EFFECT OF CLAY MINERAL ON UTILIZATION OF SOME MINERAL ELEMENTS IN RUMINANT FEEDING

BY

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A thesis submitted in partial fulfillment
of
the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Agricultural Science
(Animal Production)

Department of Animal Production

Faculty of Agriculture

Zagazig University

2012

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Date of examination: **14/3/2012**

ABSTRACT

This study was carried out to evaluate the effects of tafla and bentofarm addition on feed intake, water intake, digestibility, nutritive values, some rumen parameters, nitrogen retention, some minerals retention and some blood parameters of rams, growth performance and some blood constituents of growing lambs. Twenty seven Rahmani mature rams, averaged 45 kg of live body weight were divided randomly to three main groups each main group subdivided into three treatments (three animals each). Main first group fed 100% bereseam and served as control (T_1), the other two subgroups fed the T_1diet plus 3% tafla (T_2) or 3% bentofarm (T_3).The second main group fed 50% berseam and 50% concentrate feed mixture (T_4), the other two subgroups fed the T_4 diet plus 3% tafla (T_5) or 3% bentofarm (T_6).The third main group fed 100% concentrate feed mixture and rice straw (T_7), the other subgroups fed (T_7)diet plus 3% tafla (T_8) or 3% bentofarm (T_9).To carry out the growth trial, forty eight growing baladi male lambs about 2 months of age and average live body weight 17 kg were divided into six similar groups (eight lambs for each) according to their body weight. The experimental rations were: T_4 -T_9 in previous tasted rations. The results of digestibility of DM and CP significantly ($P<0.05$) decreased as a result of tafla and bentofarm addition than that of the control, while OM, CF, EE and NFE digestibilities were slightly improved with tafla or bentofarm compared with those of control, but the differences were not significant among treatments. However, the results of nutritive values as TDN, SV and DCP showed no significant differences among treatments.

The results of ruminal parameters as TVFA's, pH and microbial protein significantly increased as a result of tafla and bentofarm addition than that of the control, but the values of ammonia-N concentrations significantly decreased by addition of tafla and bentofarm compared with the control treatments. The amount of calcium, magnesium and iron retention g/h/d were significantly ($P<0.05$) higher by addition of tafla and bentofarm compared to the control treatments, while the results of phosphorus and zinc retention significantly ($P<0.05$) decreased by addition of tafla and bentofarm compared to the control treatment. However, copper retention as mg/h/d showed no significant differences among treatments. The results of feed intake, average daily gain, and feed efficiency improved for lambs supplemented ration with tafla and bentofarm compared with non supplemented ration but the differences between treatments were not significant. Blood serum chemical analysis showed that total protein, albumin, nitrogen, AST, ALT, T_3, T_4, creatinine, alkaline phosphatase, glucose, calcium, phosphorus and magnesium, iron, zinc, and copper were not significant affected by treatments and were within the normal ranges. It could be concluded that using tafla and bentofarm as replacement of 3% of dry matter intake for growing lambs which based on concentrate and green forage together resulted in better production performance and economic efficiency without any adverse effects on animals.

ACKNOWLEDGEMENT

All prayerful thanks are due to our generous Allah who gave me the ability to complete this work.

The author wishes to express his sincere and deepest appreciation to **Prof. Dr. S. M. Abed El-Baki,** Professor of Animal Nutrition, Animal Production Department, Faculty of Agriculture, Zagazig University for his suggesting the problem, I pray to Allah to him for forgiveness and mercy.

The author also thanks **Prof. Dr. S. M. Bassiony,** Professor of Animal Nutrition, Animal Production Department, Faculty of Agriculture, Zagazig University for his supervising, designing the work plan, great help during carrying out the present work, guidance, valuable discussion, and revision of the manuscript.

The author also thanks **Dr. Saffa Saleh,** Associate Prof. of Animal Nutrition, Nuclear Research Center, Egyptian Atomic Energy Authority for his supervising, I pray to Allah to her for forgiveness and mercy.

My deepest thanks for all people helped me in this work, especially all stuff members in Animal Nutrition Research Unit, Nuclear Research Center and Department of Animal Production, Faculty of Agriculture, Zagazig University for the facilities that made this work feasible.

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I. INTRODUCTION

Tafla as an aluminaosilicate is a member of clay family naturally obtained from some Egyptian mines. Clays are widely used as feed additives to ruminant diets. The ion exchange capabilities of tafla could possibly influence microbial and animal metabolism through the preferential trapping and release of cations. Minerals ion-binding properties of tafla make this natural alumino-silicate attractive for use dietary supplements to improve digestion in ruminants. Also, tafla clay decreased liquid flow rate, while slightly decreased fractional rate of passage of food particles in digestive tract **(Abd EL-Baki et al, 2001).**

Tafla is one of the natural clays which is used to improve feed intake, digestibility, daily gain and milk production (**Abd EL-Baki et al, 1995, 2001 and Salem et al. 2001)**

Bentonite, like other clay materials is a crystalline aluminosilscates characterized by its ability to exchange cations without major changes in structure; it is used in ruminant animal diets to improve digestibility of nutrients (**Pulatov *et al.*, 1983, Kirilov and Burikhonov, 1993 and Saleh *et al.*, 1999**), daily gain and feed intake **(Lindermann *et al*., 1993**).

Bentonite can be used as a feed binder that produces a marked increase in firmness of feed pellets **(Martin *et al.*, 1969*)***. It can absorb toxic products of digestion and decreases the accumulation of toxic substances in tissues, thus decreasing the incidence of internal disorders ***(*****Mckenzie, 1991).**

Bentonite, a mixture of clays in which the predominant clay is montmorillonite has been used as a pelleting aid in manufacturing operations for many years (**Burns, 1968).** Most nutritional studies have referred to the material used as bentonite, kaolin or simply as clay, none of the terms being very meaningful. Without x-ray analysis and data on ion-exchange capacity to identify the silicates involved, it is difficult to relate the nutritional value to the clay being used **(Burns, 1968).** Although chemical and spectrographic analyses have been reported **(Ershoff and Bajwa, 1965),** they shed little light on the nutritional quality of clay. **Burns (1968)** found that nutritionally active clays have been noted only in the phyllosilicate group. These silicates have high cation-exchange capacity, sheet-like cleavage, are soft, and have relatively low specific gravity. A high cation-exchange capacity could be of nutritional interest with respect to Ca++, Na+, K+, NH_4+, and perhaps other cations.

Sodium bentonite (NaB) is expanded lattice clay of the montmorillonite group of minerals **(Bates and Jackson, 1980)** with high ion exchange capacity that binds a wide range of cations **(Fenn and Leng, 1989).** It has improved wool growth **(Fenn and Leng, 1989, 1990; Cobon et al., 1992),** decreased ruminal ammonia concentration, and improved feed and bacterial protein flow to the small intestine **(Ivan et al., 1992).**

Sodium bentonite is inert colloidal clay of volcanic origin and is composed primarily of mineral montmorillonite, which is a hydrated form of aluminum silicate. It is able to absorb much water and certain cations and appears to improve the physical nature of pelleted feeds **(Martin *et al.*, 1969)**.**Jordan (1954)** found that bentonite improved feed intake and gains of sheep, but these effects were not consistent. **Erwin, Elam and**

Dyer (1957) found that bentonite apparently, but not significantly, improved the performance of steers fed a fattening diet. Because of its great adsorptive capacity for water and certain cations, it was postulated that it might improve the utilization of ruminant rations containing urea. The following experiments were conducted to study this possibility. **Colling et al. (1975)** reported that bentonite, added to a high-concentrate lamb ration, improved weight gain over a 30-day period. **Martin *et al.* (1969)** reported that bentonite (up to 8% of the diet) improved feedlot performance of lambs on high-roughage diets. Studies by **Erwin *et al.*, (1957)** reported that 3% bentonite in steer diets had no effect on feedlot performance.

In recent years, the use of both natural and synthetic zeolites in animal nutrition has increased mainly to improve their performance, health, and to protect against mycotoxin intoxication.

Addition of zeolites, hydrated alumino-silicates of alkali, and alkaline earth cations to the diets of lactating dairy cows has not been studied extensively. By the nature of their chemical and physical properties, crystalline zeolites have a high attraction for water and a large number of positively charged ions, such as K+, NH_4^+, Ca^{2+}, and Mg^{2+}, which can be reversibly bound or released, depending upon the surrounding conditions**.** The potential for zeolites to release ions gradually in the rumen could prove beneficial to microbial synthesis and to the animal itself. The high affinity for these nutritionally vital elements has thus created interest in investigation of zeolites as feed additives for ruminants **(Mumpton et al 1977).**

The objectives of this study were to evaluate the effects of inclusion of tafla and bentofarm as two natural clays on feed and water consumption, digestibility coefficient of nutrients, nutritive values, some ruminal parameters, nitrogen and some minerals retention and some blood constituents of rams and growth performance and some blood parameters of growing lambs.

2. REVIEW OF LITERATURE

2. I. Natural clay minerals properties.

2. I. I. Ion-exchange and buffering properties:

Clays have various surface locations that have negative charges from isomorphous substitution. Positive ions (cations) are adsorbed at these negative charged sites. These adsorbed cations resist removal by water leaching but can be exchanged by other cations through mass action. The most numerous cations on exchange sites in soil, are calcium (Ca^{++}), magnesium (Mg^{++}), hydrogen (H^{+}), sodium (Na^{+}), potassium (K^{+}) and aluminum (Al^{+++}), indicating that soil as large cation exchanger. Cation exchange capacity is the amount of exchangeable cations per unit of weight of dry soil **(Donahue, 1983)**. **Abd El-Baki 1976 and 1977.** found that the nature of their chemical and physical properties, crystalline zeolite have a high attraction for water and a large number of positively charged ions, such as K^{+}, NH_4^{+}, Ca^{++} and Mg^{++}, which can be reversibly bound and released, depending upon the surrounding conditions. **Mumpton and Fishman (1977)** found that the potential for zeolite to release ions gradually in the rumen could prove beneficial to microbial synthesis and to the animal it self. The high affinity for these nutritionally vital elements has thus created interest in vestigation of zeolite as feed additive for ruminants. Addition of sodium bentonite to grains based cattle diets on the hypothesis that its cation exchange, water absorption and buffering properties improved animal performance **(Sweeney et al., 1980).**Crystalline zeolites are some of the most effective cation exchangers with capacities of 3 to 4 milli equivalent per gram. Ion-exchange capabilities of clays could possibly influence microbial and animal metabolism through the preferential trapping and release of cations **(McCollum and Galyean, 1983)**. **Leng (1986)** recommended sodium bentonite to allow rapid introduction of stock diets high in grains and he suggested that addition of sodium bentonite, rumen undergradable protein and minerals will lead to high efficiencies of feed utilization by animals fed such diets.

I.2. Adsorption properties:

The surface area available adsorption ranges up to several hundred square meters per gram. Some zeolites are capable of absorbing up to about 30% of a gas based on dry weight of the zeolite. zeolites can absorb toxic products of digestion and decrease accumulation of toxic substances in tissues, thus decreasing the incidence of internal disorders. Natural clays have the ability to adsorb ammonia from rumen solution when its concentration is high and release it when concentration falls.

Bartos *et al*. (1982) found that bentonite capacity of absorbing ammonia from the rumen liquid and its release later was 6 -12 mg NH_3-N per g bentonite. Therefore, the bentonite addition can regulate partially the N level supply for microorganism of the rumen, particularly in ration with a high solubility of their nitrogen components.

I.3. Binding properties:

There are numerous reports indicating that some silicates have no nutritional value and may be considered as diluent in the diet **Moody, (1963); Ershoff *et al*. (1965); Jones and Handdreck, (1965)** clays has been used as a pelleting aid in manufacturing operations for many years **Burns, (1968). Mendel (1971)** stated that bentonite has been used as a binding agent in cubes and pellets manufacturing. Natural clays such as zeolite are used at a 2% level in feed manufacturing as a pellet binder **(Mumpton and Fishman, 1977).**

2. Effect of clay minerals as feed additive to ruminant rations on:

2.1. Feed and water intake

Colling *et al*. (1979) and Dunn and Embry (1979) found that addition of sodium bentonite improved feed intake in lambs fed high concentrate diets. Also,**Sweeney *et al*. (1980), Muller *et al*. (1983) and May** and **Barker (1988)** found that feed intake increased with natural clays addition in diets of ruminants.

Feeding diets containing sodium zeolite A (SZA) mixed in a complete ration of 50: 50 grain: forage ratio with levels 0% (Control), 0.5%, 1.0% and 1.5% of dry matter intake (DMI) for Holstein cows and SZA significantly ($p<0.05$) increased feed intake at all three levels from sodium zeolite **(Roussel *et al*., 1991)**.

Cho *et al*. (2000) reported that supplementing reddish clay at 5% of basal diet (milk replacer and calf starter) for 60 days to Holstrin calves, intakes of calf starter greatly increased from 34 days of age to the end of the study, but no statistically differences were found in feed intakes between groups.

Forouzani *et al*. (2004) showed that inclusion of zeolite at 10, 30 and 60 g/kg diet containing 350g maize silage (which was treated with 10g urea per kg (fresh weight), 375g barley and 275g lucerne hay on daily dry matter intake. The results showed daily dry matter intake significantly ($p<0.05$) higher with 60g zeolite than that of the control one.

El-Tahan *et al.* (2005) studied the effect of adding 2 and 4% tafla clay on performance of growing calves fed ad libtum different rations containing concentrate feed mixture plus maize silage. The results showed addition of tafla clay improved dry matter intake than control (without tafla).

Ghaemnia et al. (2010) evaluate the effects of different levels of zeolite (3, 3, 6 and 9% on dry matter intake of growing lambs with an average live weight of 35kg. The rations were fed to lambs as total mixed feed and the results showed that intake of dry matter was significantly ($p<0.05$) higher for lambs receiving zeolites.

On the other hand, **Moate *et al*. (1985) and Johnson *et al.* (1988)** reported that feed intake decreased by addition of natural clays.

Aiad (1990) reported that supplement of bentonite, kaolin and tafla clays with 3% urea in sheep rations had no effect on feed intake.

Abd El-mawla *et al.* (1998). reported that daily dry matter intake (DMI) was not affected with addition of sodium bentonite at 6 or 12g /head daily during 6 weeks of late pregnancy and 6 weeks after parturition for goats which fed a daily basal diet (the basal diet included 70% concentrate feed mixture, 15% berseem hay and 15% rice straw).

Gutierrez *et al*. (1999) found that no differences were observed between intake for the different zeolite levels when addition of zeolite added at 0, 1, 3 or 5% to sheep which fed stargrass ad libitum and 300g of a commercial concentrate as the basal diet.

Madhu *et al*. (2001) found that the total dry matter intake (DMI) did not significantly differ between groups when cattle fed diets supplemented with 3 and 6% bentonite.

Salem *et al. (*2001) showed that daily intake of dry matter, organic matter and feed components were not significantly affected by the addition of sodium bentonite at 4 and 8% to the diet of sheep**.**

Nikkhah *et al*. (2002) investigate the effect of different levels of clinoptilolite (CL; natural zeolit) at 0, 2, 4 and 6% CP to basal diet for lambs on dry matter intake (DMI) and feed conversion ratio (FCR). The results showed that feed conversion ratio significantly ($p<0.05$) improved by using CL and average DMI was not affected by dietary treatments.

Kang *et al*. (2002) studied the effect of supplementation of clay minerals (ittite, kaolinite and bentonite) at 2 and 5% as feed additives for Hanwoo steers. The results showed that concentrates and TDN intakes per kg gains were not significantly affected.

Thilsing-Hansen *et al*. (2002) reported that addition of sodium aluminium silicate (zeolite A) to pregnant cows in the last two weeks of pregnancy decreased feed intake among zeolite addition.

Abbas (2003) reported that feed intake decreased with addition of natural clay to lambs fed high concentrate ration ad libitum.

Bulido and Fehring (2004) reported that the inclusion of 0, 3 or 5% zeolite on dry matter basis to calves diet mixed with commercial calf starter and grass silage on feed intake and feed conversion efficiency. Dry matter intake, was not differed among treatments and feed conversion efficiency (kg DM intake / live weight gain) was similar among treatments.

Grabherr et al. (2009) showed that feeding of 23 g zeolite A/kg DM prepartum proved to be an adequate dosage for reducing sub clinical hypocalcaemia frequency without significant effects on feed intake.

Yazdani et al. (2009) found that daily dry matter intake was not significantly affected, when crossbred steers (average body weight 250 kg) were fed a diet with clinoptilolite substituted at levels 0, 2.5 and 5% of the diet dry matter.

Norouzian *et al*. (2010) showed that dry matter intake and feed conservation ratio were similar between the groups of lambs fed by different diets (without clinoptilolite) and the basal diet plus 1.5% and 3% clinoptilolite, for 6 weeks (3 weeks before and 3 weeks after weaning)).

Spolders et al. (2010) found that supplementation of 250 to 1000 g zeolite A per animal /day resulted in a hypocalcaemia incidence of only 0 to 22% in comparison with 72% in un supplemented control group. In addition to the zeolite A dose the zeolite A/calcium ratio has a significant impact on the success of this prevention method. High zeolite A doses of 500 to 1000 g per animal / day significantly reduced feed intake, which was associated with other side effects (reduced energy intake, hypophosphataemia), consequently a zeolite A dose of 200 to 300 g per animal /day in combination with zeolite A/calcium ratio of 6:1 to 10:1 could be recommended for practice to expect a significant preventing effect in combination with only a marginal decrease of feed intake.

2.2. Digestibility and nutritive value:

Britton *et al*. (1978) and Saleh *et al*. (1999) showed that the digestibility of dry matter insignificantly ($p<0.05$) increased when bentonite was added up to 8% of the ration fed to sheep, while supplementation of bentonite significantly ($p<0.05$) increased organic matter, crude protein and ether extract digestibility.

El-Hakim *et al*. (1994) and Saleh *et al*. (1999) reported that total digestible nutrients (TDN) and digestible crude protein (DCP) significantly ($p<0.05$) increased by addition of bentonite at levels 2.5 to 10% of the concentrate ration. The same authors reported that the improving in TDN and DCP which may be due to the increasing of digestibility coefficients of the most nutrients when bentonite was added to the rations.

Pulatov *et al*. (1983) reported that addition of bentonite to diets of calves at levels 1 or 3% of dry matter increases reactive surface areas of nutrients by promoting the action of digestive enzymes and area of contact with mucous membrane of the digestive tract.

The TDN, SE and DCP were improved with clay addition and retained N was significantly ($p<0.05$) higher with tafla and kaolin rations than control **Abd El-Baki *et al*. (1988).**

Murzin, and Peshkova (1989) showed that the addition of zeolite to rations of Black Pied steers 14 months old for 120 days on a diet (hay 4.5, silage 16, and concentrates 2 kg/day together) with zeolite at 6% of dry matter increased digestibility of organic matter by 3.9, protein 7.7, fat 13.9 and nitrogen-free extract 12.3% than that without zeolite addition.

Nowar et al. (1993) found that feeding Awassi sheep on diets containing 2.5 or 5% tafla clay improved feed efficiency and nitrogen utilization.

In heifer diets, the use of 2% bentonite supplementation increases digestibility coefficients of dry matter, crude protein, crud fiber, ether extract and nitrogen free extract than those fed the same diets without bentonite in high concentrate diets **(Richter *et al*, 1990, kirilov and Burikhonov, 1993).**

Kirilov and Burikhonov (1993) reported that addition of 2% bentonite increased digestibility coefficients of dry matter and crude protein in groups given clay than those fed on the basal diet (hay, haylage, silage, green herbage and concentrate).

Kirilov *et al.* (1995) found that addition of zeolite at 0, 3, 4 and 5% to diets of black heifers increased the digestibility of organic mater, protein, fiber and nitrogen free extract and the retention of nitrogen.

Saleh *et al*, (1999) showed that the digestibility of crude protein and nitrogen free extract significantly increased when bentonite added by 6% to concentrate ration, while using 3% bentonite did not significantly affect comparing with the control which fed to lambs.

Gutireeez *et al*. (1999) investigate the effect of adding 0, 1, 3 or 5% zeolite to star grass ad libitum plus 300g of a commercial concentrate ration as basal diet for sheep, the results showed dry matter, organic matter and nitrogen digestibility values were: 56, 62 and 59; 60, 63 and 60; 60, 61 and 55; 60, 65 and 59% for 0, 1, 3 and 5% zeolite, respectively. There was no relationship between zeolite consumed and faecal excretion of the nutrients with the exception of the acid in soluble ash content.

Salem *et al*., (2001) showed that bentonite supplementation improved ($p<0.05$) OM, CP, CF an EE digestibility and nutritive value (TDN and DCP) when animals fed basal ration (concentrate feed mixture plus berseem hay and rice straw) plus 4% or 8% bentonite compared with the basal ration (control).

Nikkhah *et al*. (2002) found that the supplementation of clinoptlolite (natural zeolite) at 0, 2, 4 and 6% levels to basal diet for lambs were significantly affective digestibility of dry matter, ether extract ($p<0.01$) and crude protein. The 2% clinoptlolite level had highest the dry matter digestibility and ether extract digestibility (65.48 and 65.84%; respectively) while the 4%

clinoptlolite level diet had the highest crude protein digestibility (63.38%). The 6% level had the lowest dry matter digestibility (56.49%) and the control diet had the lowest ether extract and crude protein digestibility (57.90 and 55.63%, respectively).

Mohsen and Tawfik (2002) found that when six month old male Angora goats were offered rations consisted of concentrate mixture (CM) and ad libtium (3%) ureated rice straw plus bentonite which mixed with the (CM) before feeding at the rate of 0, 2.5 and 5%. The obtained result showed that bentonite significantly increased ($p<0.05$) DM, OM and CP digestibility than the unsupplemented ration.

Soliman *et al.* (2003) used five groups of Frisian cows contaminated by aflatoxin with or without bentonite. Results obtained showed that feeding ammoniated concentrate feed mixture supplemented with bentonite increased ($p<0.01$) the digestibility of all nutrients and rations feeding values.

Forouzani *et al*. (2004) studied the effect of inclusion of zeolite (0, 30 and 60 g/kg diet) on digestibility of lambs. The results showed that digestibility coefficients of dry matter and crude protein were significantly ($p<0.05$) increased by zeolite ($p<0.05$) and the diet containing 30g zeolite per kg had higher neutral-detergent fiber digestibility compared with the control ($p<0.05$) one.

Digestibility of dry matter, organic matter, crude protein, cellulose; fat and nitrogen-free extract improved by addition of bentonite as mineral-vitamin premix to the rations of dairy cows. (**Mikolaichik and Morozova 2009).**

From the other side, **Aitchison et al. (1986)** reported that inclusion of bentonite at 4% to pelleted diets resulted in a significant reduction in organic matter digestibility and in dietary N when sheep were changed gradually from a chaff diet to a high grain pelleted diet.

Johnson *et al*. (1988) retorted that Holstein cows fed 2% zeolite showed lower dry matter, organic matter and crude protein digestibility than the control.

Ivan *et al*. (2001) concluded that supplementation of palm kernel cake based diets with 2% bentonite had no appreciable effect on digestibility in sheep.

Madhu-mohini *et al*. (2001) reported that addition of bentonite at 0 (control), 3% (II) and 6% (III) to concentrate mixture of rumen fistulated adult male cattle on nutrient utilization, the results showed crude protein digestibility significantly ($p<0.05$) increased in group III and the opposite was observed for crude fiber digestibility.

Grabherr et al. (2009) found that addition of zeolite to the ration over a period of three weeks at 0, 10 and 20 g/kg dry matter of cows, the results showed that zeolite supplementation led to a significantly($p<0.05$) reduce ruminal dry matter digestibility and fermentation of organic matter**.**

Ghaemnia et al. (2010) studied the effect of different levels of zeolite at 0, 3, 6 and 9% levels on digestibility of lambs. Digestibility of dry matter was lowered with addition of zeolite ($p<0.05$) and digestibility of CP and NDF were increased by inclusion of 6% zeolite. This difference was significant ($p<0.05$) but digestibility of ADF was not significantly affected ($p>0.05$).

2.3. Rumen parameters:

2.3.1. Ammonia -N

Bazanora *et al*. (1982) and Galindo *et al*. (1992).observed a sharp fall in ammonia concentration in weathers rumen given zeolite with their rations.

Bartos *et al*. (1982) found that NH_3-N concentration lower with bentonite groups may be due to the ability of bentonite to adsorb ammonia from rumen fluid when the concentration is high and release it back when the concentration is falls.

McCollum and Galyean (1983) reported that addition of clinoptilolite at 5% in the diet of beef steers decrease ammonia concentration at 3, 6 and 9 hours post feeding.

Patterson *et al*. (1985) found that ammonia concentration decrease linear with the increase in zeolite levels at 0, 100, 200 and 300g per day in the rumen of steers.

Abd El-Baki *et al*. (1988) found that ruminal NH_3-N concentration was significantly($p<0.05$) decreased at 1 and 2 hours after feeding on rations supplemented with kaolin, bentonite or tafla clays, but it was insignificantly decreased at 3 hours when compared with control ration (urea ration).

Fenn and Leng (1989) reported that bentonite added at 5 or 6.5% in sheep diet may be able to modify the concentration of ammonia and other substrates in the rumen by adsorbing and releasing them as concentrations changes.

Wallace and Newbold (1991); Ehrlich and Davison (1997) and Saleh *et al* (1999) showed that the addition of bentonite at different levels to ruminant diets led to decrease of ruminal NH_3-N concentration compared with diets without bentonite.

Similarly, **Wallace and Newbold (1991)** estimated the decrease in ammonia concentration in the rumen by 28.7% with addition of bentonite at 10% of the diet than in the control diet.

Abd El-Baki *et al.* (1992) showed that ruminal NH_3-N concentration was decreased at 1, 2 and 3 hours post-feeding as a results of tafla clay supplementation to the untreated ration, but at 4, 5 and 6 hours post feeding it was higher than control.

Baldi *et al.* (1994) reported that addition of bentonite at 2.9% on DM basis to dry cows with rumen cannulae when fed on a total mixed ration containing 20% maize silage, 80% meadow hay and urea 50 g for 56 days. Bentonite slightly decreased rumen ammonia-nitrogen and total volatile fatty acid concentrations, and significantly increased molar proportion of butyrate. The post-feeding ammonia-N peak was reduced by bentonite.

Hassona *et al*. (1995) added 3% from each of tafla, bentonite or kaolin to rations contained sulphuric acid 2.5% and urea 3% treated rice straw fed to growing lambs and goats. They found that sulphuric acid and clays addition has the ability to act as reservoir and regulator of rumen NH_3-N of the experimental animals during 6 hours post feeding.

Forouzani *et al*. (2004) showed that the addition of zeolite at 0, 30 and 60g/kg diet for male lambs led to lower ruminal ammonia concentration for all treatments (4 to 8 mg/dl) before feeding. At 4 hours after feeding the control diet had the lowest ruminal ammonia concentration (5.5mg/dl) which was significantly lower than the values for zeolite diets (35 to 39 mg/dl).

Addition of clinoptilolite at 2% to diet containing urea not only decrease ruminal ammonia nitrogen and plasma urea nitrogen concentrations, but also had partial positive effect on feedlot performance and carcass characteristics of Holstein calves **(Sadeghi *et al*. 2005)**.

On the other hand, **Moate *et al.* (1985)** found that adding bentonies to cow rations had no effect on rumen ammonia concentration. Also, **Johnson *et al*. (1988)** found similar results with cows fed 2% zeolite.

Lemser *et al*. (1992) reported that ammonia in rumen fluid was not affected for goat fed on rye-based diets alone or with 0.5, 1.5, 3 and 5% bentonite or zeolite and 2% of a humic acid preparation (Kalumat) in starter only or 3 and 2% in starter and finisher diets, respectively.

2.3.2. pH value

The pH values of the rumen liquor in animals fed clays showed variable results.

Fisher and mackay (1983) and Jacques *et al*. (1986) showed that adding sodium bentonite to cows and steers did not affected ruminal pH.

Moate *et al.* (1985) and Saleh *et al.* (1999) reported that rumen pH should similar average values in groups of diet with or without 3 or 6% bentonite supplementation.

Abd El-Baki *et al.* (1988) found that ruminal pH values did not significantly differed at 1, 2 and 3 hours after feeding among urea-kaolin, urea tafla and control rations.

Bosi *et al.* (2002) found that addition of clinoptilolite at 200 g/day to dairy cattle diets to reduce the transfer of mycotoxins in milk did not change pH, ammonia content and VFA molar percentages in the rumen.

Grabherr et al. (2009) stated that ruminal pH values were not affected when zeolite was added to different rations over a period of three weeks at 0, 10 and 20 g/kg dry matter (DM) in the rumino-intestinal-tract of cows.

On the other hand, **Altinats *et al.* (1984)** found that rumen pH values of lambs fed rations with 3% urea without zeolite was significantly less than that of lambs fed 3% urea with 2.5, 5 or 7.5% zeolite.

Pond and Yen (1985) stated that ruminal pH value values were higher in animal fed 1% urea only than those fed 1% urea plus 2% clinoptilolite.

Aitchison *et al.* (1986) reported that additions of bentonite had significantly higher ruminal pH values in sheep.

Johnson *et al.* (1988) found that rumen pH increased when 2% zeolite was added to Holstein cows' ration.

Using of a mineral salt mixture based on bentonite, zeolite, magnesium oxide and sodium bicarbonate stabilizes and maintains the pH of ruminal fluid at physiological values (6.79-6.92) and prevents the occurrence of rumen acidosis for dairy cows, in early lactation when highly concentrated feeds are used in nutrition (**Samanc *et al*. 2006)**.

2.3.3. Total volatile fatty acids (TV FA' s)

McCollum and Galyean (1983) found that the clinoptilolite supplementation tended to produce high levels of TVFA's.

Abd El-Baki *et al*. (1988) found that the TVFA's concentration in the rumen liquor of sheep increased by feeding clay supplemented rations than those fed unsupplemented ration. On the other hand, **Murray *et al*. (1992)** reported that the total volatile fatty acid concentration decreased by dietary supplementation with natural zeolite.

Walz *et al*. (1998) studied the effect of replacing soy been meal protein with fish meal protein in Suffolk lambs diets, with or without 0.75% sodium bentonite on rumen parameters. The results showed that total volatile fatty acids were increased when animals fed fish meal and sodium bentonite than the other one.

Salem et al. (2000) found that addition of bentonite at 12 g dolomite and bentonite head/day, to rations of growing sheep improved ($P<0.05$) total volatile fatty acids in the rumen.

On the other hand, the TV FA's was not affected with addition of bentonite to the rations of steers **Jacguies *et al*. (1986),** or zeolite to cows rations **Johnson *et al*, (1988).**

Madbu-Mohini *et al*. (2001) found that addition of bentonite at 0(group I), 3% (group II) and 6% (group III) of diet for cattle, the results showed that total volatile fatty acid (TV FA's) concentration decreased in group II and III, with a significant decrease ($p<0.05$) in acetate and an insignificant increase in propionate and butyrate proportion. The rate of TVFAs' production did not vary significantly among the three groups.

