytetracycline-HCl
A4 = Goat Milk + 24.4mg Oxytetracycline-HCl B4 = Cow Milk + 24.4mg Oxytetracycline-HCl

on the control treatment recorded the lowest. The kids reared on cow milk but on treatment group supplemented with the highest level (26.4mg/day) of oxytetracycline-HCl recorded the lowest intake of all the minerals. The kids on treatment B3 however consumed the highest quantity of minerals among kids reared artificially on cow milk.

Except for Mn, kids reared on cow milk had greater intake of each of the minerals compared to those kids reared with their dams. The overall mineral intake values of 0.42, 0.39, 0.21, 0.51g/day, and 43.74, 0.18 and 0.20 (mg/day) for Ca, P, Na, K, Mg, Cu and Fe, respectively, obtained for kids reared with their dams were significantly lower than the corresponding values of 0.81, 0.59, 0.58, 0.97 g/day and 94.98, 0.38 and 0.26 mg/day, respectively, obtained for kids reared artificially on cow milk ($P < 0.05$). The apparent difference between the values of 22.30 and 19.65 (mg/day) obtained for Mn intake for the two groups was not significant. The differences in the overall mean intake of each of these minerals for the two groups were essentially due to the difference in the quantity of milk intake by kids on various treatment groups.

4.3.2: SERUM MINERAL CONCENTRATIONS

The summary of the results obtained on the effect of four treatment levels of oxytetracycline-HCl administered orally on the concentration of minerals in the serum of kids reared with or without their dams is shown in Table 4.5. Table 4.6 shows the mean overall effect of oxytetracycline-HCl on the serum mineral levels of kids supplemented with four levels of this antibiotic averaged over the two rearing methods (goat and cow milk).

4.3.2.1: CALCIUM (Ca)

The bi-weekly mean serum Ca concentration of kids on groups reared with or without their dams are shownn in Appendix 6. The values for kids on treatment groups reared with their dams varied between 9.77 and 22.20 mg/100 ml. The corresponding values for those kids reared artificially on cow milk ranged from 10.60 to 17.22. The treatment effect of the rearing methods on Ca concentration in the serum was not significant. The variations observed in the concentration of Ca in the serum as the animals advanced in age up to the period covered by this study were not significant (Appendix Table 7).

The main effect of levels of oxytetracycline-HCl on the serum Ca concentration was however highly

TABLE 4.5: SUMMARY OF MEAN EFFECTS OF VARYING LEVELS OF OXYTETRACYCLINE-HCl ON SERUM MINERAL CONCENTRATIONS OF KIDS REARED WITH OR WITHOUT THEIR DAMS

	REARING METHODS							
	GOAT MILK				COW MILK			
	A1	A2	A3	A4	B1	B2	B3	B4
Mg/100 ml								
Calcium	11.97 ±0.46	17.36 ±0.70	13.55 ±0.61	12.10 ±0.42	12.79 ±0.67	13.48 ±0.54	13.27 ±0.53	13.61 ±0.75
Phosphorus	4.40 ±0.34	4.28 ±0.40	4.03 ±0.40	4.01 ±0.44	5.41 ±0.32	5.17 ±0.35	4.64 ±0.32	4.05 ±0.15
Sodium	419.44 ±15.75	419.72 ±16.54	405.28 ±13.98	457.78 ±13.98	493.06 ±17.30	500.28 ±18.66	508.06 ±15.76	436.95 ±17.15
Potassium	26.05 ±0.85	26.79 ±1.30	28.36 ±1.27	29.40 ±0.79	32.34 ±1.32	31.36 ±1.33	31.39 ±1.22	30.59 ±1.34
Magnesium	3.81 ±0.20	2.71 ±0.10	2.96 ±0.15	2.82 ±0.11	2.50 10.12	2.74 ±0.14	2.57 ±0.15	2.44 ±0.10
Ug/100 ml								
Copper	180.56 ±13.10	180.56 ±17.74	200.00 ±19.92	188.89 ±14.24	275.00 ±21.96	300.00 ±25.82	336.11 ±27.65	322.22 ±26.46
Manganese	3.14 ±0.23	2.31 ±0.19	2.89 ±0.22	2.86 ±0.21	2.83 ±0.23	3.06 ±0.18	2.14 ±0.22	2.72 ±0.23
Iron	81.78 ±3.40	88.31 ±4.97	101.22 ±7.74	77.69 ±2.95	64.64 ±3.63	68.81 ±3.51	61.14 ±2.92	66.72 ±4.83

A1 = Goat Milk + 0mg Oxytetracycline-HCl
A2 = Goat Milk + 13.2mg Oxytetracycline-HCl
A3 = Goat Milk + 19.8mg Oxytetracycline-HCl
A4 = Goat Milk + 26.4mg Oxytetracycline-HCl

B1 = Cow Milk + 0mg Oxytetracycline-HCl
B2 = Cow Milk + 13.2mg Oxytetracycline-HCl
B3 = Cow Milk + 19.8mg Oxytetracycline-HCl
B4 = Cow Milk + 26.4mg Oxytetracycline-HCl

TABLE 4.6: SUMMARY OF THE MAIN EFFECT OF OXYTETRACYCLINE-HCl ON BLOOD SERUM MINERAL CONCENTRATIONS OF KIDS AVERAGED ACROSS THE TWO REARING METHODS

	TREATMENTS			
	1	2	3	4
mg/100ml				
Calcium (Ca)	12.38[b]	15.42[a]	13.41[b]	12.86[b]
Phosphorus (p)	4.90	4.73	4.33	4.07
Sodium (Na)	456.25	460.00	456.67	447.36
Potassium (k)	29.19	29.08	29.88	29.99
Magnesium (Mg)	3.15[a]	2.73[b]	2.76[b]	2.63[b]
ug/100ml				
Copper (Cu)	227.78	240.28	268.06	255.56
Manganese (Mn)	2.99	2.68	2.51	2.79
Iron (Fe)	73.21	78.56	81.18	72.21

a,b Means with different superscripts differ ($P < 0.05$)

1 = 0mg Oxytetracycline-HCl Supplement/day
2 = 13.2mg Oxytetracycline-HCl Supplement/day
3 = 19.8mg Oxytetracycline-HCl Supplement/day
4 = 26.4mg Oxytetracycline-HCl Supplement/day

significant ($P < 0.01$). The mean serum Ca concentrations obtained for the main effect of levels of oxytetracycline-HCl were 12.38, 15.42, 13.41 and 12.86mg/100ml. respectively, for kids in the control group, and those kids on treatment groups supplemented with 13.2, 19.8 and 26.4mg of oxytetracycline-HCl. Results showed that all kids receiving oxytetracycline-HCl had higher serum Ca concentration than those in the control. Kids on the lowest level of oxytetracycline-HCl (13.2mg/day) recorded the highest serum Ca concentration and the difference was significant. Beyond this dosage, the serum Ca concentration decreased and no significant difference was apparent between the values obtained for the control and kids on treatment group receiving 19.8 and 26.4mg of oxytetracycline-HCl daily.

Interaction between rearing methods and treatment levels was highly significant ($P < 0.01$). Application of Duncan (1955) test to the various means showed that the differences among the mean serum Ca concentrations of 11.97, 13.36 and 12.10mg/100ml obtained for kids on treatments A1, A3 and A4 were not significant. The value 17.36mg/100ml obtained for kids on treatment A2 was the highest mean serum Ca concentration obtained for animals on this rearing method. It was significantly higher than any of the values for kids on treatments A1, A3 and A4.