The molar proportion of acetate in the rumen increased, propionate as well as valerate significantly decreased and the concentration of the total fatty acids were not affected when zeolite A was added to the ration over a period of three weeks at 0, 10 and 20 g/kg dry matter in the rumino-intestinal-tract of cows (**Grabherr et al. 2009**).

2.3.4. Microbial protein

Fenn and Leng (1990) used sheep offered a mainly roughage diet to examine the effect of supplementation of bentonite on the rumen activity. They found that the supplementation with bentonite 30, 50 or 60g/day consistently increased the density of rumen protozoa. It is suggested that this allows greater flow of protozoa protein from the rumen to the intestines, leading to increased wool growth in response to supplements of bentonite.

Abd El-Baki *et al*. (1988) and **Abd El-Baki *et al*. (1992)** reported that feeding tafla clays with urea in rams or lambs rations increased microbial protein comparable to those received only urea ration.

Galind *et al*. (1992) studied the inclusion of zeolite at 0.5 or 1% to diets of Holstein cows which offered ad libitum silage, concentrate 4kg and star grass grazing for 4 hours. Rumen fluid was sampled 0, 2, 4, 6 and 20h after feed intake. The results showed that there was no significant interaction between treatments and sampling hours for the different physiological groups of bacteria, except aminolytic. Inclusion of zeolite increased rumen cellulolytic bacteria and decreased lactic acid bacteria to one-third of control and zealite decreased total viable amylolytic bacteria and its effect was greater with 1 than that at 0.5%.

Wallace and Newbold (1991) found that the addition of bentonite at 10% of the diet was accompanied with reduction in protozoal numbers and an increase in bacterial numbers. The same authors concluded that the net protein yield resulting from rumen fermentation might be expected to increase in animal treated with bentonite.

Abdullah *et al*. (1995) found that addition of 2% bentonite to sheep fed palm kernel cake showed appositive effect on protozoal numbers in rumen fluid.

Madhu-Mohini *et al*. (2001) studied the effect of feeding wheat straw and concentrate mixture containing 0, 3 and 6% bentonite on microbial protein of adult male cattle. The results indicated that bacterial production rate was significantly ($p<0.05$) higher in groups 3% and 6% bentonite, which enhance the efficiency of bacterial yields per unit of energy. While protozoal production rate did not differ between groups, their number was higher in the liquid portion.

Varadyova *et al. (*2003) determined the effect of addition of silicate minerals, zeolite, bentonite, kaolin, granite on the rumen fermentation parameters, total gas, methane, total and individual volatile fatty acids and hydrogen recovery in rumen fluid inoculums from sheep. They concluded that the silicate minerals had no appreciable effect on the methane production; however, they support the microbial metabolism by influencing (bentonite, granite) and slightly influencing (zeolite, kaolin) the rumen fermentation.

Ella (2007) concluded that supplementation of yeast and/or bentonite to the diets of lactating ewes increased total dry matter intake, milk yield, and its quality as well as, rumen activity, N-balance, nutrients digestibilities, feeding values, some blood parameters and weight gain of offspring.

2.4. Mineral retention

Anke *et al. (*1992) studied the addition of 3% bentonite to semi purified diet without or with cadmium 5 mg/kg DM alone or with bentonite which fed to growing male and lactating female goats. The results showed that goats fed ration with bentonite significantly decreased calcium, phosphorus and sodium content in organs, bone, tissue and milk, while magnesium and potassium were not affected.

In growing and lactating goats given a feed with no cadmium (Cd) or with 5 mg/kg alone or with 2% fenamin (alkalized montmorillonite-rich bentonite), Cd intake increased in tissues (in kidneys by 257%). Fenamin reduced the amount of Cd incorporated into edible tissues by about one-third and also reduced the incorporation of calcium, phosphorus, sodium and copper into tissues. There was no effect on magnesium, potassium, zinc, manganese and lithium in tissues (**Kramer *et al.* 1992).**

Zeolite addition at 0, 3, 4 or 5% to concentrate feed mixture fed to heifers increased the retention of calcium and phosphorus; and had a favorable influence on blood biochemical composition **(Kirilov *et al. (*1995).**

Determine the effects of sodium zeolite (SZA) at 0.05% body weight SZA added to their milk replacer, on mineral metabolism and tissue mineral composition in calves. Aluminum retention was increased by addition of sodium zeolite. Also, silicon concentrations were increased in the aorta, spleen, lung, muscle, and kidney, however, aluminum was increased in all tissues ($p < 0.05$). Calcium concentrations were increased in aorta, liver and muscle; phosphorus concentrations were increased in aorta, but decreased in plasma; magnesium concentrations were increased in aorta, heart, kidney, liver, and pancreas, but decreased in plasma; and iron concentrations were decreased in kidney and liver ($p<0.05$). The accumulation of tissue aluminum and therefore potential adverse consequences may preclude any benefits of using SZA as a dietary supplement **(Turner *et al.* 2008)**.

On the other hand, nutrient and mineral digestibility and retention were not different among treatments by mineral source when lactating goats, was fed a hay and concentrate diet alone or supplemented with kaolin (bolus alba) 0.25 g, or Nutrimin (natural mineral mix of volcanic origin) 25 or 100 g/kg body weight; all diets were equal in energy, protein and minerals **(Kessler and Sigrist 1995)**.

Gutierrez *et al. (*1999) found that inclusion of up to 5% zeolite to sheep received stargrass ad libitum and 300 g of a commercial concentrate as a basal diet, does not increase fecal nitrogen and mineral excretion, in spite of the cationic exchange capacity of this mineral.

2.5. Growth performance and feed conversion

Body gain weight was increased with approximately 18% in young bulls **(Karadzhyan *et al*. 1987)** when diets supplemented with zeolite.

Nowar *et al*. (1993) found that Awassi sheep fed 5% clay significant increased ($p<0.05$) the absolute weights of the carcass and slight increase in percentage of carcass but not reach significance.

Kuznetsov *et al*. (1993) found that male cattle 1 to 6 months old, given a diet with 1.5 to 2% zeolite, gained 8% more body weight than did control.

Walz *et al.*, (1998) studied the effect of replacing soybean meal (SBM) protein with fish meal (FM) protein in diets adequate and slightly deficient in CP, with or without 0.75% sodium bentonite (NaB) on performance of Suffolk lambs. The average daily gain (ADG) was increased ($P<0.05$) by fish meal and sodium bentonite supplementation.

Cho *et al*. (2001) studied the effect of dietary supplements of clay mineral on the growth performance of steers. The animals were randomly allotted into 4 treatments according to the dietary supplements of clay minerals (basal diet, basal diet + 5% illite, bentonite and kaolinite). The results showed that average daily gain throughout the experimental period of 4 to 9 months of age were higher for illite (0.70 kg) and bentonite (0.69 kg) groups than for kaohinite (0.67 kg) and control group (0.65 kg), however, no statistical significance was found.

Salem *et al.* (2001) showed that average daily gain of lambs was 128.3, 185.7 and 153 g /head /day for T_1, T_2 and T_3 respectively. Tested rations were; control (T_1) consisted of a concentrate feed mixture plus berseem hay and rice
Straw, (T_2) consisted of T_1+4%bentonite (of concentrate); (T_3) consisted of T_1+8% bentonite (of concentrate).

Nikkhah *et al*. (2002) reported that supplement of different levels of natural zeolite (clinoptilolite CL) at 0, 2, 4 and 6% CL on dry matter for lambs which fed total mixed rations individually and ad libitum. The results showed that average daily gains (ADG), feed conversion ratio (FCR) were significantly improved by using clinoptilolite. The lambs which received the 4% CL diet had the highest ADG (196.92g) and the best FCR (7.07), while those, which received control diet had the lowest ADG (166. 91g), and the worst FCR (8.03).

Mohsen and Tawfik (2002) showed that the addition of the bentonite at 0, 2.5 and 5% to the rations consisted of concentrate mixture (CM) and urea (3%) treated rice straw on growth performance of Angora goats, caused a significant ($p<0.05$) improvement in feed conversion efficiency. The nutritive value (%) expressed as TDN showed an increase with bentonite addition in comparison to the control group.

The inclusion of 3% zeolite in the diet of dairy calves did not increase the dry matter and food conversion efficiency, but improved the live weight gain after 30 days of the trial (**Pulido and Fehring 2004).**

El-Tahan ***et al. (*****2005)** studied the effect of adding 2% and 4% tafla clay on performance of growing calves fed rations containing 60% of nutritional requirements from concentrate feed mixture (CFM) and maize silage ad lib. They found that feeding rations containing maize silage with 2 or 4% tafla improved daily body gain better than the un supplemented one.

Saleh et al. (2005) found that addition of natural zeolite (Z) at 1.5% zeolite with 1.0% urea (U), 3.5% zeolite with 1.0% urea and 5.5% zeolite with 1.0% urea on the average daily gain (ADG), dry matter intake (DMI), feed conversion ratio (FCR) and carcass characteristics in Varamini lambs. The results showed that ADG and FCR were improved by zeolite and urea addition. The lambs that received the 3.5% Z with 1.0% U had the highest ADG (168.63 g) and best FCR (7.74), whereas the control lambs had the lowest ADG (152.53 g) and FCR (8.16). The average DMI and carcass weight were unaffected by the dietary treatments, although they tended to increase by addition of zeolite.

Total dry matter intake and weight gain of lactating ewes increased by addition of bentonite to the diets **(Ella 2007)**.

Uskov and Matasov (2007) studied the effect of urea and bentonite applications during maize silage preparation. The most effective dosage of mineral mixture for improving maize silage quality was 6 kg of urea and 10 kg of bentonite per 1 tonne of maize green mass. Crude protein content of improved silage increased by 40.8% compared to control, while digestible protein content increased by 70%. Daily weight gain of sheep which were fed maize silage was increased by 7.62% compared to the control.

Feeding steers (average body weight 250 kg) on diets with clinoptilolite, substituted at 0 be regarded as control (T_1), 2.5% as (T_2) and 5% as (T_3) of the diet dry matter. The results showed that average daily gain of steers in T_3 diets were highest ($P<0.05$) compare to control groups and T_2 diets **(Yazdani *et al*. 2009)**.

Norouzian *et al*. (2010) studied the effects of feeding clinoptilolite on hematology, performance, and health of newborn Balouchi lambs. The newborn lambs were allocated to three groups and fed basal diet (C0; without clinoptilolite) and C_1 and C_2 (the basal diet plus 1.5% and 3% clinoptilolite, respectively, for 6 weeks (3 weeks before and 3 weeks after weaning)). Dry matter intake and feed conservation ratio were similar between the groups of lambs fed the different diets, but daily gain of lambs differed significantly ($P<0.05$) and was higher in C_2.

On the other hand, **Abd El-Baki and Nowar (1981)** reported that replacing 5% of concentrate mixture by dietary soil, insignificantly increased average daily gain and feed efficiency of growing sheep

Murray *et al.*, (1994) used two different sources of clays as feed additives in sheep rations. They found that none of the clays had any significant effect on live weight change.

2.6. Blood profile:

2.6. 1. Concentration of mineral:

Fisher and Mackay (1983) found plasma calcium and phosphorus have not been influenced by adding 0.6 or 1.2% bentonite to silage ration of lactating cows.

Moate *et al*. (1985) found no effect on plasma calcium and magnesium concentrations by adding sodium bentonite at 600g per day for cows.

Nowar *et al*. (1993) reported that Awassi sheep fed 5% clay showed no clear changes in each of Ca^{++}, Na^{+}, K^{+} and $P04^{---}$

Bosi *et al*. (2002) found that addition of clinoptilolite at 200 g/day to the diet of lactating dairy cows did not effect on mineral contents of blood plasma (Na, K, Zn, and Ca).

Using of clinoptilolite at 6% and sodium bicarbonate at 1% in ration of dairy cows did not significantly affect the plasma Ca, P, Mg, Cl, Na and K (**Nikkhah *et al*. 2003).**

Katosulos *et al*. (2006) determine the effect of clinoptilolite supplementation in the ration of dairy cows at 1.25% (group A), 2.5% (group B) and group C as control on serum copper (Cu), zinc (Zn) and iron (Fe) concentrations. The results showed that the 1.25 and 2.5% supplementation of clinoptilolite in the ration did not significantly influence the serum Cu, Zn and Fe concentration of dairy cows. The Cu, Zn and Fe concentration were within the normal ranges.

Grabherr *et al.* (2009) studied the influence of zeolite A, on feed intake, macro and trace element metabolism in dairy cows. They were fed a total mixed ration (TMR) ad libitum 2 weeks before calving. Additionally the cows in group B received 90 g zeolite A/kg dry matter (DM). The zeolite addition into the TMR showed a stabilizing effect on the average calcium concentration in the serum around calving. This effect led to a significantly lower magnesium concentration on the day of calving and 1 day post partum. The phosphorus concentration was significantly ($P<0.05$) lower already after the 1st week of zeolite supplementation and on the day of calving as compared to group A. There was no essential effect of zeolite A on the trace element concentration. Because decreased feed intake of group B after zeolite supplementation and the occurred hypophosphatemia, it is not acceptable to use zeolite A in the proved dose for preventing milk fever.

On the other hand, **Tret *et al.* (1985)** showed that in cows given zeolite at 1g/kg body weight daily there were increases in blood calcium and phosphorus.

Moate *et al.* (1985) showed a marked decrease in apparent absorption of calcium and magnesium in sheep given 4 kg pasture (fresh weight) daily with 60 g sodium bentonite (Na B), it is suggested that it may be necessary to add calcium and magnesium to diets containing Na B.

Dembinski *et al*. (1985[a]) found that the concentration of calcium, magnesium, inorganic phosphorus and zinc in serum was lower than in control by adding 2% bentonite to dairy cattle ration in the first and second months of lactation.

Dembinski *et al*. (1985[b]) found that supplementation of bentonite at 2000 mg/kg body weight for hybrid goats decreased calcium deposition in bones compared with control. Bentonite-treated goats had lower concentration of mg in serum and liver. Metabolism of phosphorus, sodium and potassium was not affected.

Roussel *et al*. (1992) showed that the addition of sodium zeolite-A at 0, 0.5, 1.0 and 1.5% comprising a grain mixture (50: 50 grain: forage) for Holstein cows significantly (P<0.01) increased calcium in milk and serum with 1% and 1.5% addition levels.

Using of zeolites at 0.4, 1.0, 2.5 and 6.25 by weight to dairy slurry offers reduced soluble phosphorous by over half, but the mechanism of this reduction is unclear (**Lefcourt and meisinger 2001).**

Thilsing-Hansen *et al*. (2002) showed that addition of 1.4 kg of sodium aluminum silicate (zeolite A) per day (0.7 kg of pure zeolite A) for cow at the last 2 wk of pregnancy significantly (p <0.05) increased the plasma calcium level on the day of calving, whereas plasma magnesium as well as inorganic phosphate was suppressed.

Thirty calves were divided equally into three groups (control, test 1, and test 2). For group test 1, clinoptilolite in the concentration of 2% of each colostrum meal was added for 48 h, and for group test 2, clinoptilolite in the concentration of 2% was added to each colostrum and milk meal for 14 days. Clinoptilolite supplementation had significant effect on the concentrations of calcium, phosphorus, sodium, and iron. The concentrations of Fe significantly higher in test group 2 than other groups ($p < 0.05$). Calcium (Ca) concentrations were significantly ($p<0.05$) higher in serum of clinoptilolite-treated than control calves ($p<0.05$). The concentrations of phosphorus were significantly lower in test groups than control group ($P<0.05$). Sodium (Na) concentrations were significantly higher in clinoptilolite-supplemented groups than control calves ($P<0.05$). Potassium and magnesium concentrations were not affected by clinoptilolite supplementation. Clinoptilolite supplementation could promote iron levels in serum and better hemopoiesis and prevent pathologic or physiologic drop of red blood cell (RBC) parameters in supplemented calves during a first few weeks of life. According to higher need and utilization of Ca in growing animals, clinoptilolite supplementation could increase available Ca. Based on the results of the present study and the importance of dietary phosphorus in many physiologic processes, the level of phosphorus in diet of neonatal dairy calves must be considered and adapted when clinoptilolite was supplemented. With an adequate supply of good quality drinking water, cattle can tolerate large quantities of dietary sodium chloride. Thus, it seems that significant increase in serum Na concentration during short-term supplementation of clinoptilolite in neonatal calves could be well tolerated without any adverse effects **(Mohri *et al*. 2008).**

Grabherr *et al*. (2009) studied the influence of different zeolite A doses on mineral metabolism, and to evaluate an optimum dosage for preventing hypocalcaemia. Eighty pregnant dry cows were assigned to four groups (I-IV). They were fed a total mixed ration (TMR) ad libitum. Groups II, III and IV received an average daily dose of 12, 23 and 43 g zeolite A/kg DM for the last 2 weeks prepartum. Zeolite supplementation in higher doses (III and IV) had a stabilizing effect on calcium metabolism around calving for older cows, whereas cows in Groups I and II showed a subclinical hypocalcaemia. The mean serum magnesium concentration decreased significantly in older cows in Group IV at calving. The mean phosphorus concentration in cows of Group IV decreased into ranges of hypophosphataemia already 1 week after beginning of zeolite feeding. Feeding of 23 g zeolite A/kg DM TMR prepartum proved to be an adequate dosage for reducing sub clinical hypocalcaemia frequency without significant effects on feed intake and phosphorus concentration in serum.

2.6.2. Other parameters:

Abd El-Baki *et al*. (1988) found that blood serum glucose was significantly increased with kaolin and tafla 3% and 3% urea containing rations, while AST and ALT activity insignificantly decreased.

Schwarz and Werner (1990) noticed that female hybrid goats receiving sodium bentonite at 2g/kg body weight, in the diets showed decreased alkaline phosphates activity.

Abdelmawla *et al*. (1998) found that females goats fed daily basal diet alone (control) or with sodium bentonite 6 or 12 g/head daily during 6 weeks of late pregnancy and 6 weeks after parturition showed exhibited higher ($P<0.01$ or 0.05) levels of serum glucose, total protein, transaminase enzymes (AST and ALT) and lower level of serum alkaline phosphates compared to the control goats.

Saleh *et al*. (1999) studied the inclusion of bentonite at 3 and 6% of concentrate to lactating buffalo. The blood data showed that plasma protein, glucose, AST and ALT significantly ($P>0.05$) increased with bentonite. On the contrary urea concentration and alkaline phosphatase significantly ($P>0.05$) decreased compared with the control.

Salem *et al*., (2001) studied the effect of bentonite supplementation on some blood physiological parameters and performance of growing lambs. The experimental rations were control ration (T_1) consisted of a concentrate feed mixture plus berseem hay and rice straw, (T_2) 2nd and (T_3) 3rd contained the control ration plus 4 or 8 % (of concentrate) respectively. Blood constituents data showed that urea nitrogen, albumin, and GOT concentration significantly ($p<0.05$) decreased by the dietary supplementation of bentonite .On the contrary, globulin concentration in both of T_2 and T_3 (4 & 8 bentonite) was increased ($p<0.05$) at 2 hr. post treatment compared with the control (T_1).

Abd El-Baki *et al.*, (2001) studied the effect of clays on animal nutrition and some physiological blood parameters. Lambs were given four pelleted complete feed formulated with 2% urea, 2% urea + 3% tafla, 2.5% urea plus 3% tafla and the control feed without urea and tafla. They found that lambs fed urea plus tafla showed higher ($p<0.01$) heamotogoical parameters, blood glucose and lower urea -N, and GPT than urea without tafla.

On the other hand, **Mohesn and Tawfik (2002)** reported that bentonite had no effect on cholesterol, glucose and hemoglobin in the blood serum of Angora goats.

Abbas (2003) fed lambs a high concentrate diet ad libtum for 8 weeks with 3% natural clay. Results showed that serum total protein, albumin and total globulin contractions were not significantly affected by clay supplementation while, serum urea nitrogen concentration was significantly ($p<0.05$) higher in lambs fed clay supplemented diet than control lambs while serum glucose concentration was significantly reduced by clay supplementation.

Rao *et al.* (2004) studied the effect of supplementing bentonite or activated charcoal on certain blood parameters of young goats fed diets with or without aflatoxin B1.The treatment groups were T_1 (Basal ration), T_2 (concentrate mixture supplemented with sodium bentnite at 2 kg per 100 kg), T_3 (concentrate mixture supplemented with activated charcoal at 2 kg per 100 Kg), T_4 (T_1+ aflatoxin B1 at 300 ppb),T_5 (T_2+

aflatoxin B1 at 300ppb), T_6 (T_3+AFB1 at 300ppb).They found that sodium bentonite had a protective effect on serum urea concentration at the end of the experiment, whereas activated charcoal had a protective effect throughout the experiment. Non-significant ($P>0.05$) elevation of serum GOT (units/ml) at one month after the start of experiment in the case of T_4 (81.73 ± 8.81) and T_5 (80.31 ± 12.81) was observed compared to their respective controls.

Holstein cows were fed a concentrate ration supplemented with 1.25 and 5% clinoptilolite. The rations were fed from four weeks before the cows' expected parturition dates until the beginning of the next dry period. Blood samples were collected from each animal at the start of the experiment, on the day of calving and then monthly. Feeding the cows with clinoptilolite for a long period had no apparent adverse effects on their liver function, and did not significantly affect the concentrations of glucose, ketone bodies, blood urea nitrogen and total proteins **(Katsoulos, et al., 2006)**.

Ghaemnia *et al*. (2010) studied the effect of different levels of zeolite (3, 6 and 9%) on some blood parameters of Arabic lambs. The plasma glucose concentration was not significantly affected by treatment but tended to be lower with added zeolite. Conversely, the dietary inclusion of zeolite lowered plasma urea-N concentration ($p<0.05$).

3. MATERIALS AND METHODS

This study was carried out at the experimental farm of Animal nutrition Research unit, Biological Applications Department, Nuclear Research center, Egyptian Atomic Energy Authority.

The study included two experiments; the first experiment was designed to study the effect of dietary supplementation of tafla and bentofarm as two natural clays available in Sharkia and Alexadria Governorate respectively on feed intake, water intake, digestibility, nutritive values, some rumen parameters, nitrogen balance, some minerals balance and some blood parameters.

The second one was carried out to evaluate the effect of dietary supplementation of tafle and bentofarm on the growth performance and some blood composition of lambs after weaning.

Tafla obtained from Bilbis and bentofarm obtained form new Borg El-Arab city 2nd industrial zone. The chemical analysis of bentofarm as analyzed by Egypt Nano-Technlogies Company Laboratries and tafla quoted from (**Abd EL-Baki et al., 1988)** are presented in Table (1).

Table (1): Chemical composition of tafla and bentofarm (on DM basis).

Item	Tafla %	Bentofarm %
SiO_2	50.05	56.6
AlO_3	20.26	24.70
FeO_3	4.74	8.30
CaO	2.02	2.67
MgO	1.95	3.25
Na_2O	2.19	2.15
K_2O	1.05	0.60
others	17.74	1.73

1-The first experiment:

Nine digestibility trials were conducted to evaluate the effect of treatments on nutrient digestibility. Twenty seven Rahmani mature rams, averaged 45kg live body weight were divided randomly to three main groups each main group subdivided into three treatments (three animals each). Main first group fed 100% bereseam (basal diet) and served as control (T_1) the other two subgroups fed the basal diet plus 3% tafla (T_2) or 3% bentofarm (T_3).The second main group fed 50% berseam and 50% concentrate feed mixture (basal diet) served as control group (T_4). The other two subgroups fed the control diets plus3% tafla (T_5) or 3% bentofarm (T_6).The third main group fed 100% concentrate feed mixture and rice strew (basal diet) served as control (T_7). The other subgroups fed the basal diet plus 3% tafla (T_8) or 3% bentofarm (T_9). The experimental diets were formulated to cover the maintenance requirements of adult rams according to **NRC, 1985** allowances. The chemical composition of ingredient and tested diets are presented in Tables (2).

The experimental rations of the first experiment were:

First main group:

T_1- 100% berseem

T_2-100% berseem with 3% tafla

T_3-100% berseem with 3% bentofarm.

Second main group:

T_4- 50% concentrate feed mixture + 50% berseem.

T_5- 50% concentrate + 50% berseem with 3% tafla.

T_6- 50% concentrate + 50%, berseem with 3% bentofarm

Third main group:

T_7-100% concentrates feed mixture (CFM) plus rice straw (RS).

T8-100% CFM + RS with 3% tafla

T_9-100% CFM + RS with 3% bentofarm

All animals were fed 3% dry matter (DM) of body weight, while tafla and bentofarm were added at 3% daily from dry matter intake. The animals in first main group (T_2 & T_3 100% berseem) gaven tafla and bentofarm by oral drenching, while, the other tested main groups (T_5, T_6, T_8 and T_9), tafla and bentofarm were mixed with rations. The daily amount of feeds was offered in two portions at 9 a.m and 3 p.m. The animals allowed free access to water; the digestibility trials lasted 28 days, 21days as preliminary period, followed by 7 days as collection period.

Daily feed intake and collected feces and urine for each animal were recorded once daily before the morning meal.

A daily sample representing 10% by weight of the total daily feces of each animal was dried in oven for approximately 24h, at 65C°. Dried fecal samples were ground in a hammer mill through a 1mm diameter screen and representative samples of feed were taken and ground for later analysis. Urine was collected in containers to which 1000 ml of 10% H_2SO_4 had been added to prevent any nitrogen losses. Urine volume was measured daily and a 10% aliquot combined and stored for nitrogen determination by the Kjeldhl method **(Concon and Soltess**, **1973)** by using an automatic electric buch 350.

1.1. Rumen parameters:

At the end of each digestibility trial, samples of rumen liquor were collected through rubber stomach tube, viaoesphage from each animal before feeding and 3hrs after feeding for determination rumen pH, ammonia-N, total volatile fatty acids (TVFA's) and microbial protein. The pH values were measured immediately after the collection and filtration of the rumen liquor through double layer of cheese cloth and before adding any preservatives, using a pH-meter (Digital pH-meter CD-64 with glass electrode). Ruminal ammonia- N (NH_3-N) was determined using the method of **Conway (1957)**. The total volatile fatty acids (TVFA's) concentration were determined by

Warner (1964). Microbial protein was measured by sodium tungsten according to **Shultz** and **Shultz (1970)**.

1.2. Blood Parameters:

Blood samples were collected at the end of digestibility trials. The samples were withdraw from jugular vein before feeding and at 3hrs post-feeding and serum was separated by centrifugation of blood at 3000 rpm x 10 min. Serum samples were kept frozen at -20C° for later analysis. Urea, total protein, albumin, creatinine were calorimetrically determined in blood serum samples by using commercial kits according to **Young (2001)**, alanine transaminase (ALT), and aspartate transaminase (AST) according to **Burtis** and **Tietz (1999)**. An alkaline phosphatase was determined using colorimetric method according to **Belfield and coldberg (1971)**. Calcium and phosphorus content in blood serum, urine and feces were determined using colorimetric method according to **Young (2001)** and magnesium according to **Tietz (1983**). Total iron, copper and zinc determined using atomic absorption spectrophotometer according to **Jackson (1958).**

Serum total triiodothyronine (T_3) was determined using Gamma coat ^{125}I-triiodothyronine radioimmunoassay (RIA) kit manufactured by IMMUNOTECH A Coulter Company, France

(Utiger, R. D, 1974). Serum total thyroxin hormone (T_4) was determined according to, **(Robbins, J. 1973).**

Proximate analysis of feeds and feces were carried out according to **A.OA.C. (1996)** methods

2-The second experiment (Growth trial):

Forty eight growing baladi male lambs about 2 months of age and average live body weight 17 kg were divided into six similar groups (eight lambs for each) according to their body weight.

The experimental lambs were fed as follow:

Treatment (1): (control ration): were fed on 50% concentrate feed mixture + 50% berseem.

Treatment (2): were fed on control ration plus 3% tafla.

Treatment (3): were fed on control ration plus 3% bentofarm.

Treatment (4): (control ration): were fed on 100% concentrate + rice straw offered adlibtum.

Treatment (5): were fed control ration plus 3% tafla.

Treatment (6): were fed control ration plus 3% bentofarm.

The chemical composition of the ingredient and tested rations are presented in Tables (2).

The experimental rations used in this study were fed to cover the energy and protein requirements for growing lambs according to **NRC (1985)**. All animals were fed 3% dry matter (DM) of body weight, while tafla and bentofarm were added at

Table (2): Chemical composition of the CFM and the other ingredients.

Items	CFM*	Berseem	Rice straw
Chemical composition (%) on DM basis			
DM	90.2	16.22	92.50
OM	93.69	88.15	81.82
CP	18.55	11.85	3.20
CF	12.22	29.70	41.00
EE	4.81	2.65	1.94
NFE	58.11	41.49	35.68
Ash	6.31	14.31	18.18
Calcium	0.51	0.89	0.36
Phosphorus	0.69	0.30	0.03
Magnesium	0.21	0.20	0.02
Iron	0.032	0.04	0.002
Copper	0.005	0.004	0.0003
Zinc	0.008	0.007	0.006

*CFM: 38.7 % Yellow corn, 30.0 % wheat bran, 22.0 % cotton seed meal, 7.0 % soy bean meal, 1.0% dicalcium phosphate,1.0% common salt, 0.2 % trace mineral ** and 0.1% VT.AD3E ***.

**Composition: Each1kg contains: Cu (3g), Iron (30g), Manganese (40g), Zinc (45g), Iodine (0.3g), Selenium (0.1g) and $CaCO_3$ (881.6g)

***Composition: Each 1kg contains: Vitamin A (20M.I.U.), VT.D3 (2M.I.U.) and VT.E (2gm).

3% daily from dry matter intake. Concentrate feed mixture was offered two times daily at 9.0 am and 3.0 pm. Lambs were weighted every two weeks in the morning before offering any feed or water. The growth experiment lasted 16 weeks. Feed consumption from berseem, CFM and rice straw for each group of lambs was estimated. Water was continuously available for animals at all time.

Blood samples were collected at the end of experimental period, from jugular vein before feeding to determine serum AST, ALT, alkalime phosphatase, total protein, albumin, creatinine, calcium, phosphorus, and magnesium, Iron, copper and zinic according the methods which mentioned before. Glucose determined according to **Tietz (1995).**

3- **Statistical analysis:**

The data were statistically analyzed with **SPSS (1998)** system, according to the following modal:

$$+ D_i + A_j + DA_{jk} + E_{ijk} \mu Y_{ijk} =$$

Where Y_{ik}= an observation, µ = the overall mean, D_i = the fixed effect of the diets, A_j is the fixed effect of the additives (tafla or bentofarm), DA_{jk} is the interaction of diets and additives and E_{ijk} = random error.Significant differences were determined by Duncan's Multiple Range test **(Duncan, 1955).**

4. RESULTS AND DISCUSSION

The effect of tafla (T) or bentofarm (B) inclusion in sheep rations included two experiments.