The variations observed among the mean serum Ca concentrations (mg/100ml) of 12.79, 13.48, 13.27 and 13.61 obtained for kids on treatments B1, B2, B3 and B4 were not significant. Comparing the individual treatment mean serum Ca concentration for animals on both rearing methods, it was revealed that the variations observed between the mean serum Ca concentrations of kids on treatments A1, A3 and A4 and kids on treatments B1, B2, B3 and B4 were not significant. The mean value obtained for kids on treatment A2 (the highest) was significantly higher ($P < 0.05$) than the values obtained for their counterparts on Factor A and kids on treatments reared on Factor B.

The interaction between the age of the animals and rearing methods, or levels of oxytetracycline-HCl, and between age, rearing methods and levels of oxytetracycline-HCl, were not statistically significant.

4.3.2.2: PHOSPHORUS (P)

The mean bi-weekly concentration of P in the serum of all kids in this study varied from 3.33 and 7.69 (Appendix 8). The effects of age, rearing methods and levels of oxytetracycline-HCl on serum P levels were not significant (Appendix Table 9). Interactions between age and rearing methods, or doses of oxytetracycline-HCl, and between age, rearing methods and levels of oxytetracycline-HCl on serum P concentrations, were not significant. Interaction between rearing methods and doses of oxytetracycline-HCl was, nevertheless, highly significant ($P<0.01$).

Appraisal of the results showed that the mean serum P concentration for kids on treatment groups supplemented with various levels of oxytetracycline-HCl were lower than the values obtained for their unsupplemented counterparts in both rearing methods. In addition, the serum values of P declined progressively as the levels of oxytetracycline-HCl supplement increased for kids on both rearing methods (Table 4.4).

4.3.2.3: SODIUM (Na)

The mean bi-weekly concentration of Na in the serum of all kids in this study varied between 403,33 and 601,67mg/100ml (Appendix 10). Analysis of variance (Appendix Table 11) shows that the variations observed in the serum Na concentration of kids on various treatment levels does not differ significantly with advancing age. Neither was the variation observed for the main effect of levels of oxytetracycline-HCl on the serum Na levels of kids significant. However, the treatment effect of rearing methods on serum Na concentration was highly significant ($P<0.01$). The variation observed between the values (mg/100ml) of 426.00 and 484.60 obtained for animals reared on Factors A and B, respectively, was highly significant ($P<0.01$).

Interaction between age and levels of oxytetracycline-HCl on one hand, and age, rearing methods and levels of oxytetracycline, on the other, were not statistically significant. Nevertheless, interaction between the age of the animals and rearing methods was significant ($P<0.05$). Interaction between rearing methods and levels of oxytetracycline-HCl was also highly significant ($P<0.01$). The variations observed among individual treatment mean values (mg/100ml) of 419.44, 419.72, 457.78; 419.44, 419.72, and 405.28 obtained for kids on treatments A1, A2, A4 and A1, A2 and A3, respectively, were not significant ($P>0.05$). The value obtained for kids on treatment A3 was the lowest mean serum Na concentration and was significantly lower than the value obtained for kids on treatment A4.

The variations observed between the mean serum Na concentration (mg/100ml) of 493.10, 500.30, and 508.10 for kids on treatments B1, B2 and B3 did not differ appreciably, but the mean value obtained for kids on treatment B4 (436.90mg/100ml) was significantly lower than the values obtained for animals on treatments B1, B2 and B3 ($P<0.05$).

4.3.2.4: POTASSIUM (K)

The bi-weekly mean K concentration in the serum of kids in different treatment groups in this experiment are shown in Appendix Table 12. The values for kids reared with their dams varied between 22.30 and 34.23 mg/100ml while the values for those kids reared artificially on cow milk on similar levels of oxytetracycline-HCl ranged from 28.05 to 35.12mg/100ml. The serum K concentration of all kids on treatment groups reared on both methods did not differ significantly with advancing age. Same was noted for the main effect of oxytetracycline-HCl on the serum K concentration (Appendix Table 13).

The main effect of rearing methods on K concentration in the serum was highly significant ($P<0.01$). The observed variations between the values 27.65 and 31.42 mg/100ml obtained for mean serum K concentration for all kids reared with or without their dams was appreciable. Interactions between age of the animals and rearing methods, or levels of oxytetracycline-HCl; rearing methods and levels of oxytetracycline-HCl, age, rearing methods and doses of oxytetracycline-HCl, were not significant ($P>0.05$).

4.3.2.5: MAGNESIUM (Mg)

The mean bi-weekly concentration of Mg in the serum of all the kids reared with their dams varied between 2.47 and 4.43g/100ml and the values for their counterparts reared on cow milk ranged from 2.11 to 3.54 mg/100ml (Appendix Table 14). The mean concentration of Mg in the serum of all kids reared with their dams and those reared on cow milk were 3.07 and 2.56mg/100ml, respectively. Analysis of variance (Appendix Table 15) showed that the variation observed between the two mean values was highly significant ($P<0.01$).

The main effect of levels of oxytetracycline-HCl on the concentration of Mg in the serum of kids supplemented with different levels of antibiotic was highly significant ($P<0.01$). The mean concentration of Mg in the serum of kids supplemented with different levels of antibiotic over the experimental period were (mg/100ml) 3.15, 2.73, 2.76 and 2.63, respectively, for kids on control group and those supplemented with 13.2, 19.8 and 26.4mg of oxytetracycline-HCl per day.

When the treatment means were compared (Duncan's, 1955), the differences observed between the mean concentration of Mg in the serum of kids supplemented with (mg/day) 13.2, 19.8 and 26.4 of oxytetracycline-HCl were not appreciable. The kids on control group had the highest serum Mg concentration and the variations observed between the value for kids on control group and those on different levels of oxytetracycline-HCl were significant ($P < 0.05$).

In addition, the concentration of Mg in the serum of kids supplemented with antibiotic level tends to decline as the level of oxytetracycline-HCl increased, though the apparent decrease was not significant. The variations observed in the concentration of Mg (mg/100ml) in the blood serum were not significant as the animals advanced in age up to the end of this study. Interactions between age and rearing methods, or levels of oxytetracycline-HCl; age, rearing methods and doses of antibiotic, were not statistically significant. Interaction between rearing methods and treatment levels was, however, highly significant ($P < 0.01$).

4.3.2.6: <u>COPPER (Cu)</u>

The mean bi-weekly concentration for Cu in the serum of kids on different treatment groups reared with or without their dams are shown in Appendix Table 16. The values for kids on treatment groups reared with their dams varied between 116.67 and 283.33ug/100ml while the corresponding values for those kids reared on cow milk ranged from 216.66 to 483.33ug/100ml. Analysis of variance (Appendix Table 17) showed a significant difference ($P<0.01$) between the values 187.50 and 308.33ug/100ml obtained for the mean serum Cu concentration of all the kids reared with their dams and those kids reared on cow milk. The main effect of levels of oxytetracycline-HCl and the effect of treatments with advancing age of the kids were not statistically significant ($P>0.05$). Interactions between age and rearing methods or levels of oxytetracycline-HCl; rearing methods and levels of antibiotic; age, rearing methods and doses of oxytetracycline-HCl on serum Cu concentration of kids on different treatment levels were not significant.

4.3.2.7: MANGANESE (Mn)

The mean bi-weekly Mn concentration in the serum of kids on different treatment groups in this study are shown in Appendix Table 18. The variations observed between Mn concentration in the blood serum of kids supplemented with different levels of oxytetracycline-HCl and reared with or without their dams were not significant with advancing age of the animals, rearing methods and levels of oxytetracycline-HCl (Appendix, Table 19). The overall mean values were 2.69 and 2.80 ug/100ml, respectively, for all kids on treatment groups reared with or without their dams.

Interaction between age of the animals and rearing methods or levels of oxytetracyline-HCl and interaction between age, rearing method and levels of antibiotic, were not significant. A significant interaction was however observed between rearing methods and levels of oxytetracycline-HCl on the concentration of Mn in the serum ($P<0.05$).