4.1. The first experiment:

This experiment was carried out to evaluate the effect of tafla (T) or bentofarm (B) addition to sheep rations on.

4.1.1. Feed intake:

The values of daily dry matter intake (DMI) as g/h/d, g/kg BW or g/kg $W^{0.75}$ as affected by tested diets to sheep rations are presented in Table (3).

4.1.1.1. Effect of diet (D):

The results of daily dry matter intake as g/h/d significantly ($p<0.05$) increased when animals fed (D_2) 50% berseem and 50% concentrate or (D_3) 100% concentrate compared to those fed (D_1)100% berseem. The highest values of dry matter intake as g/h/d was obtained with D_3 (1263.98 g/h/d), while the lowest value was recorded with the D_1 (1041.38 g/h/d).Also, the values of dry matter intake (DMI) as g/kg$W^{0.75}$ significantly ($p<0.05$) increased in D_2 and D_3 (70.55 and 67.43 g/kg$W^{0.75}$) compared to D_1 (63.88 g/kg$W^{0.75}$). However, the results of DMI as g/kg BW showed no significant differences among all tested diets.

4.1.1.2. Effect of additives (A):

The results of daily dry matter intake (DMI) as g/h/d slightly improved by supplementation of tafla (A_2) comparable to bentofarm (A_3) and control (A_1) but the differences among treatments not significant . The highest value of DMI as g/h/d was obtained with tafla (1189.63 g/h/d), while the lowest value

Table (3): Effect of tafla or bentofarm addition and its interaction effect on daily dry matter intake by sheep ($\overline{X}$ ±SE).

Items	Daily dry matter intake		
	g/h/d	g/ Kg BW	g/ Kg $W^{0.75}$
Effect of diets (D)	*	NS	*
D_1 (100%B[1])	1041.38^{b}±37.62	25.21±.68	63.88^{b}±1.65
D_2 (50%B * 50 %C[2])	1165.21^{a}±37.62	27.39±.68	70.55^{a}±1.65
D_3 (100%C)	1263.98^{a}±37.62	25.39±.68	67.43^{ab}±1.65
Effect of additives(A)	**N.S**	**N.S**	**N.S**
A_1 (Control)	1183.14±37.62	25.06±.67	65.68± 1.65
A_2 (Tafla)	1189.63±37.62	26.83±.67	69.19±1.65
A_3(Bentofarm)	1097.80±37.62	26.10±.67	66.99±1.65
Interaction effect (D*A)	**N.S**	**N.S**	**N.S**
D_1* A_1	1007.39±65.16	22.77±1.17	58.72±2.85
D_1* A_2	1084.29±65.16	26.03± 1.17	66.12±2.85
D_1* A_3	1032.47±65.16	26.83±1.17	66.80±2.85
D_2* A_1	1253.05±27.76	27.29 ±1.17	71.04±2.85
D_2* A_2	1157.08±65.16	27.02±1.17	69.11±2.85
D_2* A_3	1085.51±65.16	27.87±1.17	71.51±2.85
D_3* A_1	1288.98±65.16	25.14 ±1.17	67.28±2.85
D_3* A_2	1327.53±65.16	27.43±1.17	72.34±2.85
D_3* A_3	1175.44±65.16	23.59 ±1.17	62.68±2.85

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S = not significant.
*= significant at 0.05 level.
B: Berseem
C: Concentrate

was recorded with bentofarm (1097.80 g/h/d). Also, the values of DMI /kg and DMI /kg $W^{0.75}$ showed slightly improvement by supplementations of tafla (A_2) and bentofarm (A_3) compared to the control (A_1) .The mean values of DMI /kg BW being 25.06, 26.83 and 26.10 g/h/d and the mean values of DMI g/kg$W^{0.75}$ 65.68, 69.19 and 66.99 g/kg$W^{0.75}$ for A_1, A_2 and $A_{3,}$ respectively .This result are in agreement with those of **Eltahan *et al.* (2005)** who found that tafla clay improved dry matter intake in growing calve fed rations containing maize silage. Also, **Ghaemnia et al. (2010)** found that intake of dry matter was higher for lambs receiving zeolite. On the other side, **Moate *et al.* (1985**), **Johnson *et al.* (1988**) and **Thilsing-Hansen, et *al.* (2002)** found that feed intake decreased by addition of natural clays. However, **Yazdani *et al.* (2009)** reported that daily dry matter intake was not significantly affected, when steers were fed a diet containing natural zeolite at 0, 2.5 and 5% of the diet dry matter.

4.1.1.3. The interaction effect of diets and additives:

The results of the interaction effect between diets and additives on daily dry matter intake as g/h/d, g/kg BW and g /kg $W^{0.75}$ showed no significant difference among treatments. The highest value of DMI as g/h/d and g/kg $W^{0.75}$ was obtained with D_3*A_2 (Tafla with 100% concentrate) (1327.53 g/h/d and 72.34 g /kg $W^{0.75}$), while the lowest value was recorded with D_1*A_1 (1007.39 g/h/d and 58.72 g /kg $W^{0.75}$).

4.1.2. Water consumption:

The results of water consumption as ml/head, ml / kg$W^{0.75}$ and ml/g dry mater intake are presented in Table (4).

4.1.2.1. Effect of diets (D).

The results of water consumption as ml / head, ml/kg $W^{0.75}$ and ml /g DMI significantly ($P<0.05$) increased with animals fed

Table (4): Effect of tafla or bentofarm addition and its interaction on daily water consumption by sheep ($\bar{x}$ ±SE).

Items	Daily water consumption		
	ml/head/day	**ml / Kg $W^{0.75}$**	**ml/g DMI**
Effect of diets (D)	*	*	*
D_1 (100%B)	5827.10^{a}±242.91	355.47^{a}±16.48	5.54^{a}±.18
D_2 (50%B * 50 %C)	4777.87^{b}±242.91	290.53^{b}±16.48	4.14^{b}±.18
D_3 (100%C)	5478.46^{ab}±242.91	293.06^{b}±16.48	4.35^{b}±.18
Effect of additives (A)	N.S	N.S	N.S
A_1 (Control)	5281.90±242.91	292.63±16.48	4.48±.18
A_2 (Tafla)	5364.34±242.91	314.01±16.48	4.55±.18
A_3(Bentofarm)	5437.19±242.91	332.42±16.48	5.00±.18
Interaction effect (D*A)	N.S	N.S	N.S
D_1* A_1	5618.99±430.73	321.32±28.55	5.41±.32
D_1* A_2	6064.79±430.73	369.74±28.55	5.59±.32
D_1* A_3	5797.53±430.73	375.35±28.55	5.61±.32
D_2* A_1	5070.27±430.73	287.20±28.55	4.05^{b}±.32
D_2* A_2	4696.18±430.73	280.35±28.55	4.05^{b}±.32
D_2* A_3	4567.15±430.73	304.05±28.55	4.32^{b}±.32
D_3* A_1	5156.44±430.73	269.39±28.55	3.99±.32
D_3* A_2	5332.05±430.73	291.95±28.55	4.01±.32
D_3* A_3	5946.89±430.73	317.85±28.55	5.06±.32

a, b and c: Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

D_1 compared with those fed D_2 and D_3. The highest values of water consumption as ml/head, ml/kg $W^{0.75}$ and ml/g DMI were obtained with D_1 (5827.10, 355.47 and 5.54), while the lowest values was recorded with D_2 (4777.87, 290.53 and 4.14) respectively.

4.1.2.2. Effect of additives (A).

The results of daily water consumption as ml/head, ml/kg $W^{0.75}$ and ml/g DMI increased by addition of bentofarm (A_3) but the differences between treatments were not significant. The highest values of daily water consumption as ml/head, ml/kg $W^{0.75}$ and ml/g DMI were obtained with bentofarm (A_3) (5437.19, 332.42 and 5.00), while the lowest values were recorded with control (5281.90, 292.63 and 4.48), respectively. These results are agreed with those reported by **Huntington *et al.* (1977)** who found that addition of powdered betonies at levels 2, 4, 8 or 12% to 20% roughage diet for lambs increased drank water by 12% more ($P<0.05$) than the control.

4.1.2.3. The interaction effect of diets and additives:

The results of the interaction effect between diets and additives on daily water consumption showed no significant differences among treatments. The highest value of water consumption as ml/head, ml/kg $W^{0.75}$ and ml/g DMI were obtained with D_1*A_2 (6064.79, 369.74 and 5.59), while the lowest values were recorded with D_2*A_3, D_3*A_1 and D_3*A_1 (4567.15, 269.39 and3.99), respectively.

4.1.3. Digestibility and nutritive values:

The results of digestibility of nutrients and nutritive values are shown in Table (5).

Table (5): Effect of diets and tafla or bentofarm addition and its interaction on digestibility and nutritive values of the experimental ration ($\overline{X}$ ±SE).

Items	%DM	%OM	%CP	%CF	%EE	%NFE	TDN	SV	DCP
Effect of diets (D)	*	*	*	*	*	*	*	*	*
D_1 (100%B)	63.97^{c}±.51	67.34^{b}±.46	67.36^{b}±0.46	50.11^{a}±.87	44.41^{c}±1.56	81.63^{b}±.59	60.96^{b}±.46	42.75^{c}±.46	9.63^{b}±.11
D_2 (50%B * 50 %C)	69.75^{a}±.51	72.99^{a}±.46	73.66^{a}±0.46	43.28^{b}±.87	78.23^{b}±1.56	83.90^{a}±.59	70.09^{a}±.46	56.41^{b}±.46	12.15^{a}±.11
D_3 (100%C)	67.43^{b}±.51	71.77^{a}±.46	72.14^{a}±0.46	39.11^{c}±.87	92.4^{a}±1.569	79.32^{c}±.59	71.17^{a}±.46	61.01^{a}±.46	11.89^{a}±.11
Effect of additives(A)	*	N.S	N.S	*	N.S	N.S	N.S	N.S	N.S
A_1 (Control)	68.66^{a}±.51	70.84±.46	72.45^{a}±0.46	43.82±.87	70.85±1.56	81.84±.59	67.63±.46	53.74±.46	11.50±.11
A_2 (Tafla)	66.11^{b}±.508	70.78±.46	70.52^{ab}±0.46	44.78±.87	72.55±1.56	81.07±.59	67.72±.46	53.63±.46	11.09±.11
A_3 (Bentofarm)	66.38^{b}±.508	70.39±.46	70.19^{b}±0.46	43.90±.87	71.74±1.56	81.93±.59	66.86±.46	52.80±.46	11.09±.11
Interaction effect (D*A)	N.S	N.S	N.S	N.S	N.S	N.S	*	*	N.S
D_1* A_1	65.88±0.88	68.20±.79	68.88±68.20	51.35±1.51	42.16±2.71	83.19±1.03	62.13^{d}±.80	43.93^{d}±.80	9.85^{d}±20
D_1* A_2	63.19±0.88	67.32±.79	66.77±67.32	50.57±1.51	47.49±2.71	80.77±1.03	60.69^{d}±.80	42.46^{d}±.80	9.55^{d}±20
D_1* A_3	62.84±0.88	66.49±.79	66.43±66.49	48.41±1.51	43.59±2.71	80.92±1.03	60.05^{d}±.80	41.86^{d}±.80	9.50^{d}±20
D_2* A_1	69.89±0.88	71.61±.79	75.16±71.61	40.96±1.51	77.33±2.71	82.85±1.03	68.72^{c}±.80	55.29^{c}±.80	12.46^{a}±20
D_2* A_2	70.02±0.88	74.27±.79	74.39±74.27	45.02±1.51	78.90±2.71	83.76±1.03	72.44^{a}±.80	58.77^{b}±.80	12.30^{ab}±20
D_2* A_3	69.35±0.88	72.80±.79	71.42±72.80	43.88±1.51	78.48±2.71	85.10±1.03	69.10^{bc}±.80	55.17^{c}±.80	11.70^{bc}±20
D_3* A_{12}	70.19±0.88	72.71±.79	73.32±72.71	39.15±1.51	93.07±2.71	79.46±1.03	72.05^{a}±.80	61.99^{a}±.80	12.19^{ab}±20
D_3* A_2	65.12±0.88	70.74±.79	70.39±70.74	38.76±1.51	91.25±2.71	78.70±1.03	70.02^{abc}±.80	59.67^{ab}±.80	11.43^{c}±20
D_3* A_3	66.96±0.88.	71.87±.79	72.70±71.87	39.41±1.51	93.16±2.71	79.79±1.03	71.43^{ab}±.80	61.37^{a}±.80	12.04^{abc}±20

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

4.1.3.1. Effect of diet (D):

The digestibility of DM, OM, CP and NFE significantly (P<0.05) increased when sheep fed D_2 (50% berseem*50% concentrate) compared to those fed D_1 (100% berseem) and D_3 (100% concentrate).These results are in a good agreement with those reported by **Salem *et al.*, (2001)**who found that addition of bentonite at 4% or 8% to basal ration (concentrate feed mixture plus berseem hay and rice straw) significantly (P<0.05) improved of OM, CP, CF and EE digestibility, compared with animals fed basal ration without bentonite.

In addition, the CF digestibility significantly (P<0.05) increased for D_1 compared with D_2 and D_3. The CF values were 50.11, 43.28 and 39.11 for D_1, D_2, and D_3, respectively.

Concerning, the value of EE digestibility was significantly (P<0.05) higher in D_3 (92.4%) compared with D_1 and D_2 (44.41 and 78.23%).

The results of nutritive values as TDN, SE and DCP reflected the improvement of the digestibility of nutrients. The values of TDN and DCP were significantly (P<0.05) higher in D_2 (70.09 and 12.15%) and D_3 (71.17 and 11.89) than those fed of D_1 (60.96 and 9.63%), respectively. These results are in a good agreement with those reported by **Salem *et al.*, (2001)** who observed that addition of bentonite at 4% or 8% to basal ration (concentrate feed mixture plus berseem hay and rice straw), significantly (P<0.05) improved of nutritive value TDN and DCP compared with animals those fed basal ration without bentonite.

The values of SV was significantly (P<0.05) higher for D_3 (61.01%) compared with those of D_1 and D_2 (42.75 and 56.41%) respectively.

4.1.3.2. Effect of additives (D).

The obtained results indicated that the inclusion of tafla (A_2) or bentofarm (A_3) significantly (P<0.05) decreased the digestibility of DM and CP compared with those of the control (A_1). The highest values of DM and CP were obtained with control (A_1) (68.66 and 72.45%), while the lowest values of DM and CP were recorded with bentofarm (A_3) (66.38 and 70.19%), respectively. These results are in a good agreement with those reported by **Sweeney *et al.* (1980)** observed that digestibility of dry matter decreased when steers were fed natural

zeolite. Also, **Johnson *et al.* (1988)** who found DM, OM and CP digestibility decreased with 2% zeolite addition to diets fed to Holstein cows, and part of this reduction can be attributed to the consumption of the indigestible synthetic zeolite itself. On the other hand, **Richter *et al.* (1990) and Kirilov and Burikhonv, (1993)** reported that inclusion 2% bentonite in high concentrate diet increased digestibility of DM, CP, CF, EE and NFE for heifer. **Salem *et al.* (2001), Mohesn and Tawfik (2002) and Forouzani *et al.* (2004)** found similar results.

On the other hand, OM, CF, EE and NFE digestibility were slightly improved with tafla or bentofarm addition compared with control ones, but the differences were not significant among teatments, being 70.39 to 70.845, 43.82 to 44.78, 70.85 to 72.55 and 81.07 to 81.93% for OM, CF, EE and NFE respectively. These results were similar to those obtained by **Salem *et al.***

(2001) who found that when animals fed basal rations plus 4% or 8% bentonite improved digestibility of OM, CP, CF and EE. Also, **Murzin and Peshkova, (1989)** found that the addition of zeolite for Black pied steers at 6% of dry matter increased the digestibility of OM, EE and NFE. On the other hand, **Richter *et al.* (1990)** and **Ivan *et al.* (2001)** using 2% bentonite had no appreciable effect on digestibility in sheep.

However, the results of nutritive as TDN, SV and DCP indicated that there are no significant differences among treatments and the differences were in narrow ranges. These values ranged between (66.86 to 67.72) for TDN, (52.80 to 53.74) for SV and (11.09 to 11.50) for DCP. The obtained results are in agreement with those obtained by **Aiad (1997).** On the other hand, **Abd El-Baki *et al*. (1988)** found that TDN, SE and DCP were significantly ($P<0.05$) improve with clay rations compared with control one**.** Also, **El-Hakim *et al*. (1994) and Saleh *et al*. (1999)** reported that TDN and DCP significantly ($P<0.05$) increased by addition of bentonite at levels 2.5 to 10% from the concentrate ration.

4.1.3.3. The interaction effect of diets and additives:

The results of nutritive values as TDN and SV showed significantly ($P<0.05$) differences among treatments, the highest values of nutritive values TDN and SV obtained from D_2*A_2 and D_3*A_1 (72.44 and 61.99%) respectively, while the lowest values for TDN and SV were recorded from D_1*A_3 (60.05 and 41.86%), respectively. On the other side, the results of the interaction effect of diets and additives on DM, OM, CP, CF, EE and NFE digestibility and DCP showed no significant differences among treatments.

4.1.4. Rumen parameters:

The data of the rumen parameters are presented in Table (6) and Fig (1).

4.1.4.1. Effect of diet (D).

The results of ruminal pH indicated that pH values of the experimental rations reflected the results of ruminal NH_3-N and TVFA's.

The results of ruminal pH values before feeding and 3hr. after feeding significantly ($P<0.05$) increased in 100% berseem (D_1) compared with 50% B plus 50%C (D_2) and 100% concentrate (D_3). The mean values of pH being 7.27, 6.86 and 6.83 post feeding and 7.20, 6.19 and 6.08 at 3hr. after feeding for D_1, D_2 and D_3 respectively.

The obtained value of ruminal NH_3-N before feeding of D_3 was significantly ($P<0.05$) higher (15.02 mg/100ml) compared with those of D_1 and D_2 (11.19 and 12.15 mg/100ml), respectively while, the lowest values of ruminal NH_3-N at 3hr. after feeding was significantly ($P<0.05$) higher in D_2 (27.76 mg/100ml) compared with D_1 and D_3 (12.0 and 19.29 mg/100ml), respectively.

Concerning, the results of TVFA'S before feeding and 3hr. after feeding showed significantly ($P<0.05$) differences among the tested diets. The values of TVFA'S being 12.61, 11.92 and 9.83 meq/100ml before feeding and 16.32, 20.88 and 17.77 meq/100ml at 3hr. after feeding, for D_1, D_2 and D_3, respectively.

Also, the results of microbial protein (MP) synthesis 3hr. after feeding showed significantly ($P<0.05$) differences among all tested diets. The highest values of MP, before feeding and 3hr. after feeding obtained from D_2 and D_3 (0.99 and 1.41 g/100ml), while the lowest value of MP before feeding and 3hr. after feeding recorded with D_1 and D_2 (0.67 and 0.66g/100ml), respectively.

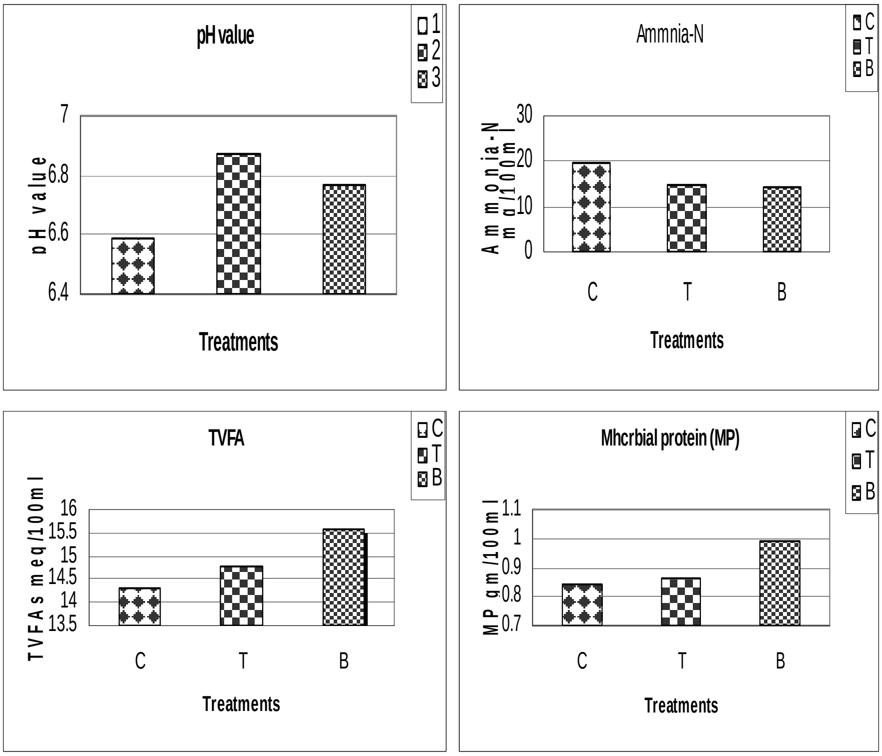

Fig. (1): Effect of additives on mean rumen parameters before feeding and 3hr. feeding after feeding.

C: control
T: tafla
B:bentofarm

Table (6): Effect of diets and tafla or bentofarm supplementation and its interaction effect on some ruminal parameters (X±SE).

Items	pH		Ammonia-N (mg/100ml)		TVFA (ml eq/100ml)		Microbial protein (gm/100)	
	0hr.	3hr.	0hr.	3hr.	0hr.	3hr.	0hr.	3hr.
Effect of diets (D)	*	*	*	*	*	*	*	*
D_1 (100%B)	$7.27^{a}\pm.03$	$7.20^{a}\pm.05$	$11.19^{b}\pm.42$	$12.00^{c}\pm.89$	$12.61^{a}\pm.71$	$16.33^{b}\pm.77$	$.67^{c}\pm.03$	$.81^{b}\pm.05$
D_2 (50%B * 50 %C)	$6.86^{b}\pm.03$	$6.19^{b}\pm.05$	$12.15^{b}\pm.42$	$27.76^{a}\pm.89$	$11.92^{ab}\pm.71$	$20.88^{a}\pm.77$	$.99^{a}\pm.03$	$.66^{c}\pm.05$
D_3 (100%C)	$6.83^{b}\pm.03$	$6.08^{b}\pm.05$	$15.02^{a}\pm.42$	$19.29^{b}\pm.89$	$9.83^{b}\pm.71$	$17.77^{b}\pm.77$	$.81^{b}\pm.03$	$1.41^{a}\pm.05$
Effect of additives	*	*	*	*	*	N.S	*	*
A_1 (Control)	$7.01^{a}\pm.03$	$6.16^{b}\pm.05$	$15.37^{a}\pm.42$	$24.28^{a}\pm.89$	$9.14^{b}\pm.71$	19.50±.77	$.90^{a}\pm.03$	$.78^{b}\pm.05$
A_2 (Tafla)	$7.04^{a}\pm.03$	$6.69^{a}\pm.05$	$12.08^{b}\pm.42$	$17.46^{b}\pm.89$	$11.16^{b}\pm.71$	18.38±.77	$.68^{b}\pm.03$	$1.03^{a}\pm.05$
A_3 (Bentofarm)	$6.91^{b}\pm.03$	$6.62^{a}\pm.05$	$10.91^{b}\pm.42$	$17.31^{b}\pm.89$	$14.05^{a}\pm.71$	17.11±.77	$.90^{a}\pm.03$	$1.07^{a}\pm.05$
Interaction effect (D*A)	*	*	*	N.S	*	N.S	*	*
D_1* A_1	$7.23^{b}\pm.05$	$6.98^{b}\pm.09$	$14.37^{b}\pm.73$	15.09±.1.54	$10.66^{bcd}\pm1.23$	18.66±1.34	$.74^{cd}\pm.05$	$.82^{bc}\pm.08$
D_1* A_2	$7.46^{a}\pm.05$	$7.43^{a}\pm.09$	$9.54^{c}\pm.73$	10.65±.1.54	$11.83^{abc}\pm1.23$	16.16±1.34	$.48^{e}\pm.05$	$.73^{bcd}\pm.08$
D_1* A_3	$7.13^{bc}\pm.05$	$7.19^{ab}\pm.09$	$9.67^{c}\pm.73$	10.25±.1.54	$15.33^{a}\pm1.23$	14.16±1.34	$.78^{cd}\pm.05$	$.88^{bc}\pm.08$
D_2* A_1	$7.00^{cd}\pm.05$	$5.83^{e}\pm.09$	$13.52^{b}\pm.73$	34.23±.1.54	$7.44^{d}\pm1.23$	22.16±1.34	$1.14^{a}\pm.05$	$.53^{d}\pm.08$
D_2* A_2	$6.79^{e}\pm.05$	$6.49^{c}\pm.09$	$13.00^{b}\pm.73$	24.76±.1.54	$14.33^{ab}\pm1.23$	19.50±1.34	$.90^{bc}\pm.05$	$.84^{bc}\pm.08$
D_2* A_3	$6.79^{e}\pm.05$	$6.27^{cd}\pm.09$	$9.92^{c}\pm.73$	24.30±.1.54	$14.00^{ab}\pm1.23$	21.00±1.34	$.95^{b}\pm.05$	$.60^{cd}\pm.08$
D_3* A_1	$6.80^{e}\pm.05$	$5.69^{e}\pm.09$	$18.22^{a}\pm.73$	23.52±.1.54	$9.33^{cd}\pm1.23$	17.66±1.34	$.83^{bc}\pm.05$	$.98^{b}\pm.08$
D_3* A_2	$6.86^{de}\pm.05$	$6.15^{d}\pm.09$	$13.72^{b}\pm.73$	16.98±.1.54	$7.33^{d}\pm1.23$	19.50±1.34	$.65^{d}\pm.05$	$1.54^{a}\pm.08$
D_3* A_3	$6.82^{e}\pm.05$	$6.42^{cd}\pm.09$	$13.13^{b}\pm.73$	17.37±.1.54	$12.83^{abc}\pm1.23$	16.16±1.34	$.96^{b}\pm.05$	$1.73^{a}\pm.08$

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$).
N.S. = not significant.
*= significant at 0.05 level.

4.1.4.2. Effect of additives (A).

The results of ruminal pH value before feeding significantly ($P<0.05$) decreased by addition of bentofarm (A_3) compared with control (A_1) and tafla (A_2) treatments. The mean values of ruminal pH before feeding were 7.01, 7.04 and 6.91 for A_1, A_2 and A_3 respectively. Also, The mean values of ruminal pH at 3hr. after feeding significantly ($P<0.05$) increased as a result of tafla (A_2) or bentofarm (A_3) addition (6.69 and 6.62) compared with control (A_1) treatment (6.16). These results are in agreement with those of **pond and Yen (1985), Aitchison *et al.* (1986)** and **johnson *et al.* (1988)** who found that addition of bentonite to the rations of sheep significantly ($P<0.05$) increased rumen pH value. On the other hand, **Grabherr *et al*. (2009)** found that ruminal values were not affect when zeolite added to the ration at 10 or 20 g/kg dry matter for cows.

The results of NH_3-N concentration before feeding and 3hr. after feeding significantly ($P<0.05$) decreased by supplementation of tafla (A_2) or bentofarm (A_3) compared with control (A_1) one, the values of NH_3-N concentration being 15.37, 12.08 and 10.91mg/100ml post feeding and 9.14, 11.16 and 17.31mg/100ml at 3hr. after feeding for control, tafla and bentofarm respectively. This result agree with the findings of **Wallace** and **New bold (1991)**, **Abd El-Baki *et al.* (1992) Ehrlich and Davison (1997) and Saleh *et al*. (1999)** they reported that ruminal NH_3-N concentration decreased when added the bentonite at different level to ruminant diets. **Bartos *et al*. (1982)** reported that lower NH_3-N concentration may be due to the ability of bentonite to adsorb ammonia form rumen fluid when the concentration is high and release it back when the concentration is falls. On the other hand, **Lemser *et al*. (1992)** reported that ammonia concentration was not affected by adding bentonite for goat ration.

The values of total volatile fatty acids (TVFA's) before feeding were significantly ($P<0.05$) higher with bentofarm (A_3) (14.05 meq/100ml) compared with the control (A_1) and tafla (A_2) treatments (9.14 and 11.16 meq/100ml) these results agree with the findings of **Mccollum** and **Galean(1983), Abd El-Baki *et al*. (1988)** and **Walz *et al*.(1998)** and **Salem *et al*. (2000)** who found that adding clays to the rations increase ruminal TVFA's. On the other hand, **Murray *et al.* (1992)** and **Madbu-Mohini *et al.* (2001)** found that TVFA's decreased by addition of natural zeolite or bentonite at 3 and 6% of diet for cattle. However, the results of TVFA's at 3hr. after feeding showed no significant differences among treatments and nearly similar which ranged from 17.11 to 19.50 meq/ 100ml. These results agree with the findings of **Fisher and mackay (1983) and Jacques *et al*. (1986)** who showed that adding sodium bentonite to cows and steers rations did not affected ruminal pH.

Microbial protein (MP) synthesis before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among treatments. The highest values of MP before feeding and 3hr. after feeding obtained from A_3 (0.90 and 1.07 gm/100ml), while the lowest value was recorded from A_2 and A_1 (0.68 and 0.78g/100ml) respectively. Similar result was obtained by **Abd El-Baki *et al.* (1988) and Abd El-Baki *et al.* (1992)** who found that addition of clay to rations of rams or lambs increased microbial protein comparable to those which received only urea rations. Also, **Fenn and Leng (1990)** found that addition of bentonite at 30, 50 or 60g/day to sheep offered mainly roughage increased the density of rumen protozoa leading to increased wool growth in response to supplements of bentonite.

4.1.4.3. Interaction effect between diet and additives.

The results of the interaction effect between diet and additives on pH values before feeding and at 3hr. after feeding showed significant (P<0.05) differences among treatments. The highest values of pH before feeding and 3hr. after feeding obtained from D_1*A_2 (7.46 and 7.43), while the lowest values were recorded from D_2*A_2, D_2*A_3 and D_3*A_1(6.79 and 5.69), respectively. Concerning, the results of ruminal NH_3-N concentration revealed significant (P<0.05) differences among the tested treatments before feeding but the highest value of NH_3-N concentration before feeding obtained from D_3*A_1 (18.22mg/100ml), while the lowest value recorded with D_1*A_2 (9.54mg/100ml). On the other side, the results of NH_3-N and TVFA'S concentration at 3hr. after feeding showed no significant differences among the tested treatments.

The obtained values of total volatile fatty acids (TVFA's) before feeding showed significant (P<0.05) differences among the tested treatments. The highest values of TVFA'S concentration before feeding obtained with D_1*A_3 (15.33 meq /100ml), while the lowest values recorded with D_3*A_2 (7.33 meq /100ml).