The mean serum Mn concentration over the experimental period (ug/100ml) were 3.14, 2.31, 2.89 and 2.86, respectively, for kids on treatments A1, A2, A3, and A4. The corresponding values (ug/100ml) were 2.83, 3.06, 2.14 and 2.72, respectively, for kids on treatments

B1, B2, B3 and B4. The individual mean serum Mn concentration for kids on different levels of oxytetracycline-HCl on both rearing methods failed to follow a consistent trend with increased level of oxytetracycline-HCl. However, oxytetracycline-HCl supplement tended to result in decreases in the blood serum Mn compared to the control.

4.3.2.8: IRON (Fe)

The mean bi-weekly serum Fe concentration for all kids in this study ranged from 64.6 to 101.20ug/100ml (Appendix Table 20). The treatment effects of rearing methods on Fe concentration in the serum was highly significant ($P<0.01$). The mean value of 87.25ug/100ml obtained for all animals reared with their dams was appreciably higher than the corresponding value of 65.33ug/100ml obtained for all kids reared artificially on cow milk.

The variations observed in the serum Fe (mg/100ml) were not significant as the age of the animals advanced, as well as the various doses of oxytetracycline-HCl supplements (Appendix Table 21). Interaction between rearing methods and levels of oxytetracycline-HCl was significant ($P<0.05$). Interactions such as between age and rearing methods or levels of oxytetracycline-HCl;

age, rearing methods, and levels of antibiotic on the serum Fe concentrations were, however, not significant ($P > 0.05$).

4.4: DISCUSSION

There were variations in the mean mineral constituents of goat milk from week to week. The variations in part might be due to changes in feed mineral components since the lactating dams were fed the Teaching and Research Farm regular concentrate; but most largely, it could be a function of stage of lactation. Akinsoyinu and Akinyele (1978) demonstrated that colostrum was richer in some mineral elements compared to mature milk and in addition, mineral contents of milk varied with advancing lactation (Jenness and Sloan, 1971). The mean mineral contents of cow milk reported in this study were similar to those reported elsewhere (Haenlein, 1980; Awah, 1981).

The mean serum Ca value (9.77 to 22.20mg/100ml) obtained in this study is not lower than the normal range (9 to 11mg/100ml) for an adequately fed cattle/ sheep in temperate climate (ARC, 1980); rather, some of the kids in this study had blood serum Ca concentration above the published values for adult cattle and sheep. It follows then that kids in this study had adequate intake of Ca. This result is expected since the kids were fed milk for most part of the experiment and milk is an excellent source of Ca.

The different rearing methods, as well as the varying levels of oxytetracycline-HCl had not depressed the blood serum Ca levels. Kids supplemented with varying levels of oxytetracycline-HCl had higher serum Ca values than those in the control group.

This observation was in support of findings (Rashidov and Mamatkulov, 1972; Kuthe, 1975; Luckey, 1959) but did not agree with reports (March, 1978; Kirchgessner, et al., 1972) which indicated a decrease in the absorption and retention of Ca, when antibiotics were fed to either man or livestock. In addition, the data obtained indicated that the minimum level of oxytetracycline-HCl (13.2mg/day) produced the highest level of serum Ca and it was not meaningful to supplement kids of similar age with higher levels for optimum serum Ca value.

Most of the animals used in this experiment had mean serum P concentration ranging from 3.33 to 5.83 mg/100ml, although a few but insignificant number had values lower or slightly higher than the range. The serum P concentration values obtained in this study were lower than the values (mg/100ml) 6.57 to 8.35, 6.94 to 9.43 and 7.37 to 7.54, respectively, reported for kids from day 0 to 6, lambs 0 to 7, and calves 0 to 7, respectively, (Bartlet, et al., 1971) and values of 5.00 to 6.50mg/100ml reported for human infants (Sauberlich, et al., 1981). However, the values reported here compared favorably with those reported for adult ruminants of different species (Vaskov, et al., 1969; Muniz, et al., 1974; Mba, 1982; Lane, 1968) and the recommended minimum serum P level (4mg/100ml) for sheep (ARC, 1980). The rearing methods did not influence the blood serum P levels significantly.

Oxytetracycline-HCl slightly depressed blood serum P concentration of kids supplemented with various levels of the antibiotic in both rearing methods. Previous research (Rashidov and Mamatkulov, 1972; Kirchgessner, et al., 1961; and Kuthe, 1975) showed that there was a favorable effect of antibiotics on the absorption, retention and metabolism of P.

All kids on antibiotic treatment groups in this study exhibited higher mean serum Na levels than values reported elsewhere for ruminants (Kessler, 1981; Mba, 1982; Cakala, 1972; Sauvant, 1979) and normal adult men and women (Sauberlich, et al., 1981). The differences between the present results and values obtained elsewhere (Kessler, 1981 and Cakala, et al., 1972) could not be attributed to the effects of treatment, since the kids on the control treatment recorded an equally high serum Na concentration as the animals on various doses of oxytetracycline-HCl.

The amount of Na intake could provide a reasonable explanation for the fairly higher serum Na value, since serum Na levels appeared to reflect the pattern of Na intake in general. Report (Anke and Schellner, 1969/70), however, showed that increasing Na content of diet already adequate in Na failed to alter the blood serum Na values. The varying levels of oxytetracycline-HCl had no appreciable influence on blood serum Na levels.

The diet of kids used in this experiment appeared to be adequate in terms of K intake, since the serum K values (21.30 to 39.00mg/100ml) obtained were within the upper range of reported values in previous studies (Wood, 1955; Roy, et al., 1959; Musherry and Grinyner, 1954). On the other hand, the results were slightly higher than the values reported for young goats (Kessler, 1981), adult WAD goats (Mba, 1982), as well as man on balanced diet (Sauberlich, et al., 1981). The varying levels of oxytetracycline-HCl had no adverse effect on the blood serum K levels.

It is pertinent to note that the serum Na and K values observed in this study were either higher than, or close to the upper range of published values. Similar studies with WAD goat kids have not been found in literature. The reason for the higher levels of these mineral elements in the serum of animals used in this study could be in part due to the differences in age and diet of animals used in the experiment compared to previous experiments (Mba, 1982; Roy, et al., 1959).

Observations indicated an appreciable decrease in the serum Mg values of kids supplemented with oxytetracycline-HCl and reared with their dams, compared with corresponding values for kids on the control treatment. Although the serum Mg concentration of kids reared on cow milk did not follow a consistent trend, some increase above the serum Mg values of the control were apparent when antibiotic was fed at levels between 13.2 and 19.8mg/day.

The treatment effect of rearing methods on the serum Mg levels was appreciable. The overall effect of treatments on the serum Mg values was negative, since the mean values obtained for all the kids in treatment groups fed oxytetracycline-HCl were lower compared with the control. This report confirmed findings (March, 1978). Rodale and Staff (1972) reported that antibiotic such as tetracycline interfered with magnesium metabolism.

The mean serum Cu range of 116.67 to 283.33 ug/100ml obtained for kids reared with their dams were comparable with the range of 181.00 to 200.00ug/100ml recorded for young mares and close to the value of 177.70ug/100ml obtained for older mares. The range value (233.33 to 483.33ug/100ml) obtained for kids reared on cow milk were higher than the values reported elsewhere (Nuriddinor, 1972). The higher serum Cu obtained for the kids reared on cow milk was justified, since the level of Cu intake would directly influence the absorption and utilization of Cu in goat kids. The treatment effect of rearing methods was significant.

The result obtained in this study did not demonstrate any deleterious effect on serum Cu by feeding varying levels of oxytetracycline-HCl to kids reared with or without their dams, since the serum Cu levels of kids supplemented with oxytetracycline-HCl were higher than the value obtained for the control, though the apparent difference between treatments was not significant. This result did agree with such findings (Kirchgessner, et al., 1961) which showed that the absorption of Cu was enhanced with antibiotic supplement of piglets.

Toullet, et al. (1980) noted that cow milk seems to be sufficiently rich in all micro-elements, with the exception of Mn. The serum Mn values (1.67 to 4.67ug/100ml) obtained for kids on varying treatment levels of antibiotic reared with their dams and those reared on cow milk in this study, were higher than the value (0.5ug/100ml) reported for adult WAD goats (Mba, 1982).

Though there was a decrease in the serum Mn levels with addition of oxytetracycline-HCl, the decrease was not appreciable. The effect of rearing methods on the serum Mn values was not significant. This finding is in agreement with a report (Kirchgessner, et al., 1961) which showed that antibiotic supplement had no significant effect on serum Mn level but did not agree with the observations reported for chicks (Pepper, et al., 1952).

The mean serum Fe values obtained for most kids on this experiment fell below 100ug/100ml with few kids having blood serum Fe values slightly higher. The blood serum Fe values obtained for kids on different treatment levels in this experiment were lower than the values reported elsewhere for ram, ewe, buck and cows (Underwood and Morgan, 1963), as well as the values reported for man and woman (Tchai, 1970) and children (Nuriddinor, 1972). Although no recommended serum Fe value for goat kids has been found in literature, the result obtained in this study was expected since the animals used in this experiment survived mainly on milk for most part of this study.

Murthy (1974) and N.R.C. (1980) reported that the Fe content of milk is generally low, a factor which could have been responsible for the present low serum Fe values obtained for animals in this study.

The significant effect of rearing methods and the interaction between rearing methods and levels of oxytetracycline-HCl showed that addition of different levels of oxytetracycline-HCl to the two diets produced different effects on serum Fe. Oxytetracycline-HCl produced small but insignificant improvement on serum Fe levels of kids above the value obtained for kids on the control group, particularly when fed at levels between 13.2 and 19.8mg/day to kids reared with their dams and at lowest level (13.2mg/day) to kids reared on cow milk. The overall effect of varying levels of oxytetracycline-HCl on the serum Fe levels was not significant. This finding was similar to reports (Kirchgessner, et al., 1961) which noted that feeding antibiotics to pigs had no appreciable effect on Fe levels of the serum. March (1978) and Reo (1985) reported impaired absorption of iron when antibiotic was administered orally in man. Neuvonen et al. (1970) showed that when organic iron was given with tetracyclines, lower blood levels of these antibiotics resulted.

4.5: CONCLUSION AND RECOMMENDATIONS

The results obtained in this study showed that oxytetracycline-HCl can be used in rearing goat kids running with their dams as attested to by improved intake, liveweight gain, and better feed efficiency. On the other hand, supplementing goat kids on adequate quantity of cow milk with oxytetracycline-HCl was not encouraging as they showed no appreciable improvement in performance over their counterparts fed unrestricted cow milk but no oxytetracycline-HCl supplement.

Oxytetracycline-HCl supplement to goat kids reared with or without their dams improved the serum Ca, Na, K, Cu, and Fe status of the animals, particularly when the dosages were between 13.2 and 19.8mg/day.

Dietary supplement with 26.4mg of orally administered oxytetracycline-HCl daily to kids reared conventionally was sufficient to promote adequate liveweight gain and feed efficiency.

There is a sharp fall in milk production of the dams from the third week after parturition; this is the period when administration of antibiotics could be critical to sustain the resistance of the kids before supplementary feeding can augment the fall in milk diet. Studies with goat kids reared conventionally and supplemented with antibiotics with a view to formulate a ration that could augment the short-fall in milk production of the dams, would go a long way in addressing some nutritional problems facing goat management, particularly in the raising of kids in the tropics.

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APPENDICES

APPENDIX TABLE 1: SUMMARY OF MEAN WEEKLY MILK INTAKE (IN LITRES) OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

	REARING METHODS							
	GOAT MILK				COW MILK			
WEEKS	A1	A2	A3	A4	B1	B2	B3	B4
2	1.98	2.50	2.27	2.56	2.32	1.92	2.69	2.07
3	2.36	2.74	2.73	2.93	3.50	2.77	3.89	3.20
4	2.48	2.27	1.95	3.05	4.21	3.30	4.30	3.30
5	2.60	1.97	2.20	3.15	4.75	4.40	4.50	3.80
6	1.55	2.33	2.31	2.58	4.45	4.53	4.52	3.95
7	1.35	1.96	1.94	2.63	5.06	4.93	5.25	3.65
8	2.00	1.65	2.27	2.63	5.07	4.68	5.12	4.00
9	1.42	1.60	2.15	2.65	5.30	4.95	4.86	4.05
10	1.90	1.92	0.97	2.80	5.27	5.20	5.15	4.30
11	1.35	1.32	1.70	2.05	5.58	6.32	5.75	4.55
12	1.15	1.42	1.65	2.02	5.60	6.80	6.28	5.27
13	0.71	1.08	1.45	2.00	5.60	6.95	6.25	5.60

A1 = Goat Milk + 0mg Oxytetracycline-HCl B1 = Cow Milk + 0mg Oxytetracycline-HCl
A2 = Goat Milk + 13.2mg Oxytetracycline-HCl B2 = Cow Milk + 13.2mg Oxytetracycline-HCl
A3 = Goat Milk + 19.6mg Oxytetracycline-HCl B3 = Cow Milk + 19.6mg Oxytetracycline-HCl
A4 = Goat Milk + 26.4mg Oxytetracycline-HCl B4 = Cow Milk + 26.4mg Oxytetracycline-HCl

APPENDIX TABLE 2: SUMMARY OF MEAN WEEKLY MILK INTAKE (kg) PER KILOGRAM METABOLIC SIZE OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HC1 REARED WITH OR WITHOUR THEIR DAMS

	REARING METHODS							
	GOAT MILK				COW MILK			
WEEKS	A1	A2	A3	A4	B1	B2	B3	B4
2	1.16	1.37	1.24	1.19	1.34	1.06	1.56	1.36
3	1.30	1.41	1.37	1.24	1.90	1.59	2.03	1.70
4	1.26	1.06	0.92	1.06	2.01	1.83	1.97	1.63
5	1.20	0.86	0.96	1.04	2.10	2.09	1.88	1.78
6	0.68	0.96	0.96	0.80	1.85	1.84	1.80	1.77
7	0.58	0.76	0.77	0.81	1.89	1.89	1.82	1.53
8	0.80	0.61	0.86	0.79	1.74	1.67	1.76	1.58
9	0.55	0.57	0.78	0.77	1.75	1.66	1.61	1.51
10	0.72	0.66	0.35	0.79	1.61	1.65	1.59	1.53
11	0.50	0.45	0.61	0.54	1.58	1.79	1.62	1.60
12	0.42	0.47	0.57	0.53	1.50	1.90	1.71	1.68
13	0.26	0.36	0.48	0.51	1.45	1.87	1.75	1.70

A1 = Goat Milk + 0mg Oxytetracycline-HC1
A2 = Goat Milk + 13.2mg Oxytetracycline-HC1
A3 = Goat Milk + 19.6mg Oxytetracycline-HC1
A4 = Goat Milk + 26.4mg Oxytetracycline-HC1

B1 = Cow Milk + 0mg Oxytetracycline-HC1
B2 = Cow Milk + 13.2mg Oxytetracycline-HC1
B3 = Cow Milk + 19.6mg Oxytetracycline-HC1
B4 = Cow Milk + 26.4mg Oxytetracycline-HC1