Microbial protein (MP) synthesis before feeding and 3hr. after feeding showed significant (P<0.05) differences among treatments. The highest values of MP before feeding and 3hr. after feeding obtained from D_2*$A_1$and D_3*A_3 (1.14 and 1.73 gm/100ml), while the lowest value was recorded from D_1*$A_2$and D_2*A_1(0.48 and 0.53g/100ml) respectively.

4.1.5. Nitrogen retention:

The results of daily nitrogen intake, fecal and urinary nitrogen and nitrogen retention are given in Table (7).

4.1.5.1. Effect of diet (D).

The results of nitrogen intake as g/h/d and g/kg $W^{0.75}$ showed significant ($P<0.05$) differences among diets. The values of nitrogen intake as g/h/d significantly ($P<0.05$) decreased with D_1 (23.81g/h/d) than those of D_2 and D_3 (32.85 and 33.34g/h/d). On the other side, the nitrogen intake as g/kg $W^{0.75}$ significantly ($P<0.05$) increased in D_2 (1.92) compared with D_1 and D_3 (1.45 and 1.77).

The daily fecal nitrogen as g/h/d significantly ($P<0.05$) increased in D_3 (9.27g/h/d) than those of D_1 and D_2 (7.79 and 8.59 g/h/d).

Concerning, the results of fecal nitrogen as g/kg $W^{0.75}$ and urinary nitrogen as g/h/d showed no significant differences among diets.

The results of total nitrogen excretion as g/h/d and g/kg $W^{0.75}$ showed significant ($P<0.05$) differences among diets. The mean values of total nitrogen excretion being 20.98, 23.30 and 23.25 g/h/d and 1.30, 1.35 and 1.24 g/kg $W^{0.75}$ for D_1, D_2, and D_3, respectively.

The values of nitrogen retention as g/h/d and g/kg $W^{0.75}$

Table (7): Effect of diets and tafla or bentofarm supplementation and its interaction effect on nitrogen retention ($\overline{X}$ ±SE).

Items	N.intake		Fecal .N		Urinary. N		Total .N excretion		N. retention		N. retention % of intake
	g/head/day	g / Kg $W^{0.75}$	g/head/day	g / Kg $W^{0.75}$	g/head/day	g / Kg $W^{0.75}$	g/head/day	g / Kg $W^{0.75}$	g/head/day	g / Kg $W^{0.75}$	
Effect of diets (D)											
	*	*	*	N.S	N.S	*	*	*	*	*	*
D_1 (100%B)	$23.81^{b}\pm.61$	$1.45^{c}\pm.04$	$7.79^{c}\pm0.21$	$.47\pm.02$	$13.19\pm.51$	$.82^{ab}\pm0.03$	$20.98^{b}\pm.55$	$1.30^{ab}\pm.03$	$3.12^{b}\pm.63$	$.17^{a}\pm.03$	$12.00^{b}\pm1.70$
D_2 (50%B * 50 %C)	$32.85^{a}\pm.61$	$1.92^{a}\pm.04$	$8.59^{b}\pm0.21$	$.50\pm.02$	$14.71\pm.51$	$.85^{a}\pm0.03$	$23.30^{a}\pm.55$	$1.35^{a}\pm.03$	$9.54^{a}\pm.63$	$.55^{a}\pm.03$	$28.99^{a}\pm1.70$
D_3 (100%C)	$33.34^{a}\pm.61$	$1.77^{b}\pm.04$	$9.27^{a}\pm0.21$	$.49\pm.02$	$13.98\pm.51$	$.74^{b}\pm0.03$	$23.25^{a}\pm.55$	$1.24^{b}\pm.03$	$10.09^{a}\pm.63$	$.53^{a}\pm.03$	$30.19^{a}\pm1.70$
Effect of additives(A)											
	N.S	*	*	*	N.S	N.S	N.S	*	N.S	N.S	N.S
A_1 (Control)	$30.19\pm.61$	$1.66^{b}\pm.04$	$8.19^{b}\pm0.21$	$.45^{b}\pm.02$	$13.91\pm.51$	0.77 ± 0.03	$22.11\pm.55$	$1.22^{b}\pm.03$	$8.08\pm.63$	$.44\pm.03$	26.07 ± 1.70
A_2 (Tafla)	$30.84\pm.61$	$1.78^{a}\pm.04$	$8.86^{a}\pm0.21$	$.51^{a}\pm.02$	$14.67\pm.51$	0.85 ± 0.03	$23.53\pm.55$	$1.36^{a}\pm.03$	$7.42\pm.63$	$.41\pm.03$	22.41 ± 1.70
A_3 (Bentofarm)	$28.96\pm.61$	$1.70^{ab}\pm.04$	$8.60^{ab}\pm0.21$	$.50^{a}\pm.02$	$13.29\pm.51$	0.80 ± 0.03	$21.89\pm.55$	$1.31^{ab}\pm.03$	$7.25\pm.63$	$.40\pm.03$	22.69 ± 1.70
Interaction effect (D*A)											
	N.S	N.S	*	*	*	*	*	*	N.S	N.S	*
D_1* A_1	23.06 ± 1.05	$1.33\pm.06$	$7.17^{d}\pm.37$	$.41^{b}\pm.03$	$11.20^{c}\pm.88$	$.65^{c}\pm.05$	$18.38^{c}\pm.96$	$1.07^{c}\pm.05$	4.68 ± 1.09	$0.27\pm.06$	$20.25^{b}\pm2.96$
D_1* A_2	24.82 ± 1.05	$1.51\pm.06$	$8.26^{bc}\pm.37$	$.50a^{b}\pm.03$	$14.16^{ab}\pm.88$	$.86^{ab}\pm.05$	$22.42^{ab}\pm.96$	$1.36^{ab}\pm.05$	2.72 ± 1.09	$0.14\pm.06$	$9.68^{c}\pm2.96$
D_1* A_3	23.55 ± 1.05	$1.51\pm.06$	$7.93^{cd}\pm.37$	$.49^{ab}\pm.03$	$14.19^{ab}\pm.88$	$.95^{a}\pm.05$	$22.13^{ab}\pm.96$	$1.48^{a}\pm.05$	1.96 ± 1.09	$0.11\pm.06$	$6.07^{c}\pm2.96$
D_2* A_1	33.23 ± 1.05	$1.88\pm.06$	$8.26^{bcd}\pm.37$	$.47^{ab}\pm.03$	$15.13^{a}\pm.88$	$.85^{ab}\pm.05$	$23.39^{ab}\pm.96$	$1.32^{ab}\pm.05$	9.84 ± 1.09	$0.56\pm.06$	$29.56^{ab}\pm2.96$
D_2* A_2	33.24 ± 1.05	$1.94\pm.06$	$8.12^{cd}\pm.37$	$.47^{ab}\pm.03$	$15.51^{a}\pm.88$	$.91^{ab}\pm.05$	$23.63^{ab}\pm.96$	$1.38^{ab}\pm.05$	9.60 ± 1.09	$0.56\pm.06$	$28.75^{ab}\pm2.96$
D_2* A_3	32.08 ± 1.05	$1.94\pm.06$	$9.41^{ab}\pm.37$	$.56^{a}\pm.03$	$13.48^{abc}\pm.88$	$.80^{abc}\pm.05$	$22.89^{ab}\pm.96$	$1.36^{ab}\pm.05$	9.19 ± 1.09	$0.54\pm.06$	$28.65^{ab}\pm2.96$
D_3* A_1	34.29 ± 1.05	$1.78\pm.06$	$9.14^{abc}\pm.37$	$.47^{ab}\pm.03$	$15.41^{a}\pm.88$	$.80^{abc}\pm.05$	$24.56^{a}\pm.96$	$1.28^{b}\pm.05$	9.73 ± 1.09	$0.51\pm.06$	$28.40^{ab}\pm2.96$
D_3* A_2	34.48 ± 1.05	$1.88\pm.06$	$10.20^{a}\pm.37$	$.56^{a}\pm.03$	$14.33^{ab}\pm.88$	$.78^{bc}\pm.05$	$24.54^{a}\pm.96$	$1.33^{ab}\pm.05$	9.94 ± 1.09	$0.54\pm.06$	$28.82^{ab}\pm2.96$
D_3* A_3	31.26 ± 1.05	$1.66\pm.06$	$8.46^{bc}\pm.37$	$.45^{b}\pm.03$	$12.19^{bc}\pm.88$	$.65^{c}\pm.05$	$20.66^{bc}\pm.96$	$1.10^{c}\pm.05$	10.60 ± 1.09	$0.56\pm.06$	$33.35^{a}\pm2.96$

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$), N.S. = not significant, *= significant at 0.05 level.

were significantly (P<0.05) higher in D_2 and D_3 than the value of D_1.The mean values of nitrogen retention being 3.12, 9.54 and 10.09 g/h/d and 0.17, 0.55 and 0.53 g/kg $W^{0.75}$ for D_1, D_2 and D_3, respectively.

Also, nitrogen retention % of intake (NB/NI %) significantly (P<0.05) higher in D_2 and D_3 (28.99 and 30.19%) compared with D_1 (12.00%).

4.1.5.2. Effect of additives.

Daily nitrogen intake as g/h/d showed insignificant differences among treatments, while the daily nitrogen intake as g/kg$W^{0.75}$ significantly (P<0.05) decreased with unsupplemented diet (1.66 g/kg$W^{0.75}$) compared with tafla and bentofarm supplemented diets (1.78 and 1.70 g/kg$W^{0.75}$), respectively.

The obtained results of fecal nitrogen as g/h/d and g/kg$W^{0.75}$ significantly (P<0.05) increased by addition of tafla (A_2) or bentofarm (A_3) compared with control (A_1). The mean values of fecal nitrogen, being 8.19, 8.86 and 8.60 g/h/d and 0.45, 0.51 and 0.50 g/kg$W^{0.75}$ for A_1, A_2 and A_3 respectively.

The urinary nitrogen as g/h/d and g/kg$W^{0.75}$ showed no significant differences among treatments. These results are in agreement with those of **Rindsig and Schultz (1970)** who reported that the amount of fecal nitrogen increased, while urinary nitrogen decreased by addition of bentonite at 5 or 10% to cow diet.

Total nitrogen excretion as g/h/d showed no significant differences among treatments, the values of total nitrogen excretion as g/kg$W^{0.75}$ significantly (P<0.05) decreased in control (A_1) (1.22 g/kgW$^{0.75}$) compared with tafla and bentofarm (1.36 and 1.31 g/kgW$^{0.75}$).

Fecal and urinary-N excretion reflected on the values of nitrogen retention (NB) and other form of nitrogen utilization (NB/NI %). The values of nitrogen retention as g/h/d, g/kgW$^{0.75}$and NB / NI% were decreased in both treatments compared with control one, without significant differences.

4.1. 5.3. Interaction effect between diet and additives.

The interaction effect on nitrogen intake as g/h/d and g/kgW$^{0.75}$ and nitrogen balance as g/h/d and g/kgW$^{0.75}$showed no significant differences among treatments.

Fecal nitrogen as g/h/d and g/kg W$^{0.75}$ showed significant ($P<0.05$) differences among treatments. The highest values of fecal nitrogen as g/h/d and g/kg W$^{0.75}$ were obtained with D_3*A_2 (10.20 g/h/d and 0.56 g/kgW$^{0.75}$), while the lowest value was recorded from D_1*A_1 (7.17 g/h/d and 0.41 g/kgW$^{0.75}$), respectively.

Significant ($P<0.05$) differences were obtained of urinary nitrogen as g/h/d, g/kg BW and g/kg W$^{0.75}$ among different treatments. The highest values of urinary nitrogen as g/h/d obtained with D_2*A_2 and $D_{1*}A_3$ (15.51 g/h/d and 0.95 g/kg w0.75), while the lowest value was recorded with D_1*A_1 (11.20 g/h/d and 0.65 g/kg w0.75), respectively.

Total nitrogen excretion as g/h/d, g/kg BW and g/kg W$^{0.75}$ showed significantly ($P<0.05$) differences among treatments. The highest values of total excretion as g/h/d and g/kgW$^{0.}$75 was obtained with D_3*A_1 and D_1*A_3 (24.56 g/h/d and 1.48 g/kgW$^{0.75}$), while the lowest value was recorded from D_1* A_1

(18.38 g/h/d and 1.07 g/kg w 0.75), respectively. On the other side, the results of nitrogen retention as g/h/d and g/kg$W^{0.75}$ showed no significant differences among treatments. The values of nitrogen balance as NB/NI% showed significantly ($P<0.05$) differences among treatments. The highest values of NB/NI% was obtained with D_3*A_3 (33.35%), while the lowest value was recorded with D_1*A_3 (6.07%), respectively.

4.1. 6. Calcium retention:

The daily calcium intake, fecal, urinary and calcium retention are given in Table (8) and Fig (2).

4.1.6.1. Effect of diet:

The results of daily Ca intake was significantly ($P<0.05$) increased when animals fed D_1 (9.61 g/h/d) compared to those which fed D_2 and D_3 (8.53 and 6.64 g/h/d), respectively. On the other side, the results of fecal and urinary calcium showed no significant differences among treatments.

Total excreted and calcium retention g/h/d showed significant ($P<0.05$) differences among diets. The values of total excreted calcium being 4.74, 4.83 and 4.03 g/h/d and the values of calcium retention were 4.87, 3.70 and 2.61, g/h/d for D_1, D_2 and D_3, respectively.

4.1.1.6.2. Effect of additives (A).

The results of daily calcium, fecal Ca, urinary Ca and total Ca excreted (g/h/d) showed no significant differences among treatments. The highest value of total calcium excreted obtained with tafla (A_2) addition (4.86 g/h/d), while the lowest value recorded with bentofarm (A_3) addition (4.32 g/h/d). The present results are supported by findings of **Gutierrez *et al.* (1999)** who

Table (8): Effect of tafla or bentofarm supplementation and its interaction effect on calcium retention expressed as

Items	Daily Ca intake (g/h/d)	Fecal Ca (g/h/d)	Urinary Ca (g/h/d)	Total Ca excreted (g/h/d)	Calcium retention (g/h/d)
Effect of diets (D)	*	N.S	N.S	*	*
D_1 (100%B)	9.61^a±.23	4.54±.30	$.20^a$±.01	4.74^a±0.23	4.87^a±.23
D_2 (50%B * 50 %C)	8.53^b±.23	4.64±.30	$.18^{ab}$±.01	4.83^a±0.23	3.70^b±.23
D_3 (100%C)	6.64^c±.23	4.20±.30	$.14^b$±.01	4.03^b±0.23	2.61^c±.23
Effect of additives(A)	N.S	N.S	N.S	N.S	*
A_1 (Control)	8.02±.23	4.68±.30	.17±.01	4.86±0.23	3.15^b±.23
A_2 (Tafla)	8.55±.23	4.24±.30	.17±.01	4.41±0.23	4.14^a±.23
A_3 (Bentofarm)	8.22±.23	4.45±.30	.18±.01	4.32±0.23	3.89^a±.23
Interaction effect (D*A)	N.S	*	N.S	*	*
D_1* A_1	8.97±.39	4.11^{ab}±.52	.15±.02	4.27^b±.38	4.69^b±.41
D_1* A_2	10.07±.39	3.81^b±.52	.21±.02	4.02^b±.38	6.08^a±.41
D_1* A_3	9.79±.39	5.69^a±.52	.25±.02	5.94^a±.38	3.84^{ab}±.41
D_2* A_1	8.65±.39	5.02^{ab}±.52	.22±.02	5.24^{ab}±.38	3.41^{ab}±.41
D_2* A_2	8.57±.39	4.88^{ab}±.52	.15±.02	5.04^{ab}±.38	3.52^{ab}±.41
D_2* A_3	8.39±.39	4.02^{ab}±.52	.18±.02	4.21^b±.38	4.18^{ab}±.41
D_3* A_1	6.44±.39	4.92^{ab}±.52	.15±.02	5.07^{ab}±.38	1.36^d±.41
D_3* A_2	7.01±.39	4.04^{ab}±.52	.15±.02	4.19^b±.38	2.82^c±.41
D_3* A_3	6.48±.39	3.63^b±.52	.13±.02	2.83^c±.38	3.66^{ab}±.41

a, b, c and d : Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

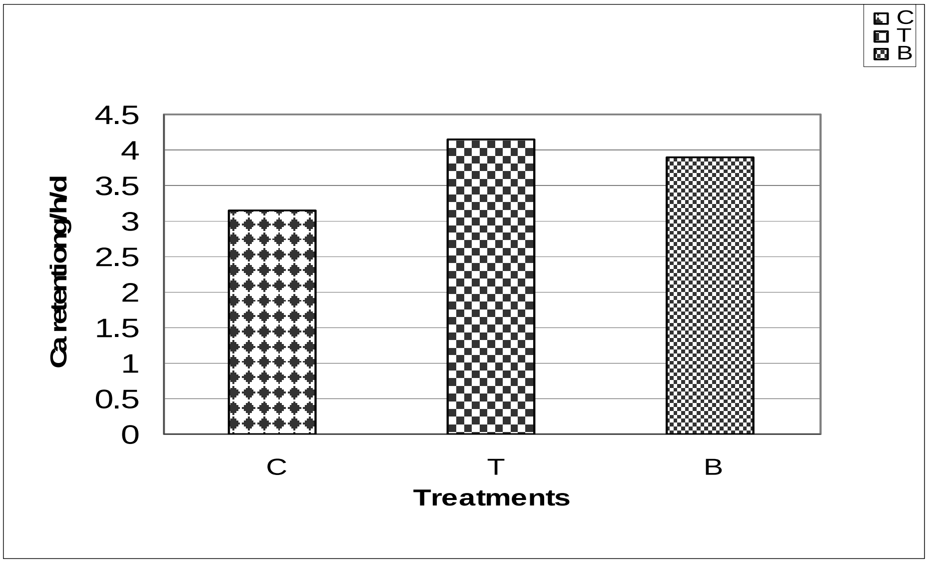

Fig. (2): Effect of additives on calcium retention g/h/d.
C: control
T: tafla
B: bentofarm

reported that inclusion of up to 5% zeolite to sheep fed star grass adlibitum and 300g of commercial concentrate does not increase fecal nitrogen and mineral excretion. Also, **Marten *et al.* (1969)** observed that urinary excretion of calcium was not affected by level of bentonite. **Kessler and Sigrist (1995)** found that inclusion of up to 5% zeolite to sheep diets does not increase fecal nitrogen and mineral excretion in spite of the cationic exchange capacity of this mineral.

In addition to the amount of Ca retention g/h/d were significantly ($P<0.05$) higher by addition of tafla (A_2) or bentfarm (A_3) (4.14 and 3.89 g/h/d) compared with the control one (3.15 g/h/d). The present results are in agreement with those obtained by **Kirilov *et al.* (1995)** who found that addition of zeolite at 3, 4 or 5% to black pied heifers increased retention of calcium and phosphorus. However, **Huntington *et al.* (1977)** showed that addition of bentonite at 8 or 12% had no effect on calcium retention.

4.1.6.3. Interaction effect between diet and additives (A).

The results of the interaction effect on daily calcium intake and urinary calcium as g/h/d showed no significant differences among treatments. Concerning fecal calcium and total calcium excreted as g/h/d significant (P<0.05) differences among treatments were recorded. The highest values of fecal calcium and total calcium excreted obtained from D_1*A_3 treatment (5.69 and 5.94 g/h/d), respectively, while the lowest values recorded from D_3*A_3 treatment (13.63 and 2.83 g/h/d), respectively. In addition to the values of Ca retention g/h/d showed significantly (P<0.05) differences among treatments. The highest values of calcium retention obtained from D_1*A_2 (6.08 g/h/d), while the lowest value was recorded from D_3*A_1 treatment (1.36 g/h/d).

4.1.7. Phosphorus retention:

The daily phosphorus intake, fecal phosphorus, urinary phosphorus and phosphor retention are presented in Table (9) and Fig. (3).

4.1.7.1. Effect of diet:

The results of daily phosphorus intake was significantly (P<0.05) higher with animals fed D_3 (7.60 g/h/d) compared to those fed D_1 and D_2 (3.12 and 6.25 g/h/d), respectively.

Fecal phosphorus and total phosphorus excreted were significantly (P<0.05) increased in D_2 and D_3 compared to D_1. The mean values of fecal phosphorus being 1.90, 4.45 and 5.15

Table (9): Effect of tafla or bentofarm and its interaction effect on phosphorus retention as g/h/d ($\overline{X}$ ±SE).

Items	Daily P intake (g/h/d)	Fecal P (g/h/d)	Urinary p (g/h/d)	Total P excreted (g/h/d)	P retention (g/h/d)
Effect of diets (D)	*	*	N.S	*	*
D_1 (100%B)	3.12^{c}±.18	1.90^{c}±.09	0.08±0.01	1.97^{c}±.08	1.14^{c}±.07
D_2 (50%B * 50 %C)	6.25^{b}±.18	4.45^{b}±.09	0.08±0.01	4.52^{b}±.08	1.72^{b}±.07
D_3 (100%C)	7.60^{a}±.18	5.15^{a}±.09	0.06±0.01	5.21^{a}±.08	2.43^{a}±.07
Effect of additives(A)	N.S	*	N.S	*	*
A_1 (Control)	5.74±.18	3.40^{c}±.09	0.06±0.01	3.49^{b}±.08	2.24^{a}±.07
A_2 (Tafla)	5.79±.18	3.92^{b}±.09	0.07±0.01	3.99^{a}±.08	1.79^{b}±.07
A_3 (Bentofarm)	5.45±.18	4.17^{a}±.09	0.06±0.01	4.22^{a}±.08	1.26^{c}±.07
Interaction effect (D*A)	*	*	N.S	*	*
D_1* A_1	3.02^{c}±.31	2.04^{e}±.16	0.08±0.02	2.12^{d}±.14	0.90^{e}±.13
D_1* A_2	3.25^{c}±.31	1.92^{e}±.16	0.09±0.02	2.01^{d}±.14	1.23^{de}±.13
D_1* A_3	3.09^{c}±.31	1.73^{e}±.16	0.06±0.02	1.79^{d}±.14	1.30^{de}±.13
D_2* A_1	6.37^{b}±.31	4.63^{b}±.16	0.11±0.02	4.74^{b}±.14	1.63^{cd}±.13
D_2* A_2	6.28^{b}±.31	3.96^{c}±.16	0.06±0.02	4.02^{c}±.14	2.26^{b}±.13
D_2* A_3	6.11^{b}±.31	4.76^{b}±.16	0.07±0.02	4.80^{b}±.14	1.28^{de}±.13
D_3* A_1	7.82^{a}±.31	3.54^{d}±.16	0.07±0.02	3.61^{c}±.14	4.21^{a}±.13
D_3* A_2	7.83^{a}±.31	5.90^{b}±.16	0.06±0.02	5.95^{a}±.14	1.88^{bc}±.13
D_3* A_3	7.14^{a}±.31	6.01^{b}±.16	0.06±0.02	6.07^{a}±.14	1.19^{e}±.13

a, b, c and d : Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

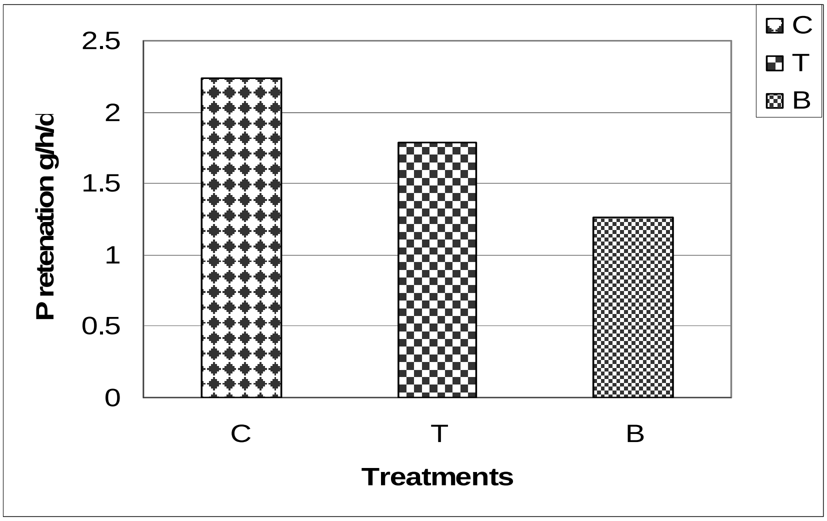

Fig .(3):Effect of additives on phosphorus retention g/h/d.
C: control
T: tafla
B:bentofarm

g/h/d and the mean values of total phosphorus excreted being 1.97, 4.52 and 5.21 g/h/d for D_1, D_2 and D_3 respectively.

The urinary phosphorus excretion was nearly similar for all diets which ranged from 0.06 to 0.089 g/h/d.

In addition to, the results of phosphorus retention showed significant ($P<0.05$) differences among diets. The highest values of phosphorus retention was obtained from D_3 (2.43 g/h/d), while the lowest value was recorded with D_1 (1.14 g/h/d).

4.1.7.2. Effect of additives (A).

The results of daily phosphorus intake indicated that there are no significant differences among treatments. The mean values of daily phosphorus intake g/h/d being 5.74, 5.79 and 5.45 g/h/d for control (A_1) tafla (A_2) and bentoarm (A_3), respectively.

The requirements of phosphorus for sheep as recorded by **NRC (1985)** ranged between 1.04 to 2.9 g/h/d.

The urinary phosphorus was almost similar with all treatments and the differences were within narrow range and not significant being 0.06 to 0.07 g/h/d.

The mean values of fecal phosphorus excretion significantly (P<0.05) increased by addition of tafla and bentofarm (4.17 and 3.92 g/h/d respectively) comparable to the control one (3.40 g/h/d). These results agree with that found by **Kindsig and Schultz (1969)** who found fecal excretion of phosphorus was higher when cows fed on 5 or 10% bentonite in their diets.

The results of total excreted phosphorus significantly (P<0.05) increased with tafla and bentofarm (3.99 and 4.22 g/h/d) compared with the control treatment (3.49 g/h/d), respectively.

Phosphorus retention showed significantly (P<0.05) lower values by addition of tafla and bentofarm (1.79 and 1.26 g/h/d) compared to the control without addition (2.24 g/h/d) respectively. The present results are supported by the findings of **Huntington *et al.* (1977)** who found that addition of bentonite at 8 or 12% had lower phosphorus retention and there was no significant effect of bentonite on calcium retention. On the other hand, **Martin *et al.* (1969)** reported that bentonite lowered calcium but increased phosphorus retention in sheep.

4.1.7.3. Interaction effect between diet and additives.

The interaction effect on daily phosphorus intake and urinary phosphorus showed no significant differences among treatments.

The values of fecal phosphorus and total phosphorus excreted as g/h/d showed significant ($P<0.05$) differences among treatments. The highest values excreted obtained from D_3*A_3 (6.01 and 6.07), respectively, while the lowest values recorded from D_1*A_3 (1.73 and 1.79 g/h/d), respectively.

Also, the interaction effect on phosphorus retention showed significant ($P<0.05$) difference among treatments. The highest value of phosphorus retention obtained from D_3*A_1 treatment (4.21 g/h/d), while the lowest values recorded from D_1*A_1 treatment (0.90 g/h/d).

4.1.8. Magnesium retention:

The daily magnesium intake, fecal and urinary magnesium and magnesium retention are presented in Table (10) and Fig. (4).

4.1.8.1. Effect of diet:

The results of daily magnesium intake showed significant ($P<0.05$) differences among diets. The mean values of daily magnesium intake being 2.41, 2.70 and 2.63 for D_1, D_2 and D_3, respectively.

Fecal, urinary magnesium and total magnesium excreted and magnesium retention showed no significant differences among diets.

4.1.8.2. Effect of additives (A).

The average daily magnesium intake was significantly

Table (10): Effect tafla or bentofarm supplementation and its interaction effect on magnesium retention as g/h/d ($\overline{X}$ ±SE).

Items	Daily Mg intake (g/h/d)	Fecal Mg (g/h/d)	Urinary Mg,(g/h/d)	Total Mg excreted, (g/h/d)	Mg retention (g/h/d)
Effect of diets (D)					
	*****	**N.S**	**N.S**	**N.S**	**N.S**
D_1 (100%B)	2.41^{b}±.08	.83±.04	0.09±0.02	.92±.06	1.51±.11
D_2 (50%B * 50 %C)	2.70^{a}±.08	.79±.04	0.16±0.02	.95±.06	1.74±.11
D_3 (100%C)	2.63^{ab}±.08	.89±.04	0.11±0.02	.95±.06	1.74±.11
Effect of additives(A)					
	*****	*****	**N.S**	*****	*****
A_1 (Control)	2.36^{b}±.08	1.25^{a}±.04	0.08±0.02	1.32^{a}±.06	1.04^{b}±.11
A_2 (Tafla)	2.66^{a}±.08	$.71^{b}$±.04	0.17±0.02	$.87^{b}$±.06	1.85^{a}±.11
A_3 (Bentofarm)	2.72^{a}±.08	$.57^{b}$±.04	0.07±0.02	$.63^{c}$±.06	2.11^{a}±.11
Interaction effect (D*A)					
	N.S	*****	**N.S**	**N.S**	**N.S**
D_1* A_1	2.15±.14	1.08^{b}±.08	0.07±0.01	1.15±0.11	1.00±0.19
D_1* A_2	2.51±.14	$.82^{c}$±.08	0.13±0.01	.94±0.11	1.57±0.19
D_1* A_3	2.57±.14	$.59^{cd}$±.08	0.09±0.01	.68±0.11	1.97±0.19
D_2* A_1	2.57±.14	1.23^{ab}±.08	0.12±0.01	1.34±0.11	1.22±0.19
D_2* A_2	2.72±.14	$.56^{cd}$±.08	0.31±0.01	.87±0.11	1.85±0.19
D_2* A_3	2.81±.14	$.60^{cd}$±.08	0.06±0.01	.87±0.11	2.15±0.19
D_3* A_1	2.36±.14	1.43^{a}±.08	0.04±0.01	1.47±0.11	.89±0.19
D_3* A_2	2.76±.14	$.73^{cd}$±.08	0.07±0.01	.80±0.11	2.13±0.19
D_3* A_3	2.78±.14	$.51^{d}$±.08	0.06±0.01	.57±0.11	2.21±0.19

a, b, c and d : Means in the same column having different superscripts differ significantly ($p<0.05$).
N.S. = not significant.
*= significant at 0.05 level.

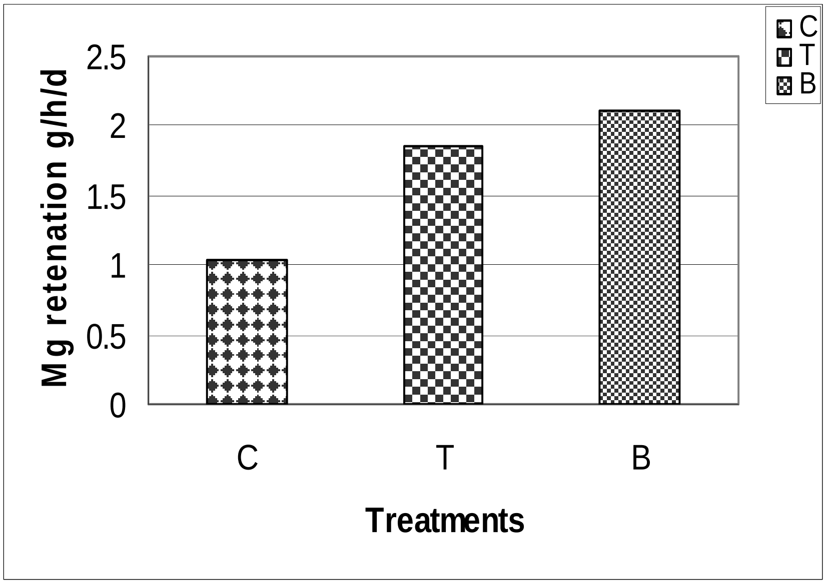

Fig. (4): Effect of additives on magnesium retention g/h/d.
C: control
T: tafla
B:bentofarm

(P<0.05) higher with tafla and bentofarm inclusion (2.66 and 2.72 g/h/d) comparable to the control treatment (2.36 g/h/d), respectively.

Also, the results of fecal magnesium excretion significantly (P<0.05) decreased by addition of tafla and bentofarm (0.71 and 0.57 g/h/d) compared to the control treatment (1.25 g/h/d), respectively.

The urinary magnesium was almost similar with all treatments. The differences were within narrow range and not significant being 0.07 to 0.17 g/h/d.

Total excreted magnesium showed significant (P<0.05) differences among treatments, and the highest value was obtained with control treatments (1.32 g/h/d), while the lowest value was recorded with bentofarm addition (0.63 g/h/d).

The results of magnesium retention showed significantly (P<0.05) higher values with tafla and bentofarm treatments (1.85 and 2.11 g/h/d) compared with the control treatment (1.04 g/h/d), respectively. This results are in agreement with those of **Ha *et al.* (1985)** who found that lambs fed 2% bentonite retained significantly (P<0.05) more magnesium. On the other hand, **Rindsig and Schultz (1970)** reported that when dairy cows fed bentonite at 5 or 10% had low magnesium and phosphorus retention.

4.1.8.3. Interaction effect between diets and additives.

The interaction effect on daily magnesium intake, urinary and total magnesium excreted and magnesium retention showed no significant differences among treatments.

The results of fecal magnesium excretion showed significant (P<0.05) differences among treatments. The highest values of fecal magnesium was obtained from D_3*A_1 treatment (1.43 g/h/d), while the lowest value was recorded with D_3*A_3 treatment (0.51 g/h/d).

4.1.9. Iron retention:

The daily iron intake, iron excretion in feces and urine and iron retention are presented in Table (11) and Fig (5).

4.1.9.1. Effect of diet (D).

Daily intake of iron showed significant (P<0.05) differences among all diets. The mean values of iron intake were

Table (11): Effect of tafla or bentofarm supplementation and its interaction effect on iron retention as mg/h/d ($\overline{X}$ ±SE).

Items	Daily Fe intake (mg/h/d)	Fecal Fe (mg/h/d)	Urinary Fe (mg/h/d)	Total Fe excreted (mg/h/d)	Fe retention (mg/h/d)
Effect of diets (D)	*	*	*	**N.S**	*
D_1 (100%B)	835.65^{ab}±12.18	322.24^{b}±12.54	22.76^{a}±1.48	345.00±1.48	490.65^{b}±8.77
D_2 (50%B * 50 %C)	855.17^{a}±12.18	286.02^{ab}±12.54	13.54^{b}±1.48	310.67±1.48	544.50^{a}±8.77
D_3 (100%C)	810.12^{b}±12.18	326.84^{a}±12.54	12.12^{b}±1.48	337.34±1.48	471.17^{b}±8.77
Effect of additives(A)	*	*	**N.S**	*	*
A_1 (Control)	386.10^{c}±12.18	165.78^{c}±12.54	15.05±1.48	179.21^{c}±1.48	205.26^{c}±8.77
A_2 (Tafla)	883.47^{b}±12.18	417.52^{a}±12.54	16.10±1.48	433.62^{a}±1.48	449.87^{b}±8.77
A_3 (Bentofarm)	1231.37^{a}±12.18	351.80^{b}±12.54	17.27±1.48	380.19^{b}±1.48	851.18^{a}±8.77
Interaction effect (D*A)	**N.S**	*	**N.S**	*	*
D_1* A_1	366.89±21.10	167.75^{c}±21.72	18.17±2.56	185.92^{c}±2.56	180.97^{f}±15.19
D_1* A_2	892.60±21.10	413.61^{a}±21.72	24.56±2.56	438.17^{a}±2.56	454.42^{de}±15.19
D_1* A_3	1247.46±21.10	385.36^{a}±21.72	25.55±2.56	410.92^{a}±2.56	836.55^{b}±15.19
D_2* A_1	427.19±21.10	188.20^{c}±21.72	15.33±2.56	203.53c±2.56	223.6^{f}±15.195
D_2* A_2	895.24±21.10	400.12^{a}±21.72	11.21±2.56	411.34^{a}±2.56	483.90^{d}±15.19
D_2* A_3	1243.09±21.10	269.73^{b}±21.72	14.09±2.56	317.15^{b}±2.56	925.94^{a}±15.19
D_3* A_1	364.22±21.10	141.40^{c}±21.72	11.66±2.56	148.19^{c}±2.56	211.16^{f}±15.19
D_3* A_2	862.58±21.10	438.83^{a}±21.72	12.53±2.56	451.36^{a}±2.56	411.30^{e}±15.19
D_3* A_3	1203.55±21.10	400.30^{a}±21.72	12.19±2.56	412.49^{a}±2.56	791.06^{c}±15.19

a, b, c and d : Means in the same column having different superscripts differ significantly (p<0.05).
N.S. = not significant.
*= significant at 0.05 level.

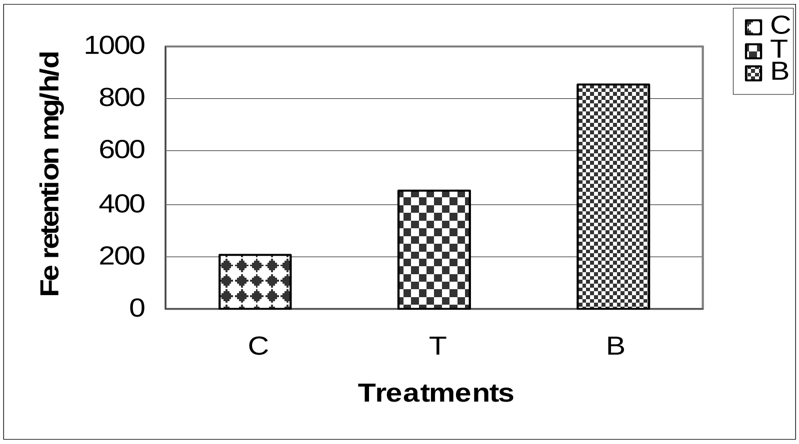

Fig.(5):Effect of additives on iron retention mg/h/d.
C: control
T: tafla
B:bentofarm

835.65, 855.17 and 810.12 for D_1, D_2 and D_3 respectively.

Fecal and urinary iron excretion were significant ($P<0.05$) among all diets, the mean values of fecal excretion being 322.24, 286.02 and 326.84 g/h/d and the mean values of urinary iron excretion being 22.76, 13.54 and 12.12 g/h/d for D_1, D_2 and D_3, respectively.

In addition to, the results of iron retention showed significantly ($P<0.05$) higher values with D_2 (544.50 mg/h/d) compared with D_1 and D_3 (490.65 and 471.17 g/h/d), respectively.

4.1.9.2. Effect of additives (A).

The results of daily iron intake significantly ($P<0.05$) increased as a result of tafla or bentofarm supplementation compared with the control treatment. The mean values of iron intake were 883.47, 1231.37and 386.10 mg/h/d) for A_1, A_2 and A_3, respectively.

Fecal excretion of iron was significantly (P<0.05) increased with tafla and bentofarm inclusion (417.52 and 351.80 mg/h/d) compared with the control (A_1) one (165.78 g/h/d), respectively.

Urinary iron excretion was nearly similar among treatments which ranged from 15.05 to 17.27 g/h/d. Also, the values of total iron excretion was significantly (P<0.05) higher with tafla and betofarm addition (433.62 and 380.19 mg/h/d) comparable to the control without addition (179.21 g/h/d), respectively.

Also, the values of iron retention showed significantly (P<0.05) higher values with tafla and bentofarm treatments (449.87 and 851.18 mg/h/d) than with the control treatment (205.26), respectively.

4.1.9.3. Interaction effect between diets and additives.

The results of the interaction effect on daily iron intake and urinary iron excreted showed no significant differences among treatments.

Fecal and total iron excreted showed significant (P<0.05) differences among treatments. The highest values of fecal and total iron excreted were obtained from D_3*A_2 and D_2*A_3 treatment (451.36 and 925.94), while the lowest values recorded from D_3 $A_1$and D_1 A_1 treatment (148.19 and 180.97 g/h/d), respectively.

Also, the interaction effect on iron balance showed significant differences among treatments. The highest value of iron was obtained from D_2*A_3 treatment (925.94 g/h/d), while the lowest values recorded with D_1*A_1 treatment (180.97 g/h/d).

4.1.10. Copper retention:

The daily copper intakes, copper excreted in feces and urine and copper retention are presented in Table (12).

4.1.10.1. Effect of diet (D).

The results of daily copper intake significantly ($P<0.05$) decreased in D_1 (44.67 mg/h/d) compared to D_2 and D_3 (53.27 and 53.48 g/h/d), respectively.

Fecal and urinary excretion values of copper showed significant ($P<0.05$) differences among all diets. The mean values of fecal copper being 22.86, 27.19 and 31.78 gm /h/d and the mean values of urinary copper being 1.67, 1.03 and 1.27mg/h/d for D_1, D_2 and D_3 respectively.

The mean values of total excreted copper showed significant ($P<0.05$) differences among all diets, the highest value was obtained from D_3 (33.06 mg/h/d), while the lowest value recorded with D_1 (24.53 mg/h/d).

Concerning, the results of copper retention showed there are no significant differences among all diets.

4.1.10.2. Effect of additives (A).

The results of daily copper intake, fecal, urinary and total copper excreted and copper retention as mg/h/d showed no significant differences among treatments.

4.1.10.3. Interaction effect between diets and additives (A).

The interaction effect showed no significant effect on daily copper intake, fecal copper, urinary, total excreted and copper retention as mg/h/d.

Table (12): Effect of tafla or bentofarm supplementation and its interaction effect on copper retention as mg/h/d ($\overline{X}$ ±SE).

Items	Daily Cu intake (mg/h/d)	Fecal Cu (mg/h/d)	Urinary Cu (mg/h/d)	Total Cu excreted (mg/h/d)	Cu retention ((mg/h/d)
Effect of diets (D)	*	*	*	*	N.S
D_1 (100%B)	44.67^b±1.75	22.86^b±1.71	1.67^a±.12	24.53^b±1.74	20.14±1.93
D_2 (50%B * 50 %C)	53.27^a±1.75	27.19^{ab}±1.71	1.03^b±.12	28.22^{ab}±1.74	25.04±1.93
D_3 (100%C)	53.48^a±1.75	31.78^a±1.71	1.27^b±.12	33.06^a±1.74	20.42±1.93
Effect of additives(A)	N.S	N.S	N.S	N.S	N.S
A_1 (Control)	51.91±1.75	25.75±1.71	1.25±.12	27.01±1.74	24.89±1.93
A_2 (Tafla)	51.51±1.75	30.40±1.71	1.26±.12	31.67±1.74	19.84±1.93
A_3 (Bentofarm)	48.02±1.75	25.68±1.71	1.45±.12	27.14±1.74	20.88±1.93
Interaction effect (D*A)	N.S	N.S	N.S	N.S	N.S
D_1* A_1	43.21±3.03	21.17±2.96	1.59±.22	22.76±3.02	20.45±3.34
D_1* A_2	46.52±3.03	26.42±2.96	1.52±.22	27.94±3.02	18.57±3.34
D_1* A_3	44.29±3.03	20.98±2.96	1.90±.22	22.88±3.02	21.40±3.34
D_2* A_1	57.44±3.03	25.52±2.96	1.23±.22	26.75±3.02	30.69±3.34
D_2* A_2	52.82±3.03	30.50±2.96	.95±.22	31.45±3.02	21.36±3.34
D_2* A_3	49.56±3.03	25.56±2.96	.91±.22	26.47±3.02	23.09±3.34
D_3* A_1	55.07±3.03	30.56±2.96	.95±.22	31.52±3.02	23.55±3.34
D_3* A_2	55.19±3.03	34.28±2.96	1.32±.22	35.60±3.02	19.58±3.34
D_3* A_3	50.20±3.03	30.51±2.96	1.55±.22	32.06±3.02	18.14±3.34

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

4.1.11. Zinc retention:

The daily zinc intake, zinc excretion in feces and urine and zinc retention are presented in Table (13) and Fig. (6).

4.1.11.1. Effect of diet (D).

The average daily zinc intake significantly ($P<0.05$) increased in D_2 and D_3 (78.88 and 96.08 mg/h/d) compared to D_1 (58.63 mg/h/d), respectively.

The results of fecal zinc excretion showed significant ($P<0.05$) differences among all diets. The mean values of fecal zinc were 47.81, 52.44 and 68.66 for D_1, D_2, and D_3 respectively.

Also, the results of urinary excretion showed significantly ($P<0.05$) lower values with in D_2 and D_3 (0.12 and 0.12 mg/h/d) compared to D_1 (1.78 mg/h/d). However, total zinc excreted and zinc retention as mg/h/d showed significant ($P<0.05$) difference among all diets. The mean values of total zinc excreted were 49.6% 53.24 and 69.51 mg/h/d and the mean values of zinc retention were 9.02, 25.34 and 26.56 mg/h/d for D_1, D_2 and D_3, respectively.

4.1.11.2. Effect of additives (A).

The daily zinc intake was significantly ($P<0.05$) differed among treatments, the mean values of zinc intake were 80.11, 79.85 and 73.63 for control, tafla and bentofarm, respectively. Fecal and urinary excretions of zinc were nearly similar among treatments which ranged from 54.40 to 59.82 mg/h/d for feces and 1.25 to 1.32 mg/h/d for urine. The mean values of total excreted zinc were 55.66, 61.07 and 55.93 for A_1, A_2 and A_3, respectively.

Table (13): Effect of tafla or bentofarm supplementation and its interaction effect on zinc retention as mg/h/d ($\overline{X}$ ±SE).

Items	Daily Zn intake (mg/h/d)	Fecal Zn (mg/h/d)	Urinary Zn (mg/h/d)	Total Zn excretedm (g/h/d)	Zn retention (mg/h/d)
Effect of diets (D)	*	*	*	*	*
D_1 (100%B)	58.63^{c}± 2.81	47.81^{b}±1.88	1.78^{a}± 0.12	49.60^{b}± 1.86	9.02^{b}±2.10
D_2 (50%B * 50 %C)	78.88^{b}± 2.81	52.44^{b}±1.88	$.12^{b}$± 0.12	53.54^{b}± 1.86	25.34^{a}±2.10
D_3 (100%C)	96.08^{a}± 2.81	68.66^{a}±1.88	$.12^{b}$± 0.12	69.51^{a}± 1.86	26.56^{a}±2.10
Effect of additives(A)	**N.S**	**N.S**	**N.S**	**N.S**	*
A_1 (Control)	80.11± 2.81	54.40±1.88	1.25± 0.12	55.66± 1.86	24.45^{a}±2.10
A_2 (Tafla)	79.85± 2.81	59.82±1.88	1.26± 0.12	61.07± 1.86	18.77^{ab} ±2.10
A_3 (Bentofarm)	73.63± 2.81	54.70±1.88	1.32± 0.12	55.93± 1.86	17.70^{b}±2.10
Interaction effect (D*A)	**N.S**	*	**N.S**	*	**N.S**
D_1* A_1	56.71±4.87	40.66^{d}±3.26	1.60±.20	42.27^{e}±3.22	14.44±3.64
D_1* A_2	61.04±4.87	52.62^{c}±3.26	1.95±.20	54.57^{cd}±3.22	6.47±3.64
D_1* A_3	58.12±4.87	50.16^{cd}±3.26	1.80±.20	51.96^{de}±3.22	6.16±3.64
D_2* A_1	85.43±4.87	$58.83b^{c}$±3.26	1.27±.20	60.10^{bcd}±3.22	25.32±3.64
D_2* A_2	78.00±4.87	50.04^{cd}±3.26	.83±.20	50.87^{de}±3.22	27.13±3.64
D_2* A_3	73.22±4.87	48.44^{cd}±3.26	1.22±.20	49.66^{de}±3.22	23.56±3.64
D_3* A_1	98.20±4.87	63.71^{b}±3.26	.90±.20	64.61^{bc}±3.22	33.59±3.64
D_3* A_2	100.51±4.87	76.80^{a}±3.26	.98±.20	77.78^{a}±3.22	22.73±3.64
D_3* A_3	89.54±4.87	65.49^{b}±3.26	$.93^{d}$±.20	66.16^{b}±3.22	23.38±3.64

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$).
N.S. = not significant.
*= significant at 0.05 level.

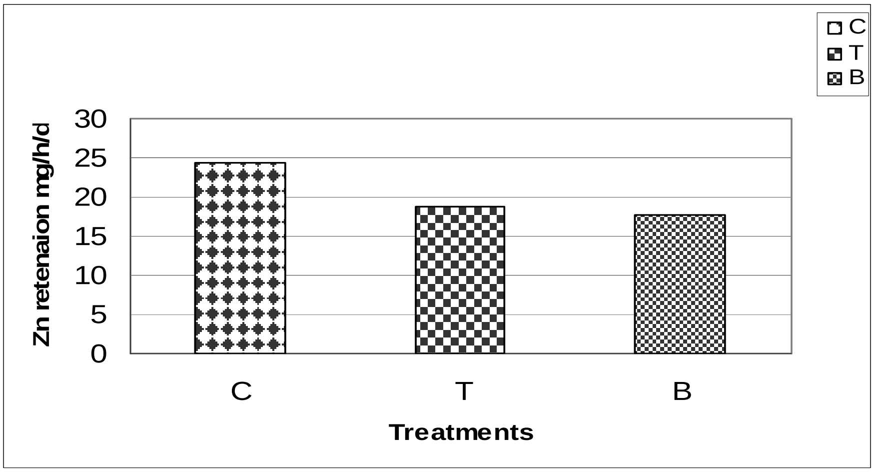

Fig. (6): Effect of additives on zinc retention mg/h/d.
C: control
T: tafla
B:bentofarm

The results of zinc retention showed significant ($P<0.05$) differences among all treatments. The highest value of zinc retention was obtained from control (24.45 mg/h/d), while the lowest value was recorded with bentfarm (17.70 mg/h/d).

4.1.11.3. Interaction effect between diets and additives.

The interaction effect showed no significant effect on daily zinc intake, urinary zinc excreted and zinc retention as mg/h/d.

The interaction effect on fecal and total zinc excreted as mg/h/d showed significant ($P<0.05$) differences among all treatments. The highest values of fecal and total zinc excreted was obtained from D_3*A_2 treatment (76.80 and 77.78 mg/h/d) respectively, while the lowest value of fecal and total zinc excreted was recorded with $D_{1*}A_1$ treatment (40.66 and 42.27 mg/h/d), respectively.

4.1.12. Blood parameters:

4.1.12.1. Serum analysis.

Total protein, albumin and creatinine are presented in Table (14).

4.1.12.1.1. Effect of diet (D).

The mean values of serum total protein before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among all treatments. The mean values of serum total protein before feeding were 6.31, 6.68 and 7.70 mg/dl and the mean values of total protein at 3hr. after feeding being 7.29, 7.51 and 8.33 mg/dl for D_1, D_2 and D_3, respectively.

The results of albumin before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among all diets. The mean values of albumin before feeding were 4.36, 4.54 and 4.67 mg/h/d and the mean values after feeding were 4.74, 4.37 and 4.67 mg/dl for D_1, D_2 and D_3, respectively.

Also, the results of serum creatinine before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among all diets. The highest values of creatinine at 0hr. and 3hr. after feeding were obtained from D_3 and D_1 (1.42 and 1.52 mg/dl), while the lowest values were recorded with D_2 and D_3 (1.25 and 1.25 mg/h/d), respectively.

4.1.12.1.2. Effect of additives (A).

The results of serum total protein percentages at 0hr. before feeding and 3hr. after feeding indicated that there is no

Table (14): Effect of tafla or bentofarm supplementation and its interaction effect on some blood serum parameters of sheep ($\bar{X}$ ±SE).

Items	Total protein g/dl		Albumin g/dl		Creatinine mg/dl	
	0 hr.	3 hr.	0 hr.	3 hr.	0 hr.	3 hr.
Effect of diets (D)	*	*	*	*	*	*
D$_1$ (100%B)	6.31^{b}±.29	7.29^{b}±0.24	4.36^{b}±0.09	4.74^{a}±0.07	1.30^{ab}±.05	1.52^{a}±±.07
D$_2$ (50%B * 50 %C)	6.68^{b}±.29	7.51^{b}±0.24	4.54^{ab}±0.09	4.37^{b}±0.07	1.25^{b}±.05	1.37^{ab}±.±.07
D$_3$ (100%C)	7.70^{a}±.29	8.33^{a}±0.24	4.67^{a}±0.09	4.67^{a}±0.07	1.42^{a}±.05	1.25^{b}±±.07
Effect of additives(A)	N.S	N.S	*	*	*	N.S
A$_1$ (Control)	7.08±.29	7.71±0.24	4.31^{b}±0.09	4.45^{b}±0.07	1.41^{a}±.05	1.42±±.07
A$_2$ (Tafla)	6.75±.29	7.87±0.24	4.63^{a}±0.09	4.68^{a}±0.07	1.21^{b}±.05	1.25±±.07
A$_3$ (Bentofarm)	6.85±.29	7.55±0.24	4.63^{a}±0.09	4.64^{ab}±0.07	1.35^{ab}±.05	1.46±.07
Interaction effect (D*A). *	N.S	N.S	*	*	N.S	N.S
D$_1$* A$_1$	6.95^{abc}±.51	6.93±.40	4.18±.16	4.79^{a}±.12	1.23^{bcd}±.08	1.47±.12
D$_1$* A$_2$	5.39^{c}±.51	7.43±.40	4.36±.16	4.58^{abc}±.12	1.46^{b}±.08	1.52±.12
D$_1$* A$_3$	6.60^{abc}±.51	7.51±.40	4.53±.16	4.85^{a}±.12	1.21^{bcd}±.08	1.57±.12
D$_2$* A$_1$	7.38^{ab}±.51	7.93±.40	4.40±.16	4.21^{c}±.12	1.27^{bcd}±.08	1.58±.12
D$_2$* A$_2$	6.92^{abc}±.51	7.76±.40	4.62±.16	4.56^{abc}±.12	1.05^{d}±.08	1.14±.12
D$_2$* A$_3$	5.73^{bc}±.51	6.85±.40	4.61±.16	4.32^{c}±.12	1.45^{b}±.08	1.39±.12
D$_3$* A$_1$	6.92^{abc}±.51	8.27±.40	4.36±.16	4.36^{bc}±.12	1.74^{a}±.08	1.20±.12
D$_3$* A$_2$	7.95^{a}±.51	8.43±.40	4.90±.16	4.90^{a}±.12	1.13^{cd}±.08	1.11±.12
D$_3$* A$_3$	8.23^{a}±.51	8.29±.40	4.74±.16	4.74^{ab}±.12	1.39^{bc}±.08	1.44±.12

a, b and c : Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

Expected value:

Total protein g/dl: 5.2- 9.1

Albumin g/dl: 3.5-5.0

Creatinine mg/dl: 0.7-1.4

significant difference among treatments. The mean values of total protein at 0hr. 7.08, 6.75 and 6.85and at 3hr. after feeding were 7.71, 7.87and 7.55 mg % for control, tafla and bentofarm respectively. These results greed with those reported by **Abbas (2003)** who reported that serum total protein was not significantly affected by clay supplementation in lamb's diet. Also, **Katsoulos, *et al.* (2006)** reported that serum total protein concentrations did not significantly affect by addition of clinoptiolite at 1.25 and 5% to Holstein cows diet.

The men values of serum albumin before feeding and 3hr. after feeding significantly (P<0.05) increased by addition of tafla or bentofarm compared with the control treatment. The mean values of serum albumin at 0hr. before feeding were 4.31, 4.63 and 4.63mg/dl and the mean values at 3hr. after feeding were 4.45, 4.68 and 4.64 mg/d/l for control, tafla and bentofarm, respectively. These results were similar to those found by **Saleh *et al.* (1999)** who found that addition of sodium bentonite at 3 and 6% of concentrate to lactating buffalo significantly (P<0.05) increased serum albumin. On the other side, **Abbas (2003)** found that lambs fed a high concentrate diet ad libtum for 8 weeks with 3% natural clay had no significant effect on total protein and albumin.

The results of serum creatinine before feeding significantly (P<0.05) decreased by addition of tafla or bentofarm compared with the control treatment. The mean values of creatinine at 0hr. were 1.41, 1.21 and 1.35mg/dl for control or tafla and bentofarm, respectively. However, the results of serum creatnine at 3hr. after feeding showed no significant differences among in all treatments. These results are in agreement with those of **Gabr et al. (2003)** who found that most of blood continents were not significantly affected by adding of bentonite to the tested rations. The obtained results of creatinine showed that addition of tafla or bentofarm had no adverse effects on kidney functions.

4.1.12.1.3. Interaction effect between diet and additives.

The results of the interaction effect on serum urea at 0hr., total protein at 3hr. after feeding, Albumin at 0hr and creatinine at 3hr. after feeding showed no significant differences among treatments. The results of the interaction effect on serum total protein before feeding, significantly ($P<0.05$) affected by treatments. The highest values of serum total protein at 0hr. were obtained from D_3*A_3 treatments 8.23mg/dl, while the lowest values were recorded with D_1*A_2 treatments 5.39 mg/dl, also, the results of serum albumin at 3hr. after feeding and creatinine before feeding showed significant ($P<0.05$) differences among treatments. The highest values of albumin at 3hr after feeding and creatinine at 0hr. before feeding were obtained from D_3*A_2 and D_3*A_1 treatments (4.90 and 1.74mg/dl), while the lowest values with recorded from D_2*A_1 and D_2*A_2 treatments (4.21 and 1.05mg/dl), respectively.

4.1.13. Serum enzymes and hormones activity:

The results of serum AST, ALT, T_3 and T_4 for sheep which fed on different experimental diets are presented in Table (15).

4.1.13.1. Effect of diet (D).

Serum AST at 0hr. before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among diets. The highest values of AST at 0hr. and 3hr. after feeding were

Table (15): Effect of tafla or bentofarm supplementation and its interaction effect on serum enzymes and hormones activity by sheep ($\bar{X}$ ±SE).

Items	AST U/L		ALT U/L		T_3 n mol/L	T_4 n mol/L
	0 hr.	3 hr.	0 hr.	3 hr.	0 hr.	3 hr.
Effect of diets (D)	*	*	*	N.S	*	*
D_1 (100%B)	62.50^{c}±2.96	62.00^{b}±3.70	12.16^{b}±.83	16.66±1.96	2.04^{c}±.08	87.19^{b}±2.84
D_2 (50%B * 50 %C)	83.16^{a}±2.96	69.16^{ab}±3.70	18.66^{a}±.83	18.66±1.96	3.38^{a}±.08	124.47^{a}±2.84
D_3 (100%C)	74.16^{b}±2.96	79.00^{a}±3.70	13.00^{b}±.83	19.44±1.96	2.70^{b}±.08	128.81^{a}±2.84
Effect of additives(A)	N.S	*	N.S	N.S	N.S	*
A_1 (Control)	75.66±2.96	73.83^{a}±3.70	14.33±.83	18.00±1.96	2.73±.08	116.65^{a}±2.84
A_2 (Tafla)	68.00±2.96	59.33^{b}±3.70	15.83±.83	15.88±1.96	2.60±.08	101.28^{b}±2.84
A_3 (Bentofarm)	76.16±2.96	77.00^{a}±3.70	13.66±.83	20.88±1.96	2.80±.08	122.53^{a}±2.84
Interaction effect (D*A	*	*	*	*	*	*
D_1* A_1	67.50^{bcd}±5.12	50.00^{cd}±6.42	12.00^{cd}±1.44	16.66^{bc}± 3.40	2.49^{c}±.14	99.50^{c}±4.92
D_1* A_2	63.00^{cd}±5.12	47.00^{d}±6.42	14.50^{c}±1.44	14.66^{bc}± 3.40	1.80^{d}±.14	67.74^{d}±4.92
D_1* A_3	57.00^{d}±5.12	89.00^{a}±6.42	10.00^{cd}±1.44	18.66^{abc}± 3.40	1.82^{d}±.14	94.31^{c}±4.92
D_2* A_1	89.00^{a}±5.12	82.50^{a}±6.42	19.00^{b}±1.44	8.00^{c}± 3.40	2.74^{c}±.14	115.56^{b}±4.92
D_2* A_2	78.00^{abc}±5.12	57.00^{bcd}±6.42	25.00^{a}±1.44	23.00^{ab}± 3.40	3.49^{b}±.14	119.80^{b}±4.92
D_2* A_3	82.50^{ab}±5.12	68.00^{abc}±6.42	12.00^{cd}±1.44	25.00^{ab}± 3.40	3.93^{a}±.14	138.05^{a}±4.92
D_3* A_1	70.50^{bcd}±5.12	89.00^{a}±6.42	12.00^{cd}±1.44	29.33^{a}± 3.40	2.95^{c}±.14	134.90^{a}±4.92
D_3* A_2	63.00^{cd}±5.12	74.00^{ab}±6.42	8.00^{d}±1.44	10.00^{c}± 3.40	2.50^{c}±.14	116.30^{b}±4.92
D_3* A_3	89.00^{a}±5.12	74.00^{ab}±6.42	19.00^{b}±1.44	19.00^{abc}± 3.40	2.66^{c}±.14	135.25^{a}±4.92

a, b, c and d: Means in the same column having different superscripts differ significantly ($p<0.05$).

N.S. = not significant.

*= significant at 0.05 level.

Expected value:

AST U/L: Up to 40

ALT U/L: Up to 12

T_3 n mol/L:2.9-8.05

T_4 n mol/L: 58-161

obtained from D_2 and D_3 (83.16 and 79.00U/L), while the lowest values were recorded with D_1 (62.50 and 62.00, U/L), respectively.

The results of ALT at 0hr. before feeding significantly (P<0.05) higher in D_2 (18.66 μ/L) compared with D_1 and D_2 (12.16 and 13.00 μ/L), while the results of ALT at 3hr. after feeding showed no significant differences among treatments.