APPENDIX TABLE 3: ANALYSIS OF VARIANCE TABLE FOR MILK INTAKE (kg/W$^{0.75}$kg)

Source of Variation	DF(MV)	SS	SS%	MS	VR	F-PR
Rep. Stratum	5	13.0295	6.75	2.6059		
Rep* Units Stratum						
Weeks	11	11.5732	6.00	1.0521	10.294	0.001**
Type	1	114.1692	59.16	114.1692	1117.057	0.001**
Treatment	3	0.0467	0.02	0.0156	0.152	0.928
Weeks type	11	8.1192	4.21	0.7381	7.222	0.001**
Weeks treatment	33	3.1733	1.64	0.0962	0.941	0.565
Type treatment	3	1.4280	0.74	0.4760	4.657	0.003*
Week. type treatment	33	2.2945	1.19	0.0695	0.680	0.912
Residual	461(14)	47.1167	24.42	0.1022		
Total	556	187.9208	97.38	0.3380		
Grand total	561	200.9503	104.13			

** = Significant ($P<0.01$)
* = Significant ($P<0.05$)

APPENDIX TABLE 4: SUMMARY OF MEAN WEEKLY LIVEWEIGHT CHANGE (g) OF KIDS SUPPLEMENTED WITH VARIOUS LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

	REARING METHODS							
	GOAT MILK				COW MILK			
WEEKS	A1	A2	A3	A4	B1	B2	B3	B4
2	157.00	286.00	358.30	566.71	175.00	80.00	150.01	208.29
3	188.00	340.01	286.69	370.01	133.29	189.99	391.72	200.31
4	240.00	340.00	205.00	621.70	398.31	348.28	450.02	282.99
5	333.31	250.02	239.70	375.00	256.69	226.71	346.69	188.29
6	216.00	220.00	260.00	275.00	245.01	401.70	185.00	125.01
7	108.31	300.00	200.29	279.98	500.00	506.69	343.29	375.03
8	248.50	200.69	236.69	178.29	425.00	295.01	346.69	195.00
9	131.10	180.00	208.29	196.69	399.99	345.02	271.71	240.00
10	141.11	196.30	38.30	275.00	478.31	324.99	381.68	226.69
11	178.60	90.01	171.69	233.31	390.02	466.70	361.70	263.31
12	31.10	120.00	193.30	208.29	248.29	220.01	211.69	325.00
13	36.00	70.30	198.28	225.00	316.71	378.27	180.00	313.28

A1 = Goat Milk + 0mg Oxytetracycline-HCl
A2 = Goat Milk + 13.2mg Oxytetracycline-HCl
A3 = Goat Milk + 19.6mg Oxytetracycline-HCl
A4 = Goat Milk + 26.4mg Oxytetracycline-HCl
B1 = Cow Milk + 0mg Oxytetracycline-HCl
B2 = Cow Milk + 13.2mg Oxytetracycline-HCl
B3 = Cow Milk + 19.6mg Oxytetracycline-HCl
B4 = Cow Milk + 26.4mg Oxytetracycline-HCl

APPENDIX TABLE 5: ANALYSIS OF VARIANCE TABLE FOR WEEKLY LIVEWEIGHT CHANGE

Source of Variation	DF(MV)	SS	SS%	MS	VR	F-PR
Rep Stratum	5	911439	3.78	182288		
Weeks	11	939635	3.90	85421	2.462	0.005
Type	1	407928	1.69	407928	11.757	.001**
Treatment	3	162908	0.68	54303	1.565	0.197
Weeks. Type	11	1880789	7.81	170981	4.928	.001**
Weeks. Treatment	33	1726152	7.16	52308	1.508	0.038
Type Treatment	3	1148865	4.77	382755	11.031	.001**
Week. Type Treatment	33	1480814	6.15	44873	1.293	0.132
Residual	461(14)	15995415	66.38	34697		
Total	556	23741906	98.53	42701		
Grand Total	561	24653346	102.31			

** = significant ($P<0.01$)
* = significant ($P<0.05$)

APPENDIX TABLE 6: MEAN BI-WEEKLY SERUM CALCIUM CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUR THEIR DAMS

MILK	TRT	WEEK	N	CALCIUM
C	1	1	6	12.6833333
C	1	2	6	10.6000000
C	1	3	6	14.0666667
C	1	4	6	15.0000000
C	1	5	6	11.9333333
C	1	6	6	12.4666667
C	2	1	6	14.2833333
C	2	2	6	16.0166667
C	2	3	6	13.8000000
C	2	4	6	11.3666667
C	2	5	6	11.6000000
C	2	6	6	13.7833333
C	3	1	6	15.3166667
C	3	2	6	12.6000000
C	3	3	6	12.4833333
C	3	4	6	12.8500000
C	3	5	6	11.7000000
C	3	6	6	14.6500000
C	4	1	6	12.7333333
C	4	2	6	13.3666667
C	4	3	6	12.7833333
C	4	4	6	17.2166667
C	4	5	6	12.3166667
C	4	6	6	13.2666667
G	1	1	6	11.6666667
G	1	2	6	12.8000000
G	1	3	6	11.0333333
G	1	4	6	14.1333333
G	1	5	6	12.4333333
G	1	6	6	9.7666667
G	2	1	6	22.2000000
G	2	2	6	16.4000000
G	2	3	6	15.7000000
G	2	4	6	15.6833333
G	2	5	6	16.7833333
G	2	6	6	17.4166667
G	3	1	6	14.7833333
G	3	2	6	11.1166667
G	3	3	6	14.5333333
G	3	4	6	13.3833333
G	3	5	6	16.8833333
G	3	6	6	10.6000000
G	4	1	6	14.5166667
G	4	2	6	13.4666667
G	4	3	6	10.8000000
G	4	4	6	10.0833333
G	4	5	6	11.9000000
G	4	6	6	11.8333333

C =Cow milk G = Goat milk
TRT =Treatment N = Number of Observations
TRT1=0mg Oxytetracycline-HCl/day
TRT2=13.2mg Oxytetracycline-HCl/day
TRT3=19.8mg Oxytetracycline-HCl/day
TRT4=26.4mg Oxytetracycline-HCl/day

APPENDIX TABLE 7: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM CALCIUM

DEPENDENT VARIABLE: CALCIUM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	1534.76000000	32.65446809	2.83	0.0001	0.356743	25.1223
ERROR	240	2767.38000000	11.53075000		ROOT MSE		CALCIUM MEAN
CORRECTED TOTAL	287	4302.14000000			3.39569580		13.51666667

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	385.56916667	11.15	0.0001	3	385.56916667	11.15	0.0001**
ANIMAL	1	15.21680556	1.32	0.2518	1	15.21680556	1.32	0.2518
WEEK	5	105.62333333	1.83	0.1073	5	105.62333333	1.83	0.1073
ANIMAL*TRT	3	311.79069444	9.01	0.0001	3	311.79069444	9.01	0.0001
TRT*WEEK	15	266.64083333	1.54	0.0915	15	266.64083333	1.54	0.0915
ANIMAL*WEEK	5	141.40402778	2.45	0.0343	5	141.40402778	2.45	0.0343
ANIMAL*TRT*WEEK	15	308.51513889	1.78	0.0376	15	308.51513889	1.78	0.0376

**=significant ($P<0.01$)
*=significant ($P<0.05$)

APPENDIX TABLE 8: MEAN BI-WEEKLY SERUM PHOSPHORUS CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

MILK	TRT	WEEK	N	PHOSPHORUS
C	1	1	6	4.10722006
C	1	2	6	4.64261656
C	1	3	6	5.60783841
C	1	4	6	5.83154868
C	1	5	6	6.13820770
C	1	6	6	6.10553092
C	2	1	6	4.89397641
C	2	2	6	5.40423692
C	2	3	6	5.21571703
C	2	4	6	5.16041786
C	2	5	6	4.84621804
C	2	6	6	5.51986246
C	3	1	6	3.78799304
C	3	2	6	4.14241044
C	3	3	6	5.01462914
C	3	4	6	5.33385616
C	3	5	6	4.74567410
C	3	6	6	4.79091887
C	4	1	6	3.32549091
C	4	2	6	4.19770961
C	4	3	6	3.72263948
C	4	4	6	4.60491258
C	4	5	6	4.20273681
C	4	6	6	4.25300878
G	1	1	6	3.34057250
G	1	2	6	3.85334661
G	1	3	6	4.69791572
G	1	4	6	4.61999417
G	1	5	6	5.21068983
G	1	6	6	4.65267095
G	2	1	6	4.21530480
G	2	2	6	5.11265949
G	2	3	6	3.60198675
G	2	4	6	3.96645854
G	2	5	6	4.22284559
G	2	6	6	4.57726299
G	3	1	6	4.76075569
G	3	2	6	4.48174625
G	3	3	6	2.20442594
G	3	4	6	4.90654441
G	3	5	6	4.37868871
G	3	6	6	3.42854845
G	4	1	6	5.48215848
G	4	2	6	6.07536774
G	4	3	6	7.69412522
G	4	4	6	7.29446305
G	4	5	6	4.95681638
G	4	6	6	5.07244191

C = Cow milk G = Goat milk
TRT = Treatment N = Number of Observations
TRT1= 0mg Oxytetracycline-HCl/day
TRT2= 13.2mg Oxytetracycline-HCl/day
TRT3= 19.8mg Oxytetracycline-HCl/day
TRT4= 26.4mg Oxytetracycline-HCl/day

APPENDIX TABLE 9: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM PHOSPHORUS

DEPENDENT VARIABLE: PHOSPHOR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	269.53849814	5.73486166	1.25	0.1417	0.197007	44.9634
ERROR	240	1098.63109612	4.57762957		ROOT MSE		PHOSPHOR MEAN
CORRECTED TOTAL	287	1368.16959425			2.13953957		4.75839919

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	21.80277651	1.59	0.1930	3	21.80277651	1.59	0.1930
ANIMAL	1	0.97132585	0.21	0.6455	1	0.97132585	0.21	0.6455
WEEK	5	23.41234335	1.02	0.4047	5	23.41234335	1.02	0.4047
ANIMAL*TRT	3	113.59699077	8.27	0.0001	3	113.59699077	8.27	0.0001**
TRT*WEEK	15	56.66759340	0.83	0.6490	15	56.66759340	0.83	0.6490
ANIMAL*WEEK	5	11.02285167	0.48	0.7898	5	11.02285167	0.48	0.7898
ANIMAL*TRT*WEEK	15	42.06461659	0.61	0.8636	15	42.06461659	0.61	0.8636

**=significant (P<0.01)
*=significant (P<0.05)

APPENDIX TABLE 10: MEAN BI-WEEKLY SERUM SODIUM CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

MILK	TRT	WEEK	N	SODIUM
C	1	1	6	495.000000
C	1	2	6	453.333333
C	1	3	6	436.666667
C	1	4	6	591.666667
C	1	5	6	505.000000
C	1	6	6	476.666667
C	2	1	6	470.000000
C	2	2	6	601.666667
C	2	3	6	506.666667
C	2	4	6	458.333333
C	2	5	6	478.333333
C	2	6	6	486.666667
C	3	1	6	548.333333
C	3	2	6	553.333333
C	3	3	6	491.666667
C	3	4	6	466.666667
C	3	5	6	488.333333
C	3	6	6	500.000000
C	4	1	6	481.666667
C	4	2	6	485.000000
C	4	3	6	473.333333
C	4	4	6	311.666667
C	4	5	6	403.333333
C	4	6	6	466.666667
G	1	1	6	416.666667
G	1	2	6	411.666667
G	1	3	6	335.000000
G	1	4	6	413.333333
G	1	5	6	503.333333
G	1	6	6	436.666667
G	2	1	6	355.000000
G	2	2	6	423.333333
G	2	3	6	415.000000
G	2	4	6	441.666667
G	2	5	6	438.333333
G	2	6	6	445.000000
G	3	1	6	378.333333
G	3	2	6	361.666667
G	3	3	6	391.666667
G	3	4	6	448.333333
G	3	5	6	395.000000
G	3	6	6	456.666667
G	4	1	6	420.000000
G	4	2	6	416.666667
G	4	3	6	503.333333
G	4	4	6	471.666667
G	4	5	6	463.333333
G	4	6	6	471.666667

C = Cow milk G = Goat milk
TRT = Treatment N = Number of observations
TRT1= 0mg Oxytetracycline-HCl/day
TRT2= 13.2mg Oxytetracycline-HCl/day
TRT3= 19.8mg Oxytetracycline-HCl/day
TRT4= 26.4mg Oxytetracycline-HCl/day

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APPENDIX TABLE 11: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM SODIUM

DEPENDENT VARIABLE: SODIUM

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	966365.27777778	20560.96335697	2.47	0.0001	0.325749	20.0612
ERROR	240	2000233.33333334	8334.30555556		ROOT MSE		SODIUM MEAN
CORRECTED TOTAL	287	2966598.61111112			91.29241784		455.06944444

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	6312.50000000	0.25	0.8595	3	6312.50000000	0.25	0.8595
ANIMAL	1	250868.05555556	30.10	0.0001	1	250868.05555556	30.10	0.0001 **
WEEK	5	22611.11111111	0.54	0.7439	5	22611.11111111	0.54	0.7439
ANIMAL*TRT	3	161423.61111111	6.46	0.0003	3	161423.61111111	6.46	0.0003*
TRT*WEEK	15	235991.66666667	1.89	0.0251	15	235991.66666667	1.89	0.0251
ANIMAL*WEEK	5	126561.11111111	3.04	0.0112	5	126561.11111111	3.04	0.0112
ANIMAL*TRT*WEEK	15	162597.22222222	1.30	0.2022	15	162597.22222222	1.30	0.2022

**=significant(P∠0.01)
*=significant(P∠0.05)

APPENDIX TABLE 12: MEAN BI-WEEKLY SERUM POTASSIUM CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HC1 REARED WITH OR WITHOUR THEIR DAMS

MILK	TRT	WEEK	N	POTASSIUM
C	1	1	6	29.5000000
C	1	2	6	30.5000000
C	1	3	6	31.3333333
C	1	4	6	39.0000000
C	1	5	6	34.0500000
C	1	6	6	29.6333333
C	2	1	6	35.1166667
C	2	2	6	30.9166667
C	2	3	6	30.3333333
C	2	4	6	32.6166667
C	2	5	6	30.5333333
C	2	6	6	28.6500000
C	3	1	6	33.6666667
C	3	2	6	30.3333333
C	3	3	6	28.3333333
C	3	4	6	28.0500000
C	3	5	6	34.2166667
C	3	6	6	33.7666667
C	4	1	6	29.1666667
C	4	2	6	31.3333333
C	4	3	6	32.6166667
C	4	4	6	31.5333333
C	4	5	6	29.7500000
C	4	6	6	29.1333333
G	1	1	6	25.7666667
G	1	2	6	23.4333333
G	1	3	6	26.4000000
G	1	4	6	22.3000000
G	1	5	6	24.1500000
G	1	6	6	34.2333333
G	2	1	6	32.0333333
G	2	2	6	29.2166667
G	2	3	6	27.1666667
G	2	4	6	22.1166667
G	2	5	6	26.8666667
G	2	6	6	23.3333333
G	3	1	6	26.6166667
G	3	2	6	25.2333333
G	3	3	6	29.3166667
G	3	4	6	32.9500000
G	3	5	6	26.8500000
G	3	6	6	29.2000000
G	4	1	6	27.0000000
G	4	2	6	27.8333333
G	4	3	6	27.3166667
G	4	4	6	31.8000000
G	4	5	6	27.8833333
G	4	6	6	34.5500000