The obtained results of T_3 concentration in blood serum at 3hr. after feeding significantly (p<0.05) higher in D_2 (3.38nmol/l) compared to D_1 and D_3 (2.04 and 2.70nmol/l), respectively. Also, the obtained results of T_4 concentration in blood serum at 3hr. after feeding were significantly (p<0.05) higher in D_2 and D_3 (124.47 and 128.81nmol/L) compared to D_1 (87.19 nmol /L) respectively.

4.1.13.2. Effect of additives (A).

The results of AST at 0hr. showed no significant differences among treatments. On the other side, AST at 3hr. after feeding was significantly (P<0.05) lower in tafla treatment (59.33 μ/L) compared with the control and bentofarm treatment (73.83 and 77.00 μ/L), respectively.

The values of ALT at 0hr. before feeding and 3hr. after feeding showed no significant differences among treatments. Similar results were obtained by **Katsoulose, *et al.* (2006)** who reported that addition of clineptilolite at 1.25 and 5% to Holstein cow's diet had no apparent adverse effects on their liver function.On the other hand, **Saleh et al. (1999)** who found that addition of bentonite at 3 and 6% to lactating buffalo diets increased plasma AST and ALT. Also, **Hassona *et al.* (1999)**

found that inclusion of tafla at 3% to sheep rations increased AST and ALT concentration in blood. However, **Salem *et al.* (200l)** reported that addition of bentonite at 4 or 8% in growing lambs diet significantly (P<0.05) decreased concentration of serum AST.

The results of T_3 at 3hr. after feeding showed no significant differences among treatments. The mean values of T_3 at 3hr. after feeding being 2.73, 2.60 and 2.80 nmol/L for control, tafla and bentofarm, respectively.

Concerning, the results of T_4 significantly (P<0.05) decreased in tafla treatment (101.28nmol/L) compared with the control and bentofarm treatments (116.65 and 122.53 nmol/L), respectively, the results agreed with those reported by **Abd El-Baki et al. (1988)** who found that inclusion of tafla at 3% to calves rations significantly (P<0.05) increased T_3 while, the increase of T_4 level was not significant.

4.1.13.3. Interaction effect between diets and additives (A).

The results of the interaction effect between diets and additives on serum AST at 0hr. before feeding and 3hr. after feeding showed significant (P<0.05) differences among treatments. The highest values of AST at 0hr. and 3hr. after feeding were obtained from D_3*A_3, D_2*A_1 and D_1*A_3, D_3*A_1 (89.00 and 89.00 μ/L), while the lowest values were recorded with D_1*A_3 and D_1*A_2 (57.00 and 47.00 μ/L), respectively. Also, the results of the interaction effect on serum ALT at 0hr. before feeding and 3hr. after feeding showed significant (P<0.05) difference among the treatments. The highest values of serum ALT at 0hr. and 3hr. after feeding were obtained from

D_2*A_2 and D_3*A_1 treatments (25.00 and 29.33 μ/L), while the lowest value was recorded with (D_3*A_2 and D_2*A_1 treatments (8.00 μ/L), respectively. Also, the results of the interaction effect on serum T_3 and T_4 showed significant ($P<0.05$) differences among treatments. The highest values of T_3 and T_4 was obtained from D_2*A_3 treatment (3.93 and 138.05 nmol/L), while the lowest values were recorded from D_1*A_2 treatment (1.80 and 67.74 nmol/L), respectively.

4.1.14. Serum minerals:

The mineral contents in blood serum for the different experimental treatments of rams are presented in Table (16).

4.1.14.1. Effect of diets (D).

The obtained value of calcium concentration in blood serum at 0hr. before feeding was significantly ($P<0.05$) higher in D_3 (15.59mg/dl) compared with D_1 and D_2 (13.51 and 13.97mg/dl) respectively, but the values of serum calcium at 3hr. after feeding showed no significant differences among all diets.

The results of phosphorus in blood serum at 0hr. before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among diets. The mean values of serum phosphorus at 0hr. before feeding were 14.16, 13.52 and 19.03 mg/dl and the mean values at 3hr. after feeding were 12.15, 12.83 and 18.64mg/dl for D_1, D_2 and D_3 respectively.

Also, the results of blood serum magnesium at 0hr. before feeding showed significant ($P<0.05$) differences among diets. The highest values of serum magnesium at 0hr. before feeding was obtained from D_3 (3.21mg/dl), while the lowest values was

Table (16): Effect of tafla or bentofarm supplementation and its interaction effect on blood serum mineral contents by sheep ($\overline{X}$ ±SE).

Items	Calcium mg/dl		Phosphorus mg/dl		Magnesium mg/dl	
	0 hr.	3 hr.	0 hr.	3 hr.	0 hr.	3 hr.
Effect of diets (D)						
	*	N.S	*	*	*	N.S
D_1 (100%B)	13.51^b±.43	14.06±.61	14.16^b±0.84	12.15^b±.68	2.73^b±.12	3.60±.14
D_2 (50%B * 50 %C)	13.97^b±.43	13.55±.61	13.52^b±0.84	12.83^b±.68	2.88^{ab}±.12	3.22±.14
D_3 (100%C)	15.59^a±.43	15.48±.61	19.03^a±0.84	18.64^a±.68	3.21^a±.12	3.52±.14
Effect of additives(A)						
	*	N.S	N.S	*	N.S	N.S
A_1 (Control)	15.12^a±.43	14.18±.61	14.24±0.84	13.22^b±.68	2.91±.12	3.60±.14
A_2 (Tafla)	14.71^a±.43	15.04±.61	15.70±0.84	14.10^b±.68	2.94±.12	3.28±.14
A_3 (Bentofarm)	13.24^b±.43	13.87±.61	16.77±0.84	16.30^a±.68	2.97±.12	3.46±.14
Interaction effect (D*A)						
	*	N.S	*	*	N.S	N.S
D_1* A_1	15.45^b±.76	14.80±1.07	14.74^{bc}±1.45	14.03^c±1.18	2.74±.21	3.74±0.25
D_1* A_2	12.23^d±.76	12.93±1.07	11.52^{cd}±1.45	10.56^c±1.18	2.73±.21	3.44±0.25
D_1* A_3	12.84^{cd}±.76	14.45±1.07	16.23^{bc}±1.45	11.86^c±1.18	2.73±.21	3.63±0.25
D_2* A_1	15.27^{bc}±.76	13.81±1.07	13.36^{bcd}±1.45	11.11^c±1.18	2.73±.21	3.50±0.25
D_2* A_2	14.10^{bcd}±.76	14.34±1.07	17.47^b±1.45	13.64^c±1.18	2.92±.21	3.06±0.25
D_2* A_3	12.54^d±.76	12.50±1.07	9.73^d±1.45	13.75^c±1.18	2.98±.21	3.10±0.25
D_3* A_1	14.64^{bcd}±.76	13.92±1.07	14.63^{bc}±1.45	14.52^c±1.18	3.25±.21	3.56±0.25
D_3* A_2	17.80^a±.76	17.85±1.07	18.10^b±1.45	18.10^b±1.18	3.18±.21	3.35±0.25
D_3* A_3	14.34^{bcd}±.76	14.68±1.07	24.36^a±1.45	23.28^a±1.18	3.20±.21	3.66±0.25

a, b, c and d : Means in the same column having different superscripts differ significantly ($p<0.05$).
N.S. = not significant.
*= significant at 0.05 level.

recorded from D_1 (2.73mg/dl), but the values of magnesium at 3hr. after feeding showed no significant among diets.

4.1.14.2. Effect of additives (A).

The results of calcium concentration in blood serum at 0hr. before feeding significantly ($P<0.05$) decreased by addition of bentfarm (13.24mg/dl) compared with the control and tafla treatments (15.12 and 14.171mg/dl), respectively. However, the mean values of serum calcium at 3hr. after feeding showed no significant differences among treatments. These results are in agreements with those described by **Dembinski et al. (1985[a])** who found that adding 2% bentonite to dairy cattle reduced calcium concentration compared to the control group. Also, **Fisher and Mackay (1983), Moate et al. (1985), Noware et al. (1993) and Bosi et al. (2002)** found that adding clays to sheep rations did not effect on plasma calcium.

Concerning, the results of phosphorus concentration in blood serum at 0hr. before feeding increased by supplementation of tafla or bentofarm but the differences among treatments were not significant. Also, the results of serum phosphorus at 3hr. after feeding significantly ($P<0.05$) higher in bentofarm (A_3) treatment (16.30mg/dl) compared to the control and tafla treatments (13.22 and 14.10mg/dl), respectively. These results are in agreements with those of **Tret *et al* (1985)** who found that addition of zeolite at 1g/kg body weight daily in cow's diet increased the serum phosphorus. Also, **Fisher and Mackay (1983)** reported that plasma phosphorus did not influenced by addition of bentonite at 0.6 or 1.2% to lactation cows. On the other hand, **Dembinski et al, (1985 [a])** found that concentration of inorganic phosphorus in serum was lower than the value of control by adding 2% bentonite to dairy cattle. Also, **Grabherr et al. (2009)** found that in dairy cows given synthetic zeolite at 90g/kg dry matter daily significantly ($P<0.05$) decreased serum phosphorus.

The results of serum magnesium at 0hr and 3hr after feeding indicated that there were no significant differences among all treatments. The mean values of serum magnesium at 0hr. were 2.91, 2.94 and 2.97 mg/dl, while the mean values of serum magnesium at 3hr. after feeding were 3.60, 3.28 and 3.46mg/dl for control, tafla and bentofarm respectively. The obtained results are in agreement with some of the results reported by **Moate et al. (1985) Nikkhah et al. (2003)** who found that the plasma magnesium concentration did not affected by clay supplementation. On the other side, **Dembinski, *et al*. (1985[a])** who reported that concentration of magnesium in serum lower than that of in the control by adding 2% bentonite to dairy cattle.

4.1.14.3. Interaction effect between diets and supplementation:

The results of the interaction effect on blood serum calcium at 0hr. before feeding showed significant ($P<0.05$) differences among treatments. The highest value of serum calcium at 0hr. before feeding was obtained from D_3*A_2 treatment (17.80mg/dl), while the lowest value was recorded from D_1*A_2 (12.23mg/dl). However, the results of serum calcium at 3hr. after feeding and serum magnesium at 0hr. before feeding showed no significant differences among treatments.

In addition to, the results of serum phosphorus at 0hr. before feeding and 3hr. after feeding showed significant (P<0.05) differences among treatments. The highest values of serum phosphorus at 0hr. before feeding and 3hr. after feeding were obtained from D_3*A_3 treatment (24.36 and 23.28mg/dl), while the lowest values were recorded with D_2*A_3 and D_2*S_1 treatments (9.73 and 11.11 mg/dl), respectively.

4.2. The second experiment:

Regarding to the obtained results from the digestibility trials the second experiment was designed to applied of the treatments of the 2^{nd} and 3^{rd} main tested groups (T_4-T_9) in growth trials on growing lambs.

4.2.1. Growth performance:

Growth performance results of lambs are shown in Table (17) and Fig (7& 8).

4.2.1.1. Effect of diet:

The results of daily feed intake as DMI, TDN and DCP showed significant (P<0.05) higher values in D_2 (100 % concentrate) compared with D_1 (50% berseem plus 50 % concentrate), the mean values were 780.21and 969.83 g/d for DMI, 546.66 and 692.76 g/d for TDN and 94.77and 115.31g/d for DCP for D_1 and D_2, respectively.

Final body weight, total gain and average daily gain slightly increased in D_1 compared with D_2, but the differences between diets were significant. The mean values for final body weight, were 37.18 and 35.83 kg, 18.66 and 18.15 kg for total gain an

Table (17): Effect of diets and additives and their interaction effect on daily feed intake, average daily body gain and feed conversion of lambs ($\overline{X}$ ±SE).

Items	Daily feed intake(g)			Initial body weight (kg)	Final body weight (kg)	Total gain (kg)	Average daily gain (g)	Feed conversion		
	DMI(g/d)	TDN (g/d)	DCP(g/d)					kg DM/kg gain	kg TDN/kg gain	kg DCP/kg gain
Effect of diets (D).										
	*	*	*	N.S	N.S	N.S	N.S	*	*	*
D_1 (50%B * 50 %C)	780.21^{b}±23.01	546.66^{b}±16.50	94.77^{b}±2.76	17.29±.69	37.18±.98	18.66±.65	176.86±5.98	4.49^{b}±0.24	3.14^{b}±0.14	0.54^{b}±0.03
D_2 (100%C)	969.83^{a}±23.01	692.76^{a}±16.50	115.31^{a}±2.76	16.91±.69	35.83±1.00	18.15±.65	172.31±5.98	5.75^{a}±0.24	4.06^{a}±0.14	0.70^{a}±0.03
Interaction effect (D*A)										
	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
A_1 (Control)	875.03±28.19	617.73±20.21	107.70±3.39	17.31±.86	36.33±1.23	17.80±0.84	168.33±7.33	5.30±.25	3.71±.17	0.65±.03
A_2 (Tafla)	869.24±28.19	617.90±20.21	102.66±3.39	16.88±.86	36.67±1.23	19.08±0.84	175.41±7.33	5.10±.25	3.60±.17	0.62±.03
A_3 (Bentofarm)	880.80±28.19	623.49±20.21	104.75±3.39	17.13±.86	36.52±1.18	18.33±0.84	180.01±7.33	4.96±.25	3.49±.17	0.60±.03
Interaction effect (D*A)										
	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
D_1* A_1	764.03±39.86	525.04±28.59	95.19±4.79	17.50±1.21	36.69±1.74	19.19±1.13	168.29±10.36	4.66±.35	3.20±0.25	0.57±.04
D_1* A_2	761.69±39.86	551.76±28.59	93.69±4.79	17.00±1.21	37.08±1.74	20.08±1.13	176.16±10.36	4.42±.35	3.20±0.25	0.54±.04
D_1* A_3	814.92±39.86	563.19±28.59	95.42±4.79	17.38±1.21	38.60±1.74	21.22±1.13	186.11±10.36	4.38±.35	3.02±0.25	0.52±.04
D_2* A_1	986.03±39.86	710.43±28.59	120.20±4.79	17.12±1.21	36.31±1.74	19.19±1.13	168.36±10.36	5.94±.35	4.22±0.25	0.72±.04
D_2* A_2	976.80±39.86	684.04±28.59	111.64±4.79	16.75±1.21	36.66±1.74	19.91±1.13	174.65±10.36	5.77±.35	4.00±0.25	0.71±.04
D_2* A_3	946.68±39.86	683.79±28.59	114.07±4.79	16.87±1.21	36.70±1.74	19.83±1.13	173.91±10.36	5.54±.35	3.96±0.25	0.66±.04

a and b : Means in the same column having different superscripts differ significantly ($P<0.05$), N.S. = not significant, *= significant at 0.05 level.

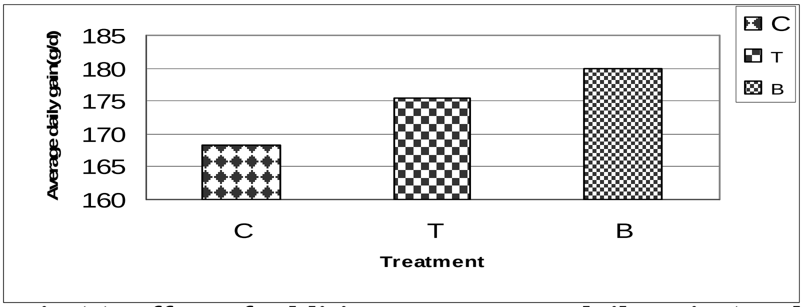

Fig.(7):Effect of additives on average daily gain (g/ d).

C: control

T: tafla

B:bentofarm

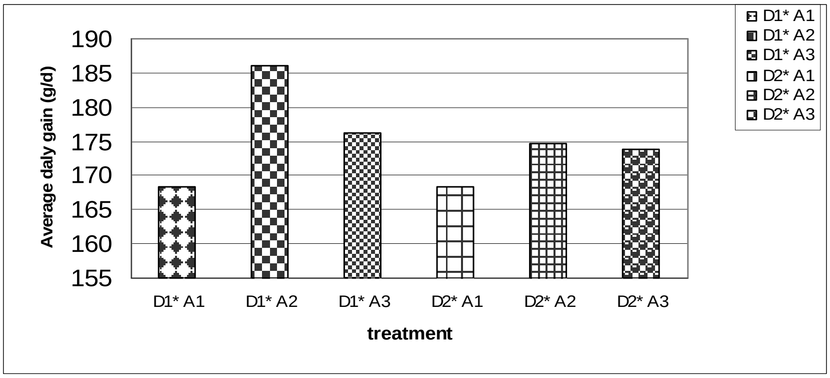

Fig.(8): Effect of the Interaction between diets and additives on average daily gain (g/ d).

C: control

T: tafla

B:bentofarm

176.86 and 172.31 g/d for average daily gain for D_1 and D_2, respectively.

Also, the results of feed conversion as kg DM/kg gain, kg TDN/ kg gain and kg DCP/ kg gain showed significant (P<0.05) higher values in D_2 (5.75, 4.06 and 0.70) comparable to values which obtained with D_1 (4.49, 3.14 and 0.54), respectively.

4.2.1.2. Effect of additives (A).

The results of daily feed intake as DMI, TDN and DCP showed no significant differences among treatments. The highest values of DMI, TDN obtained from A_3 (880.80, 623.49 g/d) and DCP obtained from A_1 (107.70 g/d) respectively, while the lowest values recorded from A_2 (869.24, 617.73 and 102.66 g/d), respectively. These results are in agreement with those of **Salem et al. (2001), Bulido and Fehring (2004), Yazdani *et al.* (2009), Grabherr *et al.* (2009)** and **Noromzian *et al.* (2010)**.

The results of final body weight and total gain slightly increased in tafla and bentofarm treatments compared to the control one but the differences between treatments were not significant. The mean values of final body weight were 36.33, 36.67 and 36.521kg and the mean values of total gain were 17.80, 19.08 and 18.33 for A_1, A_2 and A_3, respectively.

Also, the results of the average daily gain improved by 4.04% and 6.49% for lambs which fed rations supplemented with tafla and bentofarm, respectively, compared with unsupplemented ration, but the differences between treatments were not significant. The mean values of average daily gain were 168.33, 175.41and 180.01g/d for for A_1, A_2 and A_3, respectively. These results are in agreement with those of **Kuznetsov *et al*.**

(1993) and **El-Tahan et al. (2005)** who found that feeding rations containing 2 or 4% tafla improved body weight gain. Also, **Kuznetsov *et al.* (1993)** found that male cattle given a diets with 1.5 to 2% zeolite, gained 8% more body weight than did control. On the other side, **Ivan et al. (1992)** found that daily gain was significantly ($P<0.05$) decreased by addition of bentonite at 0.5% in sheep diets.

Also, the results of feed conversion as kg DM/kg gain, kg TDN/ kg gain and kg DCP/ kg gain slightly improved by addition of tafla or bentofarm compared to the control treatment but the differences between treatments were not significant. The mean values of DM/kg gain, kg TDN/ kg gain and kg DCP/ kg gain were nearly similar among treatments which ranged from 4.96to 5.30for DM, 3.49to 3.71 for TDN and .60 to .65 for DCP. These results are in agreement with those of **Norouzian et al. (2010)** who found that dry matter intake and feed conversation ratio were similar between the groups of lambs which fed different diets containing clinoptilolite at 1.5 or 3%.

4.2.1.3. Interaction effect between diet and additives.

The results of the interaction effect between diets and additives on final body weight, total gain, daily feed intake and feed conversion showed no significant differences among treatments.

4.2.2. Blood parameters:

4.2.2.1. Serum analysis:

The results of blood serum analysis for lambs fed on different experiment diets are presented in Table (18).

4.2.2.1.1. Effect of diet (D).

Table (18): Effect of diets and additives supplementation and its interaction effect on some blood constituents ($\overline{X}$ ±SE).

Items	Glucose mg/dl	Total protein mg/dl	Albumin, g/dl	AST U/L	ALT U/L	Creatinine mg/dl	Alk. Phosphatase I.U/L
Effect of diets (D)	N.S	*	*	N.S	N.S	N.S	*
D_1 (50%B * 50 %C)	46.87±1.74	4.70^{a}±.15	4.18^{b}±.06	28.33±.94	32.44±1.07	1.33±.05	242.24^{a}±9.8
D_2 (100%C)	49.58±1.74	7.63^{b}±.15	4.42^{a}±.06	29.22±.94	31.88±1.07	1.44±.05	174.36^{b}±9.8
Effect of additives(A)	N.S	N.S	N.S	N.S	*	N.S	N.S
A_1 (Control)	47.09±2.13	6.30±.19	4.19±.07	28.33±1.15	34.00^{a}±1.31	1.41±.06	195.40±12.01
A_2 (Tafla)	47.50±2.13	6.14±.19	4.36±.07	29.00±1.15	29.16^{b}±1.31	1.30±.06	205.72±12.01
A_3 (Bentofarm)	50.08±2.13	6.06±.19	4.36±.07	29.00±1.15	33.33^{a}±1.31	1.45±.06	223.79±12.01
Interaction effect (D*A)	N.S	N.S	N.S	N.S	N.S	N.S	*
D_1* A_1	47.91±3.01	4.59±.26	4.04±.10	28.33±1.63	34.33±1.85	1.40±.08	257.75^{a}±16.98
D_1* A_2	45.99±3.01	4.78±.26	4.24±.10	28.33±1.63	31.66±1.85	1.23±.08	243.53^{a}±16.98
D_1* A_3	46.71±3.01	4.73±.26	4.27±.10	28.33±1.63	31.33±1.85	1.37±.08	225.46^{a}±16.98
D_2* A_1	46.27±3.01	8.01±.26	4.34±.10	28.33±1.63	33.66±1.85	1.43±.08	133.05^{b}±16.98
D_2* A_2	49.02±3.01	7.50±.26	4.49±.10	29.66±1.63	26.66±1.85	1.37±.08	167.91^{b}±16.98
D_2* A_3	53.45±3.01	7.38±.26	4.45±.10	29.66±1.63	35.33±1.85	1.52±.08	222.13^{a}±16.98

a, b and c : Means in the same column having different superscripts differ significantly ($P<0.05$).
N.S. = not significant.
*= significant at 0.05 level.

Serum glucose, AST, ALT and creatinine showed no significant differences between diets.

Serum total protein and albumin showed significant ($P<0.05$) differences between diets, the mean values of serum total protein were 4.70 and 7.63 and the mean values of albumin were 4.18 and 4.42 for D_1 and D_2, respectively. Also, the alkaline phosphatase values significantly ($P<0.05$) decreased in D_2 (174.3b I.μ/L) compared with D_1 (242.24 I.μ/L).

4.2.2.1.2. Effect of additives (A).

The results of glucose in blood serum indicated that there are no significant differences were detected among treatments; the mean values of glucose were 47.09, 47.50 and 50.08 for control (A_1) tafla (A_2) and bentofarm (A_3), respectively. These results agree with that found by **Mohesen and Tawfik (2002)** who found that additions of bentonite had no effect on glucose in blood serum of Angora goats. Also, **Katosulos *et al*. (2006)** fed Holstein cow's zeolite at 1.25 and 5% and **Ghaemina et al. (2010)** found similar results by feeding lambs on zeolite at 3, 6 and 9%. On the other hand**, Saleh et al. (1999)** showed that the inclusion of bentonite at 3 and 6% of concentrate diet fed to lactating buffalo significantly ($P<0.05$) increased plasma glucose.

The results of serum total protein and albumin showed no significant differences among treatments, the mean values of serum total protein being 6.30, 6.14 and 6.06mg/dl and the mean values of serum albumin were 4.19, 4.36 and 4.36 mg/dl for control (A_1) tafla (A_2) and bentofarm (A_3) respectively. The present results are supported the findings of **Abbas (2003)** who reported that lambs fed a high concentrate diet ad libtum for 8 weeks with 3% natural clay did not significantly affect on serum total protein and albumin concentration. Also, **Gabr *et al*. (2003)** who reported the most of blood constituents were not significantly affected with adding bentonite to the tested rations. On the other hand, **Salem *et al*. (2001)** who found that albumin concentration significantly ($P<0.05$) decreased by addition of bentonite to growing lambs. Also, dietary treatment had no significant on AST contents among the experimental treatments. The mean values of ALT were nearly similar in all treatments which ranged from 28.33 to 29 U/L. These results were in a agreement with those found by **Katsoulos et al. (2006)** who reported that addition of clinoptilolite to diet of cows for long period had no, apparent adverse effect on their liver function. Also, **Rao *et al*. (2004)** found that supplementation of bentonite at 2kg per 100kg for young goats which, fed diets with or without added aflatoxin B1 did not significantly affect on serum AST (units/ml).On the other hand, **Salem *et al*. (2001)** reported that AST concentration significantly ($P<0.05$) decreased by addition of bentonite at 4 or 8% in growing diet.

Concerning, the results of serum ALT significantly ($P<0.05$) decreased by addition of tatla (A_2) or bentofarm (29.16 and 33.33 μ/L) compared with the control (A_1) treatment (34.00 μ/L). Similar results were found by **Abd El-Baki et al. (1988)** who found that blood serum ALT activity insignificantly decreased with kaolin and tafla at 3% and 3% urea in rations.

Also, the mean values of serum creatinine and serum alkaline phosphatase activity showed no significant differences among treatments. The mean values of serum creatinine being 1.41, 1.30 and 1.45mg/dl, and the mean values of alkaline phosphatase activity were 195.40, 205.72 and 223.79 for control (A_1) tafla (A_2) and bentofarm (A_3), respectively. The results agreed with those reported by **Aiad (1997) and Gabr et al (2003).**

4.2.2.1.3. Interaction effect between diets and additives.

The results of the interaction effect on some blood parameters are showed in Table (18). The obtained results of the interaction effect on serum, glucose, total protein albumin, AST, ALT and creatinine showed insignificant differences among treatments. However, the results of serum Alkaline phosphatase showed significant ($P<0.05$) differences among treatments. The highest values of serum alkaline phosphate was obtained from D_1*A_2 treatment (243.53 I μ/L) while, the lowest values was recorded from D_2*A_1 treatment (133.05 I μ/L).

4.2.2.2. Minerals concentration:

The mineral contents of blood serum of the different experimental treatments of lambs are presented in Table (19).

4.2.2.2.1. Effect of diet:

The obtained result of calcium and phosphorus concentrations in blood serum showed significantly ($P<0.05$) differences between the tested diets. The mean values of serum calcium were 11.11 and 9.04mg/dl and the mean values of serum phosphorus were 11.53 and 15.93mg/dl for D_1 and D_2, respectively.

Table (19): Effect of diets and additives supplementation and its interaction effect on blood serum minerals content by lambs ($\overline{X}$ ±SE).

Items	Calcium mg/dl	Phosphorus mg/dl	Magnesium mg/dl	Iron mg/ dl	Copper mg/ dl	Zinc mg/ dl
Effect of diets (D)						
	*	*	N.S	N.S	N.S	*
D_1 (50%B * 50 %C)	$11.11^{a}\pm.34$	$11.53^{b}\pm.78$	2.35±.09	169.55±6.39	.15±.06	$1.78^{b}\pm.04$
D_2 (100%C)	$9.04^{b}\pm.34$	$15.93^{a}\pm.78$	2.63±.09	164.84±6.39	.14±.06	$1.92^{a}\pm.04$
Effect of additives(A)						
	*	N.S	N.S	N.S	*	*
A_1 (Control)	$10.15^{ab}\pm.42$	14.27±.95	2.39±.12	166.10±7.83	$.16^{a}\pm.07$	$1.95^{a}\pm.05$
A_2 (Tafla)	$11.04^{a}\pm.42$	12.42±.95	2.66±.12	164.83±7.83	$.15^{a}\pm.07$	$1.75^{b}\pm.05$
A_3 (Bentofarm)	$9.04^{b}\pm.42$	14.50±.95	2.42±.12	170.66±7.83	$.12^{b}\pm.07$	$1.86^{ab}\pm.05$
Interaction effect (D*A)						
	N.S	N.S	N.S	N.S	*	*
D_1*A_1	10.82±.59	10.88±1.34	2.42±.17	167.98±11.07	$.19^{a}\pm.01$	$1.70^{cd}\pm.08$
D_1*A_2	12.80±.59	11.80±1.34	2.34±.17	169.85±11.07	$.14^{bc}\pm.01$	$1.56^{d}\pm.08$
D_1*A_3	9.72±.59	11.91±1.34	2.28±.17	170.82±11.07	$.12^{c}\pm.01$	$2.10^{ab}\pm.08$
D_2*A_1	9.48±.59	17.65±1.34	2.37±.17	164.22±11.07	$.14^{bc}\pm.01$	$2.20^{a}\pm.08$
D_2*A_2	9.28±.59	13.04±1.34	2.97±.17	159.80±11.07	$.17^{ab}\pm.01$	$1.93^{bc}\pm.08$
D_2*A_3	8.36±.59	17.09±1.34	2.55±.17	170.50±11.07	$.12^{c}\pm.01$	$1.63^{d}\pm.08$

a, b and c : Means in the same column having different superscripts differ significantly ($P<0.05$).
N.S. = not significant.
*= significant at 0.05 level.

Magnesium, iron, and copper concentrations in blood serum indicated no significant differences between diets.

In addition to the result of serum zinc value was significantly higher with D_2 (1.92mg/dl) compared with D_1 (1.78mg/dl).

4.2.2.2.2. Effect of additives (A).

The obtained results of serum calcium showed significant ($P<0.05$) differences among treatments. The mean values of serum calcium were 10.15, 11.04 and 9.04mg/dl for control (A_1) tafla (A_2) and bentofarm (A_2), respectively. The results agreed with those reported by **Tret *et al* (1985), Roussel *et al.* (1992)** and **Thilsing -Hansen *et al*. (2002)** who found that addition of zeolite in ruminant diets significantly ($P<0.05$) increased the plasma calcium. Also, **Mohri *et al*. (2008)** who reported that calcium concentrations were significantly higher in serum of animals fed zeolite treated diet than control calves. However, **Dembinski *et al*. (1985[a])** found that concentration of calcium in serum was lower than control by adding 2% bentonite to dairy cattle.

Serum phosphorus showed no significant ($P<0.05$) differences among treatments, the mean values of serum phosphorus were 14.27, 12.42 and 14.50 mg/dl for control, tafla and bentofarm, respectively. These results are in agreements, with those described by **Fisher and Mackay (1983)** who reported that adding 0.6 or 1.2% bentonite to silage ration of lactating cows did not affect on plasma phosphorus concentrations. Also **Nikkah et al. (2003)** who reported that using of clinoptilolite in rations of dairy cows did not significantly affect on plasma phosphorus of dairy cows. On the other side, **Thilsing -Hansen *et al*. (2002)** reported that addition of 0.7kg of pure zeolite for cow suppressed of plasma inorganic phosphate. Also **Grabherr *et al*. (2008)** reported that addition of zeolite 12.23 and 43g/kg significantly ($P<0.05$) decreased phosphorus concentration. However, **Nowar et al. (1993)** found that adding 5% clay for Awssi sheep indicated no clear changes in each of Ca^{++} and Po_4^{---}.Also, the values of serum magnesium were almost similar in all treatments, and the differences were within narrow ranges and not significant being 2.39 to 2.66mg/dl. These results are in agreement with those of **Moate et al. (1985)** who found that the plasma magnesium concentration did not affected by addition of bentonite at 600g per day for cows. The results of iron concentration in blood serum showed no significant differences among treatments. The values were nearly similar among treatments, which ranged from 164.83 to 170.66mg/dl. These results are in agreement with those of **Katosulos *et al*. (2006)** who found that addition of clinoptilopite at 1.25 and 2.5% in the rations of dairy cows did not significantly affect on serum concentration of iron. Also, **Grabherr et al. (2008)** who found that there was no essential effect of zeolite A on the trace element concentration when zeolite adding at 90g zeolite /kg dry matter in rations of lactating dairy cows.

The results of serum copper significantly ($P<0.05$) decreased in bentofarm (A_3) treatment (0.12mg/dl) compared with the control (A_1) and tafla (A_2) treatments (0.16 and 0.15mg/dl), respectively. Also, the results of serum zinc significantly ($P<0.05$) decreased in tafla (A_2) and bentofarm (A_3) treatments (1.75 and 1.86mg/dl) compared to the control (A_1) treatment (1.95mg/dl), respectively. These results are in agreement with those of **Dembinski *et al*. (1985[a])** found that concentration of zinc in serum was lower than control when adding 2% bentonite to dairy cattle in the first and second months of lactation. Also, **Grabherr et al. (2009)** found that there was no essential effect of zeolite A on the trace element concentration when zeolite adding at 90g zeolite /kg dry matter in rations of lactating dairy cows.

4.2.2.2.3. Interaction effect between diet and supplementation:

The results of the interaction effect on calcium, phosphorus, Magnesium and iron concentrations in blood serum showed no significant differences among treatments.

The obtained results of the interaction effect on copper and zinc concentrations in blood serum showed significant ($P<0.05$) differences among treatments. The highest values of serum copper and serum zinc were obtained with D_1*A_1 and D_2*A_1 treatments (0.19 and 2.20 mg/dl), respectively, while the lowest values were recorded with D_2*A_3, D_1*A_3 and D_1*A_2 (0.12 and 1.56mg/dl), respectively.

4.2.2.3. Economical feed efficiency:

The results of economical feed efficiency presented in Table (20), showed that economical feed efficiency increased by addition of tafla and bentofarm compared with control treatment. The best final margin (LE) was recorded in D_1*A_3 and D_1*A_2 (4.07 and 4.36 LE), respectively, compared with the other diets.

Table (20): Effect of inclusion of tafla and bentofarm on the economical efficiency of the experimental diets.

Items	Total feed intake (g)	Feed cost (LE)	Total gain (g)	Income from gain (LE)	Final margin (LE)
Effect of diets (D)					
D_1 (50%B * 50 %C)	780.21	1.75	176.86	5.31	3.56
D_2 (100%C)	969.83	2.14	172.31	5.17	3.03
Effect of additives(A)					
A_1 (Control)	875.03	1.57	168.33	5.05	3.48
A_2 (Tafla)	869.24	1.69	175.41	5.26	3.57
A_3(Bentofarm)	880.80	184.4	180.01	5.40	3.56
Interaction effect (D*A)					
D_1*A_1	764.03	1.22	168.29	5.05	3.83
D_1*A_2	761.69	1.22	176.16	5.29	4.07
D_1*A_3	814.92	1.54	186.11	5.58	4.36
D_2*A_1	986.03	1.79	168.36	5.05	3.26
D_2*A_2	976.80	1.92	174.65	5.24	3.34
D_2*A_3	946.68	1.99	173.91	5.22	3.22

Price of 1kg diet was 1.99LE.

Cost of kg tafla and bentofarm was 0.5 and 1.0 LE, respectively.

Selling price of 1kg = 30 LE.

Final margin (LE) = income from gain (LE) – feed cost (LE).

These results are in agreement with those of **Saleh et al. (1999)** who found that economical feed efficiency increased by 12.7 and 15.6% and feed cost decreased when bentonite was added to rations of lactating buffalo cows at 3 and 6%, respectively.

5. SUMMARY AND CONCLUSION

This study was carried out at the experimental farm of Animal nutrition Research unit, Biological Applications Department, Nuclear Research center, Egyptian Atomic Energy Authority.

The study included two experiments; the first experiment was designed to study the effect of dietary supplementation of tafla and bentofarm as two natural clays available in Sharkia and Alexadria Governorate respectively on feed intake, water intake, digestibility, nutritive values, some rumen parameters, nitrogen balance, some minerals balance. The second one was carried out to evaluate the effect of dietary supplementation of tafle and bentofarm on the growth performance and some blood composition of lambs after weaning.

1-The first experiment:

Twenty seven Rahmani mature rams, averaged 45kg live body weight were divided randomly to nine similar treatments and were used for nine digestibility trials.

The experimental rations of the first experiment were:

T_1- 100% berseem

T_2-100% berseem with 3% tafla

T_3-100% berseem with 3% bentofarm.

T_4- 50% concentrate feed mixture + 50% berseem.

T_5- 50% concentrate + 50% berseem with 3% tafla.

T_6- 50% concentrate + 50%, berseem with 3% bentofarm.

T_7-100% concentrates feed mixture (CFM) plus rice straw (RS).

T8-100% CFM + RS with 3% tafla

T_9-100% CFM + RS with 3% bentofarm

The experimental diets were formulated to cover the maintenance requirements of adult rams according to **NRC, 1985** allowances. All animals were fed 3% dry matter (DM) of body weight, while tafla and bentofarm were added at 3% of dry matter intake. The animals in first main group (T_2 & T_3 100% berseem) gaven tafla and bentofarm by oral drenching, while, the other tested main groups (T_5, T_6, T_8 and T_9), tafla and bentofarm were mixed with rations.

The results of the first experiment could be summarized as follows:

1-Feed intake:

1- Effect of diet on daily dry matter intake as g/h/d significantly ($p<0.05$) increased in D_2 50% berseem (B) and 50% concentrate(C) and D_3 100% concentrate (C) compared to D_1 100% berseem (B).

2- The effect of supplementation on dry matter intake (DMI) as g/h/d slightly improved by supplementation of tafla (A_2) comparable to bentofarm (A_3) and control (A_1), but the differences among treatments were not significant .

3- The interaction effect between diets and supplementation on daily dry matter intake as g/h/d, showed no significant differences among treatments.

2-Water consumption:

1- Effect of diet on water consumption as ml / head, ml/kg $w^{0.75}$ and ml /g DMI were significantly ($P<0.05$) increased in D_1 compared with D_2 and D_3.

2- The effect of additives on daily water consumption as ml/head, ml/kg $W^{0.75}$ and ml/g DMI increased by addition of bentofarm (A_1) but the differences between treatments were not significant.

3-The interaction effect between diets and additives on daily water consumption showed no significant differences among treatments.

3-Digestibility coefficient and nutritive values:

1- Effect of diets on digestibility of DM, OM, CP and NFE significantly ($P<0.05$) increased in D_2 (50% berseem*50% concentrate) compared to D_1 (100% berseem) and D_3 (100% concentrate), and the CF digestibility significantly ($P<0.05$) increased for D_1 compared with D_2 and $D_{3.}$ Concerning, the EE digestibility showed significantly ($P<0.05$) higher value in D_3 compared with D_1 and $D_{2.}$ The results of nutritive values as TDN, SE and DCP reflected the improvement of the digestibility of nutrients. The values of TDN and DCP showed significantly ($P<0.05$) higher values in D_2 and D_3 compared with D_1, while the values of SV showed significantly higher for D_3 compared to D_1 and D_2.

2-The effect of additives on digestibility indicated that the inclusion of tafla (A_2) or bentofarm (A_3) significantly ($P<0.05$) decreased the digestibility coefficient of DM and CP compared with the control (A_1), while values of OM, CF, EE and NFE digestibility were slightly improved for tafla (A_2) or bentofarm (A_3) compared with control (A_1) but the differences not significant among treatments and within narrow ranges. However, the results of nutritive values as TDN, SV and DCP indicated that no significant differences among treatments and the differences were in narrow ranges.

3- The interaction effect between diet and additives on DM, OM, CP, CF, EE and NFE digestibility and nutritive value as DCP showed no significant differences among treatments. On the other side, the results of nutritive values as TDN and SV showed significantly ($P<0.05$) differences among treatments.

4-Rumen parameters:

1- Effect of diet on ruminal pH values before feeding and 3hr. after feeding significantly ($P<0.05$) increased in D_1 compared with D_2 and D_3,while, the values of NH_3-N post feeding significantly ($P<0.05$) higher in D_3 compared to D_1 and D_2. Concerning, the results of TVFA'S and microbial protein (MP) synthesis before feeding and 3hr. after feeding showed significantly ($P<0.05$) differences among the tested diets.

2- The effect of additives on ruminal pH value before feeding were significantly ($P<0.05$) decreased by addition of bentofarm (A_3) compared with control (A_1) and tafla (A_2) treatments. Also, The mean values of ruminal pH at 3hr. after feeding significantly ($P<0.05$) increased as a result of tafla (A_2) or bentofarm (A_3) addition compared with control (A_1) treatment. The results of NH_3-N concentration before feeding and 3hr. after feeding significantly ($P<0.05$) decreased by supplementation of tafla (A_2) or bentofarm (A_3) compared to control (A_1) treatment. Concerning, the values of total volatile fatty acids (TVFA'S) before feeding significantly ($P<0.05$) higher with bentofarm (A_3) compared with the control (A_1) and tafla (A_2) treatments. However, the results of TVFA'S at 3hr. after feeding showed no significant differences among treatments and nearly similar. The results of microbial protein (MP) synthesis at 0hr. before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among treatments.

3- The interaction effect between diets and additives on pH value before feeding and at 3hr. after feeding showed significant($P<0.05$) differences among treatments. Also, the results of ruminal NH_3-N concentrations reveal significant ($P<0.05$) differences among the tested treatments before feeding. On the other side, the results of NH_3-N and TVFA'S concentrations at 3hr. after feeding showed no significant differences among tested treatments. The obtained values of total volatile fatty acids (TVFA'S) before feeding and microbial protein (MP) before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among the tested treatments.

5-Nitrogen retention:

1-The effect of diet on nitrogen retention as g/h/d and g/kg $W^{0.75}$ were significantly ($P<0.05$) higher in D_2 and D_3 comparable to D_1.The mean values of nitrogen retention being 3.12, 9.54 and 10.09 g/h/d and 0.17, 0.55 and 0.53 g/kg $w^{0.75}$ for D_1, D_2 and D_3, respectively. Nitrogen retention % of intake (NB/NI. %) significantly ($P<0.05$) higher in D_2 and D_3 (28.99 and 30.19%) compared to D_1 (12.00%).

2- Effect of additives on nitrogen retention as g/h/d and g/kg $W^{0.75}$ and NB / NI% were decreased in all treatment compared with control (A_1) treatment but the differences between treatments not significant.

3- The interaction effect between diet and additives nitrogen retention as g/h/d and g/kgW$^{0.75}$showed no significant differences among treatments and the values of nitrogen retention as NB/NI% were significantly ($P<0.05$) difference among treatments.

6- Calcium retention:

1-The effect of diet on calcium retention as g/h/d showed significantly ($P<0.05$) higher value in D_1 compared with the values of D_2 and D_3.

2- Effect of additives on Ca retention g/h/d were significantly ($P<0.05$) higher by addition of tafla (A_2) or bentofarm (A_3) (4.14 and 3.89 g/h/d) compared to the control (A_1) (3.15 g/h/d).

3- The interaction effect on Ca retention g/h/d showed significantly ($P<0.05$) differences among treatments. The highest values of calcium retention obtained from D_1*A_2 (6.08 g/h/d), while the lowest value was recorded from D_3*A_1 treatment (1.36 g/h/d).

7- Phosphorus retention:

1-The effect of diet on phosphorus retention showed significantly ($P<0.05$) increased in D_3 (2.43 g/h/d) compared to D_1 and D_2 (1.14 and 1.72 g/h/d).

2-Effect of additives on phosphorus retention showed significant ($P<0.05$) differences among diets. The highest value of phosphorus retention was obtained from D_3 (2.43 g/h/d), while the lowest value was recorded with D_1 (1.14 g/h/d).

2-The effect of supplementation on phosphorus retention significantly ($P<0.05$) decreased by addition of tafla (A_2) and bentofarm (A_3) (1.79 and 1.26 g/h/d) compared to the control (A_1) treatment (2.24 g/h/d) respectively.

3- The interaction effect on phosphorus retention showed significant ($P<0.05$) difference among treatments. The highest values of phosphorus balance obtained from D_3*A_1 treatment (4.21 g/h/d), while the lowest value was recorded from D_1* A_1 treatment (0.90 g/h/d).

8. Magnesium retention:

1-The effect of diet on magnesium retention showed no significant difference among diets**.**

2-Effect of additives on magnesium retention showed significantly ($P<0.05$) higher values with tafla and bentofarm treatments (1.85 and 2.11 g/h/d) compared with the control treatment (1.04 g/h/d), respectively.

3- The interaction effect on magnesium retention showed no significant differences among treatments.

9. Iron retention:

1-The effect of diet on iron retention showed significantly ($P<0.05$) higher in D_2 (544.50 g/h/d) compared with D_1 and D3 (490.65 and 471.17 g/h/d) respectively.

2-The effect of additives on iron retention showed significantly ($P<0.05$) higher values in D_2 (544.50 g/h/d) compared with D_1 and D_3 (490.65 and 471.17 g/h/d) respectively.

3-Interaction effect between diets and additives on iron retention showed significant differences among treatments. The highest value of iron retention was obtained from D_2*A_3 treatment

(925.94 g/h/d), while the lowest values was recorded from D_1* A_1 treatment (180.97 g/h/d).

10. Copper retention:

1-The effect of diet on copper retention showed no significant differences among all diets.

2-The effect of additives and interaction effect between diets and additives on copper retention as mg/h/d were not significant among treatments.

11. Zinc retention:

1-The effect of diet on zinc retention showed significantly ($P<0.05$) higher value in D_2 (125.34 g/h/d) compared with D_1 and D_3 (9.02 and 26.56 mg /h/d), respectively.

2-The effect of additives on zinc retention showed significantly ($P<0.05$) higher value in control (24.45 mg/h/d), comparable to the values of tafla and bentofarm (18.77 and 17.70 mg/h/d), respectively.

3-Interaction effect between diets and additives on zinc retention showed no significant differences among treatments.

12-Serum analysis:

1-The effect of diets on urea, total protein, albumin and creatinine at 0hr. before feeding and 3hr. after feeding showed significantly ($P<0.05$) differences among all diets.

2-The effect of additives on serum urea and albumin at 0hr. before feeding and 3hr after feeding significantly ($P<0.05$) increased by addition of tafla (A_2) or bentofarm (A_3) compared to the control (A_1) treatment. The results of serum creatinine at 0hr. before feeding significantly ($P<0.05$) decreased by addition of tafla or bentofarm compared with the control treatment. However, the results of serum creatnine at 3hr. after feeding and serum total protein percentages at 0hr. before feeding and 3hr. after feeding showed no significant differences among all treatments.

3-Interaction effect between diets and supplementation on serum total protein, creatinine at 0hr. before feeding and albumin at 3hr. after feeding showed significant (P<0.05) differences among all treatments. While, the interaction effect on serum total protein, creatinine at 3hr. after feeding and albumin at 0hr. before feeding showed no significant differences among treatments.

13- Serum enzymes and hormones activity:

1-Effect of diet on serum AST at 0hr. before feeding and 3hr. after feeding, ALT at 0hr. before feeding and T_3 and T_4 at 3hr. after feeding showed significant (P<0.05) differences among diets.

2-The effect of additives on AST and T_3 at 3hr. after feeding significantly (p<0.05) higher values with A_3 (77.0 μ/L and 122.53 nmol /L) compared to those of A_1 (73.83 μ/L, 116.65 nmol/L) and A_2 (59.33 μ/L, 101.28, nmol/L), respectively. Also, the effect of additives on serum AST at 0hr. before feeding; ALT at 0hr. before feeding at 3hr. after feeding and T_4 at 3hr. after feeding showed no significant differences among treatments.

3-Interaction effect between diets and additives on serum AST, ALT, T_3 and T_4 at 0hr. before feeding and 3hr. after feeding showed significant (P<0.05) differences among treatments.

14- **Serum minerals:**

1-Effect of diet on results of serum calcium, magnesium and phosphorus at 0hr. before feeding, significantly ($p<0.05$) higher values were obtained from D_3 compared to $D_1$and D_2 but serum calcium and magnesium at 3hr. after feeding showed no significant differences among diets.

2-The effect of supplementation on serum calcium at 3hr. after feeding, phosphorus at 0hr. before feeding and magnesium at 0hr. before feeding and 3hr. after feeding showed no significant differences among treatments, but serum calcium at 0hr. before feeding and phosphorus 3hr. after feeding showed no significant differences among diets.

3-Interaction effect between diets and additives on serum calcium at 0hr. before feeding and phosphorus at 0hr. before feeding and 3hr. after feeding showed significant ($P<0.05$) differences among treatments, but serum calcium at 0hr. before feeding and magnesium at 0hr. before feeding and 3hr. after feeding showed no significant differences among treatments.

2-The second experiment:

According to the obtained results of the digestibility trials, the 2^{nd} expectant applied on the 2^{nd} and 3rd main groups (treatments T_4-T_9) on growth performance trial for growing lambs. Forty eight male lambs about 2 months age and average live body weight 14.5kg were divided into six similar groups (eight lambs for each) according to their body weight.

The experimental lambs were fed as follow:

Treatment (1): 50% berseam and 50% concentrate.

Treatment (2): 50% berseam and 50% concentrate plus 3% tafla.

Treatment (3): 50% berseam and 50% concentrate plus 3% bentofarm.

Treatment (4): 100% concentrate plus rice straw adlibtum.

Treatment (5): 100% concentrate plus 3% tafla.

Treatment (6): 100% concentrate plus 3% bentofarm.

All animals were fed 3% dry matter (DM) of body weight, while tafla and bentofarm were added at 3% from dry matter intake.

The results of the second experiment could be summarized as follows:

2.1. Growth performance:

1-The effect of diet on final body weight, total gain and average daily gain showed no significant differences between diets, but the effect of diet on daily feed intake as DMI, TDN and DCP and feed conversion as kg DM/kg gain, kg TDN/ kg gain and kg DCP/ kg gain showed significant ($P<0.05$) increased in D_2 (100 % concentrate) compared with D_1 (50% berseem * 50 % concentrate).

2-The effect of additives on average daily gain improved by 4.04% and 6.49% for lamb's supplemented rations with tafla and bentofarm, respectively, compared with the unsupplemented ration but the differences between treatments were not significant. The mean values of average daily gain were 168.33, 175.41and 180.01g/d for A_1, A_2 and A_3 respectively. Also, feed conversion as kg DM/kg gain, kg TDN/ kg gain and kg DCP/ kg gain slightly improved by addition of tafla or bentofarm compared to the control, treatment but the differences between treatments not significant. The mean values of DM/kg gain, kg

TDN/ kg gain and kg DCP/ kg gain were nearly similar among treatments which ranged from 4.96to 5.30for DM, 3.49to 3.71 for TDN and .60 to .65 for DCP.

3-Interaction effect between diets and additives on final body weight, total gain, daily feed intake and feed conversion showed no significant differences among treatments.

2.2. Blood parameters:

2.2.1. Serum analysis:

1-The effect of diet on serum glucose, AST, ALT and creatinine showed no significant differences between diets. But the effect of diet on serum total protein and albumin showed significantly ($P<0.05$) higher value in D_2 compared with D_1 between diets, but the alkaline phosphatase values significantly ($P<0.05$) decreased in D_2 (174.3bI. μ/L) compared with D_1 (242.24 I. μ/L).

2-The effect of supplementation on serum glucose, total protein, albumin, GOT, creatinine and alkaline phosphates activity showed no significant differences among treatments. On the other side, serum ALT activity significantly ($P<0.05$) decreased in A_2 compared with A_1 and A_3.

3-Interaction effect between diets and supplementation on serum, glucose, total protein albumin, AST, ALT and creatinine showed insignificant differences among treatments. However, the results of serum Alkaline phosphatase showed significant ($P<0.05$) differences among treatments. The highest value of serum alkaline phosphatase was obtained from D_1*A_2 treatment (243.53 I μ/L) while, the lowest values was recorded from D_2*A_1 treatment (133.05 I μ/L).

2.2.2. Minerals concentration:

1-The effect of diet on serum calcium, phosphorus and zinc significantly ($P<0.05$) differences between diets. While, the effect of diet on magnesium, iron and copper concentration in blood serum indicated that there are no significant differences between diets.

2-The effect of additives on serum calcium, copper and zinc showed significant ($P<0.05$) decreased by addition of bentofarm compared with tafla and control treatments, while serum phosphorus, magnesium and iron showed insignificant differences among treatments.

3-Interaction effect between diets and additives on serum calcium, phosphorus, magnesium and iron showed no significant differences among treatments, while serum copper and zinc showed significant ($P<0.05$) differences among treatments. The highest values of serum copper and serum zinc were obtained with D_1*A_1 and D_2*A_1 treatments (19 and 2.20 mg/dl), while the lowest values was recorded from D_2*A_3, D_1*A_3 and D_1*A_2 (0.12 and 1.56mg/dl), respectively.

Conclusion:

From this study, some kinds of clay minerals such as tafla and bentofarm can be used at 3% in ruminant animals' diets which based on concentrate diets only or concentrate and green forage together because of its good effects on production performance and economic efficiency without any adverse effects on animals.

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8-ABENDX

Daily dry matter intake g/h/d

Dependent Variable: g/h/d

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13058.537[a]	8	39132.317	3.072	.023
Intercept	36135008	1	36135008	2836.736	.000
DIETS	23916.140	2	11958.070	8.789	.002
TREATMEN	47272.173	2	23636.086	1.856	.185
DIETS * TREATME	41870.224	4	10467.556	.822	.528
Error	29288.258	18	12738.237		
Total	36677355	27			
Corrected Total	42346.795	26			

a. R Squared = .577 (Adjusted R Squared = .389)

Daily dry matter intake g/ Kg W0.75

Dependent Variable: g/kgBW

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	77.899[a]	8	9.737	2.336	.064
Intercept	3251.480	1	3251.480	379.390	.000
DIETS	26.447	2	13.223	3.173	.066
TREATMEN	14.113	2	7.057	1.693	.212
DIETS * TREAT	37.339	4	9.335	2.240	.105
Error	75.017	18	4.168		
Total	3404.396	27			
Corrected Total	152.916	26			

a. R Squared = .509 (Adjusted R Squared = .291)

Daily water consumption, ml/head/day

Dependent Variable: total water consumption

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6885246.6[a]	8	60655.830	1.621	.188
Intercept	7.8E+008	1	7.8E+008	1461.279	.000
DIETS	5139814.4	2	2569907.2	4.839	.021
TREATMEN	08652.275	2	54326.137	.102	.903
DIETS * TREATM	1636780.0	4	09195.000	.771	.558
Error	9559137.8	18	31063.209		
Total	7.9E+008	27			
Corrected Total	16444384	26			

a. R Squared = .419 (Adjusted R Squared = .160)

ml/g DMI

Dependent Variable: drinking ml/gD.M

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	12.704[a]	8	1.588	5.101	.002
Intercept	591.178	1	591.178	398.948	.000
DIETS	10.235	2	5.117	16.437	.000
TREATMEN	1.407	2	.704	2.261	.133
DIETS * TREA	1.062	4	.265	.853	.510
Error	5.604	18	.311		
Total	609.485	27			
Corrected Tota	18.308	26			

a. R Squared = .694 (Adjusted R Squared = .558)

ml / Kg W0.75

Dependent Variable: drnking mlikgw

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4069.005[a]	8	4258.626	1.742	.156
Intercept	645563.7	1	645563.7	081.880	.000
DIETS	4351.593	2	2175.796	4.979	.019
TREATMEN	7135.831	2	3567.915	1.459	.259
DIETS * TREATI	2581.581	4	645.395	.264	.897
Error	4016.118	18	2445.340		
Total	723648.8	27			
Corrected Total	8085.122	26			

a. R Squared = .436 (Adjusted R Squared = .186)

Digestibility of DM %

Dependent Variable: %DM GIGESTDBIJIUTY

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mo	209.517[a]	8	26.190	11.266	.000
Intercept	21383.968	1	21383.968	2215.15	.000
diets	152.496	2	76.248	32.799	.000
treatmen	35.281	2	17.641	7.588	.004
diets * treatn	21.740	4	5.435	2.338	.094
Error	41.844	18	2.325		
Total	21635.329	27			
Corrected To	251.361	26			

a. R Squared = .834 (Adjusted R Squared = .760)

Digestibility of OM%

Dependent Variable: digo

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	176.401[a]	8	22.050	11.560	.000
Intercept	134841.894	1	134841.894	70692.44	.000
diets	155.489	2	77.745	40.759	.000
treatmen	1.088	2	.544	.285	.755
diets * treatme	19.823	4	4.956	2.598	.071
Error	34.334	18	1.907		
Total	135052.629	27			
Corrected Tota	210.735	26			

a. R Squared = .837 (Adjusted R Squared = .765)

Digestibilityof CP%

Dependent Variable: digcp

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	242.699[a]	8	30.337	7.346	.000
Intercept	136307.294	1	136307.294	33007.95	.000
diets	194.481	2	97.241	23.548	.000
treatmen	27.037	2	13.519	3.274	.061
diets * treatme	21.180	4	5.295	1.282	.314
Error	74.332	18	4.130		
Total	136624.324	27			
Corrected Tota	317.030	26			

a. R Squared = .766 (Adjusted R Squared = .661)

digestability of CF%

Dependent Variable: DIGCF

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	596.297[a]	8	74.537	10.784	.000
Intercept	;2677.584	1	;2677.584	7621.027	.000
DIETS	555.483	2	277.741	40.182	.000
TREATMEN	5.156	2	2.578	.373	.694
DIETS * TREATM	35.658	4	8.915	1.290	.311
Error	124.418	18	6.912		
Total	;3398.300	27			
Corrected Total	720.716	26			

a. R Squared = .827 (Adjusted R Squared = .751)

Digestibility of EE%

Dependent Variable: EE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	11033.668[a]	8	1379.208	62.384	.000
Intercept	138875.739	1	138875.739	6281.564	.000
diets	10977.025	2	5488.513	248.254	.000
treatmen	12.946	2	6.473	.293	.750
diets * treatme	43.696	4	10.924	.494	.740
Error	397.952	18	22.108		
Total	150307.359	27			
Corrected Tota	11431.620	26			

a. R Squared = .965 (Adjusted R Squared = .950)

Digestibilityof NFE

Dependent Variable: NFE%

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	115.214[a]	8	14.402	4.467	.004
Intercept	179862.729	1	179862.729	55793.75	.000
diets	94.625	2	47.312	14.676	.000
treatmen	3.973	2	1.987	.616	.551
diets * treatme	16.616	4	4.154	1.289	.311
Error	58.027	18	3.224		
Total	180035.970	27			
Corrected Tota	173.241	26			

a. R Squared = .665 (Adjusted R Squared = .516)

Nutritive valueTDN

Dependent Variable: nutritive value

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	604.658[a]	8	75.582	38.718	.000
Intercept	22685.526	1	22685.526	2846.899	.000
DIETS	566.249	2	283.124	145.033	.000
TREATMEN	3.995	2	1.997	1.023	.379
DIETS * TREATM	34.415	4	8.604	4.407	.012
Error	35.138	18	1.952		
Total	23325.322	27			
Corrected Total	639.796	26			

a. R Squared = .945 (Adjusted R Squared = .921)

SV

Dependent Variable: SV

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1664.128[a]	8	208.016	107.009	.000
Intercept	6970.761	1	6970.761	595.899	.000
DIETS	1623.610	2	811.805	417.615	.000
TREATMEN	4.775	2	2.388	1.228	.316
DIETS * TREATM	35.743	4	8.936	4.597	.010
Error	34.990	18	1.944		
Total	8669.880	27			
Corrected Total	1699.118	26			

a. R Squared = .979 (Adjusted R Squared = .970)

DCP

Dependent Variable: DCP

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34.334[a]	8	4.292	18.013	.000
Intercept	3375.018	1	3375.018	4165.759	.000
DIETS	32.188	2	16.094	67.551	.000
TREATMEN	1.499	2	.750	3.146	.067
DIETS * TREATM	.647	4	.162	.679	.616
Error	4.289	18	.238		
Total	3413.641	27			
Corrected Total	38.622	26			

a. R Squared = .889 (Adjusted R Squared = .840)

ruminal parameters pH at 0hr.

Dependent Variable: rumen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.380[a]	8	.172	20.809	.000
Intercept	1319.363	1	1319.363	159172.4	.000
DIETS	1.112	2	.556	67.070	.000
TREATMEN	7.801E-02	2	3.900E-02	4.706	.023
DIETS * TREATM	.190	4	4.750E-02	5.731	.004
Error	.149	18	8.289E-03		
Total	1320.892	27			
Corrected Total	1.529	26			

a. R Squared = .902 (Adjusted R Squared = .859)

ruminal parameters pH at 3hr.

Dependent Variable: 3hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.615[a]	8	1.077	38.012	.000
Intercept	1139.580	1	1139.580	0225.739	.000
DIETS	6.797	2	3.399	119.965	.000
TREATMEN	1.479	2	.739	26.103	.000
DIETS * TREATM	.339	4	8.469E-02	2.989	.047
Error	.510	18	2.833E-02		
Total	1148.705	27			
Corrected Total	9.125	26			

a. R Squared = .944 (Adjusted R Squared = .919)

ruminal parameters, Ammonia-N (mg/100ml) at 0hr.

Dependent Variable: zero time

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	186.378[a]	8	23.297	14.627	.000
Intercept	4417.282	1	4417.282	2773.320	.000
DIETS	71.610	2	35.805	22.480	.000
TREATMEN	96.362	2	48.181	30.250	.000
DIETS * TREATM	18.406	4	4.602	2.889	.052
Error	28.670	18	1.593		
Total	4632.330	27			
Corrected Total	215.048	26			

a. R Squared = .867 (Adjusted R Squared = .807)

Ammonia-N (mg/100ml) at 3hr.