C = Cow milk G = Goat milk
TRT = Treatment N = Number of Observations
TRT1= 0mg Oxytetracycline-HC1/day
TRT2= 13.2mg Oxytetracycline-HC1/day
TRT3= 19.8mg Oxytetracycline-HC1/day
TRT4= 26.4mg Oxytetracycline-HC1/day

APPENDIX TABLE 13: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM POTASSIUM

DEPENDENT VARIABLE: POTASS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	3647.51802083	77.60676640	1.54	0.0202	0.231612	24.0423
ERROR	240	12100.91166667	50.42046528		ROOT MSE		POTASS MEAN
CORRECTED TOTAL	287	15748.42968750			7.10073695		29.53437500

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	47.28871528	0.31	0.8162	3	47.28871528	0.31	0.8162
ANIMAL	1	1024.15836806	20.31	0.0001	1	1024.15836806	20.31	0.0001**
WEEK	5	100.45906250	0.40	0.8496	5	100.45906250	0.40	0.8496
ANIMAL*TRT	3	255.21899306	1.69	0.1704	3	255.21899306	1.69	0.1704
TRT*WEEK	15	756.56607639	1.00	0.4554	15	756.56607639	1.00	0.4554
ANIMAL*WEEK	5	264.46767361	1.05	0.3895	5	264.46767361	1.05	0.3895
ANIMAL*TRT*WEEK	15	1199.35913194	1.59	0.0782	15	1199.35913194	1.59	0.0782

**=significant ($P<0.01$)
*=siginficant ($P<0.05$)

APPENDIX TABLE 14: MEAN BI-WEEKLY SERUM MAGNESIUM CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

MILK	TRT	WEEK	N	MAGNESIUM
C	1	1	6	2.46071133
C	1	2	6	2.44692583
C	1	3	6	2.71574304
C	1	4	6	2.46760408
C	1	5	6	2.71574304
C	1	6	6	2.17121588
C	2	1	6	2.71574304
C	2	2	6	2.28149986
C	2	3	6	2.61235181
C	2	4	6	3.54287290
C	2	5	6	2.42624759
C	2	6	6	2.88116901
C	3	1	6	2.32285636
C	3	2	6	2.69506479
C	3	3	6	2.10918114
C	3	4	6	2.38489109
C	3	5	6	2.41246209
C	3	6	6	3.47394541
C	4	1	6	2.26082162
C	4	2	6	2.39867659
C	4	3	6	2.73642128
C	4	4	6	2.36421285
C	4	5	6	2.73642128
C	4	6	6	2.13675214
G	1	1	6	3.50840915
G	1	2	6	3.88061759
G	1	3	6	3.85993934
G	1	4	6	3.81858285
G	1	5	6	3.34298318
G	1	6	6	4.42514475
G	2	1	6	3.02591674
G	2	2	6	2.73642128
G	2	3	6	2.50896057
G	2	4	6	2.46760408
G	2	5	6	2.72952854
G	2	6	6	2.81224152
G	3	1	6	2.99145299
G	3	2	6	2.77088503
G	3	3	6	2.71574304
G	3	4	6	3.11552247
G	3	5	6	2.85359801
G	3	6	6	3.29473394
G	4	1	6	2.52274607
G	4	2	6	2.60545906
G	4	3	6	2.63303005
G	4	4	6	3.11552247
G	4	5	6	2.86049076
G	4	6	6	3.20512821

C = Cow milk G = Goat milk
TRT = Treatment N = Number of Observations
TRT1= 0mg Oxytetracycline-HCl/day
TRT2= 13.2mg Oxytetracycline-HCl/day
TRT3= 19.8mg Oxytetracycline-HCl/day
TRT4= 26.4mg Oxytetracycline-HCl/day

APPENDIX TABLE 15: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM MAGNESIUM

DEPENDENT VARIABLE: MAGNESE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	72.95537899	1.55224211	2.25	0.0001	0.306247	29.4462
ERROR	240	165.26890386	0.68862043		ROOT MSE		MAGNESE MEAN
CORRECTED TOTAL	287	238.22428285			0.82983157		2.81312908

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	11.30653940	5.47	0.0012	3	11.30653940	5.47	0.0012
ANIMAL	1	19.00708865	27.60	0.0001	1	19.00708865	27.60	0.0001 **
WEEK	5	4.27343420	1.24	0.2905	5	4.27343420	1.24	0.2905
ANIMAL*TRT	3	17.29294022	8.37	0.0001	3	17.29294022	8.37	0.0001 **
TRT*WEEK	15	7.11805900	0.69	0.7944	15	7.11805900	0.69	0.7944
ANIMAL*WEEK	5	1.32676982	0.39	0.8586	5	1.32676982	0.39	0.8586
ANIMAL*TRT*WEEK	15	12.63054770	1.22	0.2550	15	12.63054770	1.22	0.2550

**=significant ($P<0.01$)
*=significant ($P<0.05$)

APPENDIX TABLE 16: MEAN BI-WEEKLY SERUM COPPER CONCENTRATION IN THER SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

MILK	TRT	WEEK	N	COPPER
C	1	1	6	266.666667
C	1	2	6	233.333333
C	1	3	6	300.000000
C	1	4	6	366.666667
C	1	5	6	216.666667
C	1	6	6	266.666667
C	2	1	6	300.000000
C	2	2	6	300.000000
C	2	3	6	316.666667
C	2	4	6	266.666667
C	2	5	6	283.333333
C	2	6	6	333.333333
C	3	1	6	350.000000
C	3	2	6	400.000000
C	3	3	6	483.333333
C	3	4	6	250.000000
C	3	5	6	266.666667
C	3	6	6	266.666667
C	4	1	6	283.333333
C	4	2	6	300.000000
C	4	3	6	350.000000
C	4	4	6	400.000000
C	4	5	6	300.000000
C	4	6	6	300.000000
G	1	1	6	166.666667
G	1	2	6	166.666667
G	1	3	6	116.666667
G	1	4	6	266.666667
G	1	5	6	183.333333
G	1	6	6	183.333333
G	2	1	5	240.000000
G	2	2	6	200.000000
G	2	3	6	133.333333
G	2	4	6	150.000000
G	2	5	7	171.428571
G	2	6	6	200.000000
G	3	1	6	183.333333
G	3	2	6	283.333333
G	3	3	6	183.333333
G	3	4	6	133.333333
G	3	5	6	183.333333
G	3	6	6	233.333333
G	4	1	6	200.000000
G	4	2	6	183.333333
G	4	3	6	183.333333
G	4	4	6	200.000000
G	4	5	6	183.333333
G	4	6	6	183.333333

C = Cow milk　　G = Goat milk
TRT = Treatment　　N = Number of Observations
TRT1= 0mg Oxytetracycline-HCl/day
TRT2= 13.2mg Oxytetracycline-HCl/day
TRT3= 19.8mg Oxytetracycline-HCl/day
TRT4= 26.4mg Oxytetracycline-HCl/day

APPENDIX TABLE 17: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM COPPER

DEPENDENT VARIABLE: COPPER

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	175.24642857	3.72864742	2.21	0.0001	0.302214	52.3741
ERROR	240	404.62857143	1.68595238		ROOT MSE		COPPER MEAN
CORRECTED TOTAL	287	579.87500000			1.29844229		2.47916667

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	6.68055556	1.32	0.2682	3	6.57905346	1.30	0.2748
ANIMAL	1	105.12500000	62.35	0.0001	1	104.17404450	61.79	0.0001 **
WEEK	5	4.09260399	0.49	0.7869	5	4.16332953	0.49	0.7807
ANIMAL*TRT	3	1.96220701	0.39	0.7618	3	1.97268730	0.39	0.7603
TRT*WEEK	15	35.99412461	1.42	0.1368	15	36.14276477	1.43	0.1342
ANIMAL*WEEK	5	12.68487086	1.50	0.1890	5	12.76459223	1.51	0.1860
ANIMAL*TRT*WEEK	15	8.70706654	0.34	0.9898	15	8.70706654	0.34	0.9898

**=significant (P<0.01)
*=significant (P<0.05)

APPENDIX TABLE 18: MEAN BI-WEEKLY SERUM MANGANESE CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

MILK	TRT	WEEK	N	MANGANESE
C	1	1	6	2.83333333
C	1	2	6	3.16666667
C	1	3	6	3.00000000
C	1	4	6	3.16666667
C	1	5	6	2.16666667
C	1	6	6	2.66666667
C	2	1	6	3.50000000
C	2	2	6	3.33333333
C	2	3	6	2.66666667
C	2	4	6	3.00000000
C	2	5	6	3.00000000
C	2	6	6	2.83333333
C	3	1	6	2.83333333
C	3	2	6	2.00000000
C	3	3	6	1.66666667
C	3	4	6	2.00000000
C	3	5	6	1.83333333
C	3	6	6	2.50000000
C	4	1	6	3.16666667
C	4	2	6	3.50000000
C	4	3	6	3.00000000
C	4	4	6	2.16666667
C	4	5	6	2.33333333
C	4	6	6	2.16666667
G	1	1	6	2.50000000
G	1	2	6	2.66666667
G	1	3	6	2.66666667
G	1	4	6	2.66666667
G	1	5	6	3.66666667
G	1	6	6	4.66666667
G	2	1	6	2.83333333
G	2	2	6	1.66666667
G	2	3	6	2.66666667
G	2	4	6	2.50000000
G	2	5	6	2.00000000
G	2	6	6	2.16666667
G	3	1	6	3.00000000
G	3	2	6	2.83333333
G	3	3	6	2.83333333
G	3	4	6	2.66666667
G	3	5	6	2.50000000
G	3	6	6	3.50000000
G	4	1	6	3.16666667
G	4	2	6	2.66666667
G	4	3	6	2.50000000
G	4	4	6	2.66666667
G	4	5	6	3.00000000
G	4	6	6	3.16666667

C = Cow milk G = Goat milk
TRT = Treatment N = Number of Observations
TRT1= 0mg Oxytetracycline-HC/1 day
TRT2= 13.2mg Oxytetracycline-HCl/day
TRT3= 19.8mg Oxytetracycline-HCl/day
TRT4= 26.4mg Oxytetracycline-HCl/day

APPENDIX TABLE 19: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM MAGANESE

DEPENDENT VARIABLE: MANGANES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	87.65277778	1.86495272	1.10	0.3106	0.177800	47.3768
ERROR	240	405.33333333	1.68888889		ROOT MSE		MANGANES MEAN
CORRECTED TOTAL	287	492.98611111			1.29957258		2.74305556

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TRT	3	8.48611111	1.67	0.1730	3	8.48611111	1.67	0.1730
ANIMAL	1	0.88888889	0.53	0.4689	1	0.88888889	0.53	0.4689
WEEK	5	8.06944444	0.96	0.4458	5	8.06944444	0.96	0.4458
ANIMAL*TRT	3	21.38888889	4.22	0.0062	3	21.38888889	4.22	0.0062
TRT*WEEK	15	15.59722222	0.62	0.8610	15	15.59722222	0.62	0.8610
ANIMAL*WEEK	5	14.11111111	1.67	0.1423	5	14.11111111	1.67	0.1423
ANIMAL*TRT*WEEK	15	19.11111111	0.75	0.7271	15	19.11111111	0.75	0.7271

**=significant ($P<0.01$)
*=significant ($P<0.05$)

APPENDIX TABLE 20: MEAN BI-WEEKLY SERUM IRON CONCENTRATION IN THE SERUM OF KIDS SUPPLEMENTED WITH VARYING LEVELS OF OXYTETRACYCLINE-HCl REARED WITH OR WITHOUT THEIR DAMS

MILK	TRT	WEEK	N	IRON
C	1	1	6	46.666667
C	1	2	6	68.333333
C	1	3	6	57.333333
C	1	4	6	71.333333
C	1	5	6	79.333333
C	1	6	6	64.833333
C	2	1	6	61.500000
C	2	2	6	66.833333
C	2	3	6	66.666667
C	2	4	6	60.666667
C	2	5	6	80.666667
C	2	6	6	76.500000
C	3	1	6	61.666667
C	3	2	6	51.833333
C	3	3	6	46.833333
C	3	4	6	71.666667
C	3	5	6	69.166667
C	3	6	6	65.666667
C	4	1	6	53.000000
C	4	2	6	78.333333
C	4	3	6	77.833333
C	4	4	6	58.666667
C	4	5	6	63.833333
C	4	6	6	68.666667
G	1	1	6	83.000000
G	1	2	6	88.166667
G	1	3	6	97.000000
G	1	4	6	69.333333
G	1	5	6	69.333333
G	1	6	6	83.833333
G	2	1	6	112.500000
G	2	2	6	113.500000
G	2	3	6	89.000000
G	2	4	6	75.166667
G	2	5	6	78.000000
G	2	6	6	61.666667
G	3	1	6	87.666667
G	3	2	6	103.166667
G	3	3	6	115.500000
G	3	4	6	102.666667
G	3	5	6	105.666667
G	3	6	6	92.666667
G	4	1	6	60.166667
G	4	2	6	90.333333
G	4	3	6	77.000000
G	4	4	6	77.166667
G	4	5	6	76.166667
G	4	6	6	85.333333

C = Cow milk G = Goat milk
TRT = Treatment N = Number of Observations
TRT1= 0mg Oxytetracycline-HCl/day
TRT2= 13.2mg Oxytetracycline-HCl/day
TRT3= 19.8mg Oxytetracycline-HCl/day
TRT4= 26.4mg Oxytetracycline-HCl/day

APPENDIX TABLE 21: ANALYSIS OF VARIANCE TABLE FOR BLOOD SERUM IRON

DEPENDENT VARIABLE: IRON

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	47	82003.24652778	1744.74992612	2.47	0.0001	0.325840	34.8523
ERROR	240	169663.83333333	706.93263889		ROOT MSE		IRON MEAN
CORRECTED TOTAL	287	251667.07986111			26.58820488		76.28819444

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F	
TRT	3	3974.89930556	1.87	0.1345	3	3974.89930556	1.87	0.1345	
ANIMAL	1	34606.42013889	48.95	0.0001	1	34606.42013889	48.95	0.0001	**
WEEK	5	4181.68402778	1.18	0.3181	5	4181.68402778	1.18	0.3181	
ANIMAL*TRT	3	8612.56597222	4.06	0.0077	3	8612.56597222	4.06	0.0077	
TRT*WEEK	15	9396.07986111	0.89	0.5804	15	9396.07986111	0.89	0.5804	
ANIMAL*WEEK	5	7148.85069444	2.02	0.0762	5	7148.85069444	2.02	0.0762	
ANIMAL*TRT*WEEK	15	14082.74652778	1.33	0.1858	15	14082.74652778	1.33	0.1858	

**=significant (P<0.01)
*=significant (P<0.05)