Dependent Variable: 3hur.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1433.091[a]	8	179.136	24.917	.000
Intercept	10464.645	1	10464.645	1455.558	.000
DIETS	1120.726	2	560.363	77.943	.000
TREATMEN	285.170	2	142.585	19.833	.000
DIETS * TREATM	27.196	4	6.799	.946	.460
Error	129.410	18	7.189		
Total	12027.146	27			
Corrected Total	1562.501	26			

a. R Squared = .917 (Adjusted R Squared = .880)

TVFA (ml eq/100ml)at 0hr.

Dependent Variable: VFA zero

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	210.152[a]	8	26.269	5.825	.001
Intercept	3543.891	1	3543.891	785.824	.000
DIETS	37.690	2	18.845	4.179	.032
TREATMEN	109.524	2	54.762	12.143	.000
DIETS * TREATM	62.938	4	15.735	3.489	.028
Error	81.176	18	4.510		
Total	3835.219	27			
Corrected Total	291.328	26			

a. R Squared = .721 (Adjusted R Squared = .598)

TVFA (ml eq/100ml) at 3hr.

Dependent Variable: 3hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	155.500[a]	8	19.438	3.626	.011
Intercept	9075.000	1	9075.000	1692.746	.000
DIETS	97.556	2	48.778	9.098	.002
TREATMEN	25.722	2	12.861	2.399	.119
DIETS * TREATM	32.222	4	8.056	1.503	.243
Error	96.500	18	5.361		
Total	9327.000	27			
Corrected Total	252.000	26			

a. R Squared = .617 (Adjusted R Squared = .447)

Microbial protein (gm/100)at 0hr

Dependent Variable: M.P.zero

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.890[a]	8	.111	12.771	.000
Intercept	18.551	1	18.551	2128.620	.000
DIETS	.488	2	.244	28.023	.000
TREATMEN	.304	2	.152	17.430	.000
DIETS * TREATM	9.818E-02	4	2.454E-02	2.816	.056
Error	.157	18	8.715E-03		
Total	19.598	27			
Corrected Total	1.047	26			

a. R Squared = .850 (Adjusted R Squared = .784)

Microbial protein(gm/100 at 3 hr.)

Dependent Variable: M.B3hour.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.975[a]	8	.497	21.990	.000
Intercept	25.095	1	25.095	1110.574	.000
DIETS	2.886	2	1.443	63.866	.000
TREATMEN	.457	2	.228	10.110	.001
DIETS * TREATM	.632	4	.158	6.991	.001
Error	.407	18	2.260E-02		
Total	29.477	27			
Corrected Total	4.382	26			

a. R Squared = .907 (Adjusted R Squared = .866)

N.intake as g/head/day

Dependent Variable: nitrogen intake g/h/d

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	545.665[a]	8	68.208	20.732	.000
Intercept	24308.401	1	24308.401	7388.530	.000
DIETS	518.481	2	259.241	78.796	.000
TREATMEN	16.406	2	8.203	2.493	.111
DIETS * TREATM	10.778	4	2.694	.819	.530
Error	59.220	18	3.290		
Total	24913.286	27			
Corrected Total	604.885	26			

a. R Squared = .902 (Adjusted R Squared = .859)

N.intake g / Kg W0.75

Dependent Variable: nitrogen intake g/kgW0.75

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.188[a]	8	.149	13.191	.000
Intercept	79.774	1	79.774	7085.158	.000
DIETS	1.050	2	.525	46.641	.000
TREATMEN	5.722E-02	2	2.861E-02	2.541	.107
DIETS * TREATM	8.069E-02	4	2.017E-02	1.792	.175
Error	.203	18	1.126E-02		
Total	81.165	27			
Corrected Total	1.391	26			

a. R Squared = .854 (Adjusted R Squared = .790)

Fecal .N asg/h/d

Dependent Variable: fecal nitrogeng/h/d

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	19.399[a]	8	2.425	5.973	.001
Intercept	1975.307	1	1975.307	4865.598	.000
DIETS	9.927	2	4.963	12.226	.000
TREATMEN	2.040	2	1.020	2.513	.109
DIETS * TREATM	7.432	4	1.858	4.577	.010
Error	7.308	18	.406		
Total	2002.014	27			
Corrected Total	26.707	26			

a. R Squared = .726 (Adjusted R Squared = .605)

Fecal .N as g / Kg W0.75

Dependent Variable: fecal N g/kgw0.75

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5.256E-02[a]	8	6.570E-03	3.134	.021
Intercept	6.473	1	6.473	3087.781	.000
DIETS	4.830E-03	2	2.415E-03	1.152	.338
TREATMEN	1.814E-02	2	9.070E-03	4.327	.029
DIETS * TREATM	2.959E-02	4	7.398E-03	3.529	.027
Error	3.773E-02	18	2.096E-03		
Total	6.563	27			
Corrected Total	9.030E-02	26			

a. R Squared = .582 (Adjusted R Squared = .396)

Urinary. N, g/head/day

Dependent Variable: urinary Ng/h/d

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mode	51.248[a]	8	6.406	2.750	.036
Intercept	5262.082	1	5262.082	2258.645	.000
diets	10.403	2	5.201	2.233	.136
treatmen	8.621	2	4.310	1.850	.186
diets * treatme	32.224	4	8.056	3.458	.029
Error	41.936	18	2.330		
Total	5355.266	27			
Corrected Tota	93.183	26			

a. R Squared = .550 (Adjusted R Squared = .350)

Urinary. N,g / Kg W0.75

Dependent Variable: urinary Ng/kgW0.75

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mode	.257[a]	8	.032	4.605	.003
Intercept	17.618	1	17.618	2528.847	.000
diets	.058	2	.029	4.159	.033
treatmen	.029	2	.015	2.086	.153
diets * treatme	.170	4	.042	6.088	.003
Error	.125	18	.007		
Total	18.000	27			
Corrected Tota	.382	26			

a. R Squared = .672 (Adjusted R Squared = .526)

Total .N excretion g/head/day

Dependent Variable: total excreated g/h/d

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	93.420[a]	8	11.677	4.205	.005
Intercept	13685.855	1	13685.855	4928.551	.000
DIETS	31.783	2	15.892	5.723	.012
TREATMEN	14.304	2	7.152	2.576	.104
DIETS * TREATM	47.332	4	11.833	4.261	.013
Error	49.983	18	2.777		
Total	13829.259	27			
Corrected Total	143.403	26			

a. R Squared = .651 (Adjusted R Squared = .497)

Total .N excretion g / Kg W0.75

Dependent Variable: total excreationg/kgw0.75

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.426[a]	8	5.323E-02	5.075	.002
Intercept	45.786	1	45.786	4365.203	.000
DIETS	6.402E-02	2	3.201E-02	3.052	.072
TREATMEN	8.596E-02	2	4.298E-02	4.097	.034
DIETS * TREATM	.276	4	6.897E-02	6.576	.002
Error	.189	18	1.049E-02		
Total	46.401	27			
Corrected Total	.615	26			

a. R Squared = .693 (Adjusted R Squared = .556)

N . retention g/head/day

Dependent Variable: balance g/h/d

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	284.110[a]	8	35.514	9.931	.000
Intercept	1554.205	1	1554.205	434.594	.000
DIETS	270.456	2	135.228	37.813	.000
TREATMEN	3.467	2	1.733	.485	.624
DIETS * TREATM	10.188	4	2.547	.712	.594
Error	64.372	18	3.576		
Total	1902.687	27			
Corrected Total	348.482	26			

a. R Squared = .815 (Adjusted R Squared = .733)

N . retention g / Kg W0.75

Dependent Variable: balance g/kgw0.75

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.905[a]	8	.113	10.631	.000
Intercept	4.788	1	4.788	449.815	.000
DIETS	.852	2	.426	40.038	.000
TREATMEN	8.867E-03	2	4.433E-03	.416	.666
DIETS * TREATM	4.404E-02	4	1.101E-02	1.034	.417
Error	.192	18	1.064E-02		
Total	5.885	27			
Corrected Total	1.097	26			

a. R Squared = .825 (Adjusted R Squared = .748)

N. retention % of intake

Dependent Variable: balance N % of intake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2235.345[a]	8	279.418	10.624	.000
Intercept	15203.574	1	15203.574	578.068	.000
DIETS	1862.847	2	931.424	35.414	.000
TREATMEN	74.637	2	37.319	1.419	.268
DIETS * TREATM	297.860	4	74.465	2.831	.055
Error	473.412	18	26.301		
Total	17912.330	27			
Corrected Total	2708.756	26			

a. R Squared = .825 (Adjusted R Squared = .748)

Daily Ca intake, (g/h/d)

Dependent Variable: Ca intake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	43.358[a]	8	5.420	11.583	.000
Intercept	1844.459	1	1844.459	3941.962	.000
DIETS	40.667	2	20.334	43.457	.000
TREATMEN	1.298	2	.649	1.387	.275
DIETS * TREATM	1.392	4	.348	.744	.575
Error	8.422	18	.468		
Total	1896.239	27			
Corrected Total	51.780	26			

a. R Squared = .837 (Adjusted R Squared = .765)

Urinary Ca, (g/h/d)

Dependent Variable: ur

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	.038[a]	8	.005	2.196	.079
Intercept	.857	1	.857	400.972	.000
diets	.018	2	.009	4.161	.033
treatmen	.001	2	.000	.220	.805
diets * treatme	.019	4	.005	2.201	.110
Error	.038	18	.002		
Total	.933	27			
Corrected Total	.076	26			

a. R Squared = .494 (Adjusted R Squared = .269)

Fecal Ca,(g/h/d)

Dependent Variable: fecal

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.424[a]	8	1.428	1.701	.166
Intercept	537.430	1	537.430	640.094	.000
DIETS	.972	2	.486	.579	.571
TREATMEN	.868	2	.434	.517	.605
DIETS * TREATM	9.584	4	2.396	2.854	.054
Error	15.113	18	.840		
Total	563.967	27			
Corrected Total	26.537	26			

a. R Squared = .430 (Adjusted R Squared = .177)

Total Ca excreted, (g/h/d)

Dependent Variable: total excreation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	19.465[a]	8	2.433	5.698	.001
Intercept	555.515	1	555.515	1300.904	.000
DIETS	3.459	2	1.729	4.050	.035
TREATMEN	1.484	2	.742	1.738	.204
DIETS * TREATM	14.521	4	3.630	8.501	.000
Error	7.686	18	.427		
Total	582.666	27			
Corrected Total	27.151	26			

a. R Squared = .717 (Adjusted R Squared = .591)

Calcium retention ,(g/h/d)

Dependent Variable: CA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	39.760[a]	8	4.970	9.778	.000
Intercept	376.096	1	376.096	739.942	.000
DIETS	22.970	2	11.485	22.596	.000
TREATMEN	4.741	2	2.370	4.664	.023
DIETS * TREATM	12.049	4	3.012	5.926	.003
Error	9.149	18	.508		
Total	425.005	27			
Corrected Total	48.909	26			

a. R Squared = .813 (Adjusted R Squared = .730)

Daily P intake, (g/h/d)

Dependent Variable: Pintake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	96.110[a]	8	12.014	71.874	.000
Intercept	865.346	1	865.346	5177.079	.000
DIETS	94.968	2	47.484	284.082	.000
TREATMEN	.605	2	.302	1.810	.192
DIETS * TREATM	.536	4	.134	.802	.540
Error	3.009	18	.167		
Total	964.464	27			
Corrected Total	99.118	26			

a. R Squared = .970 (Adjusted R Squared = .956)

Fecal P,(g/h/d)

Dependent Variable: fecalP

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	65.737[a]	8	8.217	137.274	.000
Intercept	397.287	1	397.287	6637.016	.000
DIETS	52.793	2	26.397	440.980	.000
TREATMEN	2.728	2	1.364	22.789	.000
DIETS * TREATM	10.215	4	2.554	42.663	.000
Error	1.077	18	5.986E-02		
Total	464.101	27			
Corrected Total	66.814	26			

a. R Squared = .984 (Adjusted R Squared = .977)

Urinary p, (g/h/d)

Dependent Variable: urine

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	'.867E-03[a]	8	9.833E-04	1.553	.208
Intercept	.141	1	.141	222.368	.000
DIETS	..356E-03	2	5.778E-04	1.070	.364
TREATMEN	2.289E-03	2	1.144E-03	1.807	.193
DIETS * TREATM	1.222E-03	4	1.056E-03	1.667	.201
Error	..140E-02	18	5.333E-04		
Total	.160	27			
Corrected Total	..927E-02	26			

a. R Squared = .408 (Adjusted R Squared = .145)

Total P excreted, (g/h/d)

Dependent Variable: ttal excreation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	65.181[a]	8	8.148	139.160	.000
Intercept	411.685	1	411.685	7031.557	.000
DIETS	52.302	2	26.151	446.658	.000
TREATMEN	2.515	2	1.257	21.476	.000
DIETS * TREATM	10.364	4	2.591	44.254	.000
Error	1.054	18	5.855E-02		
Total	477.919	27			
Corrected Total	66.234	26			

a. R Squared = .984 (Adjusted R Squared = .977)

P retention ,(g/h/d)

Dependent Variable: balance (P)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	24.199[a]	8	3.025	59.965	.000
Intercept	84.376	1	84.376	1672.653	.000
DIETS	7.434	2	3.717	73.686	.000
TREATMEN	4.380	2	2.190	43.412	.000
DIETS * TREATM	12.385	4	3.096	61.381	.000
Error	.908	18	5.044E-02		
Total	109.483	27			
Corrected Total	25.107	26			

a. R Squared = .964 (Adjusted R Squared = .948)

Daily Mg intake, (g/h/d)

Dependent Variable: Mg hntake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.124[a]	8	.140	2.213	.077
Intercept	180.291	1	180.291	2840.883	.000
DIETS	.403	2	.201	3.173	.066
TREATMEN	.665	2	.332	5.236	.016
DIETS * TREATM	5.646E-02	4	1.411E-02	.222	.922
Error	1.142	18	6.346E-02		
Total	182.557	27			
Corrected Total	2.266	26			

a. R Squared = .496 (Adjusted R Squared = .272)

Fecal Mg, (g/h/d)

Dependent Variable: fecal mg

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.659[a]	8	.332	16.504	.000
Intercept	19.102	1	19.102	948.582	.000
DIETS	4.216E-02	2	2.108E-02	1.047	.372
TREATMEN	2.356	2	1.178	58.503	.000
DIETS * TREATM	.260	4	6.512E-02	3.234	.036
Error	.362	18	2.014E-02		
Total	22.123	27			
Corrected Total	3.021	26			

a. R Squared = .880 (Adjusted R Squared = .827)

Urinary Mg,(g/h/d)

Dependent Variable: Mg urine

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.156[a]	8	1.955E-02	.898	.538
Intercept	.297	1	.297	13.625	.002
DIETS	4.999E-02	2	2.499E-02	1.148	.339
TREATMEN	5.361E-02	2	2.680E-02	1.231	.315
DIETS * TREATM	5.281E-02	4	1.320E-02	.606	.663
Error	.392	18	2.177E-02		
Total	.845	27			
Corrected Total	.548	26			

a. R Squared = .285 (Adjusted R Squared = -.032)

Total Mg excreted, (g/h/d)

Dependent Variable: total excreation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.414[a]	8	.302	7.739	.000
Intercept	24.159	1	24.159	619.460	.000
DIETS	4.274E-03	2	2.137E-03	.055	.947
TREATMEN	2.207	2	1.103	28.291	.000
DIETS * TREATM	.203	4	5.087E-02	1.304	.306
Error	.702	18	3.900E-02		
Total	27.275	27			
Corrected Total	3.116	26			

a. R Squared = .775 (Adjusted R Squared = .675)

Mg retention,(g/h/d)

Dependent Variable: Mg balance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.370[a]	8	.796	7.688	.000
Intercept	75.067	1	75.067	724.789	.000
DIETS	.316	2	.158	1.525	.244
TREATMEN	5.629	2	2.815	27.177	.000
DIETS * TREATM	.425	4	.106	1.026	.421
Error	1.864	18	.104		
Total	83.301	27			
Corrected Total	8.235	26			

a. R Squared = .774 (Adjusted R Squared = .673)

Daily Fe intake, (mg/h/d)

Dependent Variable: Fe intake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3261745.7[a]	8	)7718.214	305.245	.000
Intercept	18764236	1	18764236	4048.162	.000
DIETS	9189.214	2	4594.607	3.440	.054
TREATMEN	3248653.2	2	1624326.6	1216.080	.000
DIETS * TREATM	3903.259	4	975.815	.731	.583
Error	24042.736	18	1335.708		
Total	22050024	27			
Corrected Total	3285788.4	26			

a. R Squared = .993 (Adjusted R Squared = .989)

Fecal Fe, (mg/h/d)

Dependent Variable: fecal fe

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	43134.017[a]	8	42891.752	30.287	.000
Intercept	2623285.9	1	2623285.9	1852.400	.000
DIETS	9000.201	2	4500.101	3.178	.066
TREATMEN	)6873.482	2	53436.741	108.347	.000
DIETS * TREATM	27260.335	4	6815.084	4.812	.008
Error	25490.800	18	1416.156		
Total	2991910.7	27			
Corrected Total	58624.817	26			

a. R Squared = .931 (Adjusted R Squared = .900)

Urinary Fe , (mg/h/d)

Dependent Variable: urine excreaion

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	724.858[a]	8	90.607	4.580	.004
Intercept	7038.655	1	7038.655	355.824	.000
DIETS	600.623	2	300.311	15.182	.000
TREATMEN	22.290	2	11.145	.563	.579
DIETS * TREATM	101.945	4	25.486	1.288	.312
Error	356.063	18	19.781		
Total	8119.575	27			
Corrected Total	1080.920	26			

a. R Squared = .671 (Adjusted R Squared = .524)

Total Fe excreted, (mg/h/d)

Dependent Variable: total excreation urine

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	49085.848[a]	8	43635.731	28.275	.000
Intercept	2958345.6	1	2958345.6	1916.917	.000
DIETS	5846.074	2	2923.037	1.894	.179
TREATMEN	23910.618	2	61955.309	104.942	.000
DIETS * TREATM	19329.156	4	4832.289	3.131	.040
Error	27779.098	18	1543.283		
Total	3335210.5	27			
Corrected Total	76864.946	26			

a. R Squared = .926 (Adjusted R Squared = .894)

Fe retention,(mg/h/d)

Dependent Variable: balance Fe

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1953439.2[a]	8	44179.897	352.437	.000
Intercept	6807060.1	1	6807060.1	9824.959	.000
DIETS	25967.500	2	12983.750	18.740	.000
TREATMEN	1914299.0	2	57149.514	1381.500	.000
DIETS * TREATM	13172.646	4	3293.161	4.753	.009
Error	12471.002	18	692.833		
Total	8772970.3	27			
Corrected Total	1965910.2	26			

a. R Squared = .994 (Adjusted R Squared = .991)

Daily Cu intake, (mg/h/d)

Dependent Variable: Cu intake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	991.138[a]	8	123.892	14.026	.000
Intercept	73754.539	1	73754.539	8350.054	.000
DIETS	896.345	2	448.173	50.739	.000
TREATMEN	56.127	2	28.063	3.177	.066
DIETS * TREATM	38.666	4	9.667	1.094	.389
Error	158.991	18	8.833		
Total	74904.668	27			
Corrected Total	1150.129	26			

a. R Squared = .862 (Adjusted R Squared = .800)

Fecal Cu (mg/h/d)

Dependent Variable: fecal Cu

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	493.033[a]	8	61.629	2.341	.064
Intercept	20093.902	1	20093.902	763.304	.000
DIETS	358.592	2	179.296	6.811	.006
TREATMEN	131.590	2	65.795	2.499	.110
DIETS * TREATM	2.851	4	.713	.027	.998
Error	473.848	18	26.325		
Total	21060.783	27			
Corrected Total	966.881	26			

a. R Squared = .510 (Adjusted R Squared = .292)

Urinary Cu (mg/h/d))

Dependent Variable: Urine Cu

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.851[a]	8	.356	2.367	.061
Intercept	47.627	1	47.627	316.383	.000
DIETS	1.870	2	.935	6.210	.009
TREATMEN	.227	2	.114	.755	.484
DIETS * TREATM	.754	4	.189	1.253	.325
Error	2.710	18	.151		
Total	53.188	27			
Corrected Total	5.561	26			

a. R Squared = .513 (Adjusted R Squared = .296)

Total Cu excreted,(mg/h/d)

Dependent Variable: VAR00001

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	458.476[a]	8	57.309	2.100	.091
Intercept	22097.506	1	22097.506	809.833	.000
DIETS	329.451	2	164.726	6.037	.010
TREATMEN	126.635	2	63.318	2.320	.127
DIETS * TREATM	2.389	4	.597	.022	.999
Error	491.157	18	27.287		
Total	23047.139	27			
Corrected Total	949.633	26			

a. R Squared = .483 (Adjusted R Squared = .253)

Cu retention ,((mg/h/d)

Dependent Variable: Cu balance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	343.648[a]	8	42.956	1.285	.311
Intercept	12918.391	1	12918.391	386.466	.000
DIETS	136.466	2	68.233	2.041	.159
TREATMEN	128.416	2	64.208	1.921	.175
DIETS * TREATM	78.767	4	19.692	.589	.675
Error	601.686	18	33.427		
Total	13863.725	27			
Corrected Total	945.334	26			

a. R Squared = .364 (Adjusted R Squared = .081)

Daily Zn intake, (mg/h/d)

Dependent Variable: Zn intake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6783.647[a]	8	847.956	11.913	.000
Intercept	63711.552	1	63711.552	2299.945	.000
DIETS	6326.835	2	3163.418	44.442	.000
TREATMEN	242.498	2	121.249	1.703	.210
DIETS * TREATM	214.313	4	53.578	.753	.569
Error	1281.251	18	71.181		
Total	71776.450	27			
Corrected Total	8064.898	26			

a. R Squared = .841 (Adjusted R Squared = .771)

Fecal Zn (mg/h/d)

Dependent Variable: fecal Zn

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2887.475[a]	8	360.934	11.330	.000
Intercept	85608.656	1	85608.656	2687.282	.000
diets	2158.115	2	1079.057	33.872	.000
treatmen	166.934	2	83.467	2.620	.100
diets * treatmen	562.426	4	140.607	4.414	.012
Error	573.425	18	31.857		
Total	89069.557	27			
Corrected Total	3460.901	26			

a. R Squared = .834 (Adjusted R Squared = .761)

Urinary Zn (mg/h/d)

Dependent Variable: urine Zn

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	4.151[a]	8	.519	4.304	.005
Intercept	44.083	1	44.083	365.679	.000
diets	3.611	2	1.805	14.976	.000
treatmen	.023	2	.011	.095	.910
diets * treatme	.517	4	.129	1.073	.399
Error	2.170	18	.121		
Total	50.404	27			
Corrected Tota	6.321	26			

a. R Squared = .657 (Adjusted R Squared = .504)

Total Zn excreted,(mg/h/d)

Dependent Variable: total excreation Zn

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mode	2760.119[a]	8	345.015	11.092	.000
Intercept	89445.938	1	89445.938	2875.596	.000
diets	2001.315	2	1000.657	32.170	.000
treatmen	167.563	2	83.782	2.693	.095
diets * treatmer	591.241	4	147.810	4.752	.009
Error	559.893	18	31.105		
Total	92765.950	27			
Corrected Total	3320.012	26			

a. R Squared = .831 (Adjusted R Squared = .756)

Zn retention ,((mg/h/d)

Dependent Variable: zink balance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	2100.358[a]	8	262.545	6.594	.000
Intercept	11138.613	1	11138.613	279.734	.000
diets	1726.170	2	863.085	21.675	.000
treatmen	236.995	2	118.498	2.976	.076
diets * treatme	137.193	4	34.298	.861	.506
Error	716.736	18	39.819		
Total	13955.707	27			
Corrected Tota	2817.094	26			

a. R Squared = .746 (Adjusted R Squared = .632)

Total protein g/dl,0 hr.

Dependent Variable: total proteinat 0 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mode	20.485[a]	8	2.561	3.234	.018
Intercept	1285.884	1	1285.884	1624.100	.000
diets	9.278	2	4.639	5.859	.011
treatmen	.517	2	.259	.327	.725
diets * treatme	10.689	4	2.672	3.375	.032
Error	14.252	18	.792		
Total	1320.621	27			
Corrected Tota	34.737	26			

a. R Squared = .590 (Adjusted R Squared = .407)

Total protein g/dl,3 hr.

Dependent Variable: total protein at 3 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	8.059[a]	8	1.007	2.030	.101
Intercept	1607.305	1	1607.305	3238.478	.000
diets	5.395	2	2.698	5.435	.014
treatmen	.477	2	.238	.480	.626
diets * treatme	2.187	4	.547	1.102	.386
Error	8.934	18	.496		
Total	1624.297	27			
Corrected Tota	16.993	26			

a. R Squared = .474 (Adjusted R Squared = .241)

Albumin g/dl,0 hr.

Dependent Variable: albumin at zero hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	1.180[a]	8	.148	1.786	.146
Intercept	553.249	1	553.249	6699.434	.000
diets	.438	2	.219	2.655	.098
treatmen	.595	2	.298	3.605	.048
diets * treatme	.146	4	.037	.443	.776
Error	1.486	18	.083		
Total	555.916	27			
Corrected Tota	2.667	26			

a. R Squared = .443 (Adjusted R Squared = .195)

Albumin g/dl,3 hr.

Dependent Variable: albumin at 3 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	1.485[a]	8	.186	4.205	.005
Intercept	570.125	1	570.125	12918.23	.000
diets	.709	2	.354	8.030	.003
treatmen	.264	2	.132	2.994	.075
diets * treatme	.512	4	.128	2.898	.052
Error	.794	18	.044		
Total	572.404	27			
Corrected Tota	2.279	26			

a. R Squared = .651 (Adjusted R Squared = .497)

Creatinine mg/dl,0 hr.

Dependent Variable: CREATININE at zerotime

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	1.070[a]	8	.134	6.396	.001
Intercept	47.627	1	47.627	2277.208	.000
diets	.133	2	.067	3.185	.065
treatmen	.195	2	.098	4.671	.023
diets * treatme	.742	4	.185	8.864	.000
Error	.376	18	.021		
Total	49.074	27			
Corrected Tota	1.447	26			

a. R Squared = .740 (Adjusted R Squared = .624)

Creatinine mg/dl,3 hr.

Dependent Variable: creatinineat 3hur

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	.811[a]	8	.101	2.117	.089
Intercept	51.612	1	51.612	1077.915	.000
diets	.329	2	.165	3.438	.054
treatmen	.219	2	.109	2.284	.131
diets * treatme	.263	4	.066	1.374	.282
Error	.862	18	.048		
Total	53.285	27			
Corrected Tota	1.673	26			

a. R Squared = .485 (Adjusted R Squared = .256)

AST U/L,0 hr.

Dependent Variable: GOTat zero hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	3357.167[a]	8	419.646	5.321	.002
Intercept	144980.083	1	144980.083	1838.423	.000
diets	1932.667	2	966.333	12.254	.000
treatmen	377.167	2	188.583	2.391	.120
diets * treatme	1047.333	4	261.833	3.320	.033
Error	1419.500	18	78.861		
Total	149756.750	27			
Corrected Tota	4776.667	26			

a. R Squared = .703 (Adjusted R Squared = .571)

AST U/L,3 hr.

Dependent Variable: GOT at 3 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Mod	6036.667[a]	8	754.583	6.095	.001
Intercept	132510.083	1	132510.083	1070.308	.000
diets	1311.167	2	655.583	5.295	.016
treatmen	1597.167	2	798.583	6.450	.008
diets * treatme	3128.333	4	782.083	6.317	.002
Error	2228.500	18	123.806		
Total	140775.250	27			
Corrected Tota	8265.167	26			

a. R Squared = .730 (Adjusted R Squared = .611)

ALT U/L at 0 hr.

Dependent Variable: GPT ATzero time

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	688.519[a]	8	86.065	13.832	.000
Intercept	5749.481	1	5749.481	924.024	.000
DIETS	237.852	2	118.926	19.113	.000
TREATMEN	27.185	2	13.593	2.185	.141
DIETS * TREATM	423.481	4	105.870	17.015	.000
Error	112.000	18	6.222		
Total	6550.000	27			
Corrected Total	800.519	26			

a. R Squared = .860 (Adjusted R Squared = .798)

ALT U/L3 hr.

Dependent Variable: GPTAT 3HOUR

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4836.074[a]	8	1854.509	1.261	.322
Intercept	7531.259	1	7531.259	11.921	.003
DIETS	2983.407	2	1491.704	1.014	.382
TREATMEN	3733.852	2	1866.926	1.270	.305
DIETS * TREATM	8118.815	4	2029.704	1.380	.280
Error	6470.667	18	1470.593		
Total	8838.000	27			
Corrected Total	1306.741	26			

a. R Squared = .359 (Adjusted R Squared = .074)

T3 n mol/L at 0 hr.

Dependent Variable: T3 at zero hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.436[a]	8	1.430	25.023	.000
Intercept	196.129	1	196.129	3433.046	.000
DIETS	8.193	2	4.097	71.707	.000
TREATMEN	.189	2	9.458E-02	1.656	.219
DIETS * TREATM	3.054	4	.764	13.364	.000
Error	1.028	18	5.713E-02		
Total	208.593	27			
Corrected Total	12.465	26			

a. R Squared = .918 (Adjusted R Squared = .881)

T4 n mol/L at 0 hr.

Dependent Variable: T4 at zero time

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12728.120[a]	8	1591.015	21.909	.000
Intercept	47777.621	1	47777.621	4788.950	.000
DIETS	9424.853	2	4712.427	64.891	.000
TREATMEN	2168.523	2	1084.262	14.930	.000
DIETS * TREATM	1134.744	4	283.686	3.906	.019
Error	1307.175	18	72.621		
Total	61812.917	27			
Corrected Total	14035.296	26			

a. R Squared = .907 (Adjusted R Squared = .865)

Calcium mg/dl at 0 hr.

Dependent Variable: calcium at zero hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	72.520[a]	8	9.065	5.216	.002
Intercept	5568.234	1	5568.234	3203.735	.000
DIETS	21.564	2	10.782	6.204	.009
TREATMEN	17.575	2	8.787	5.056	.018
DIETS * TREATM	33.381	4	8.345	4.801	.008
Error	31.285	18	1.738		
Total	5672.039	27			
Corrected Total	103.805	26			

a. R Squared = .699 (Adjusted R Squared = .565)

Calcium mg/dl at 3 hr.

Dependent Variable: calicium at 3 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	55.419[a]	8	6.927	2.007	.105
Intercept	5573.117	1	5573.117	1614.753	.000
DIETS	18.035	2	9.017	2.613	.101
TREATMEN	6.562	2	3.281	.951	.405
DIETS * TREATM	30.822	4	7.705	2.233	.106
Error	62.125	18	3.451		
Total	5690.661	27			
Corrected Total	117.544	26			

a. R Squared = .471 (Adjusted R Squared = .237)

Phosphorus mg/dl at 0 hr.

Dependent Variable: phosphorus at 0 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	434.208[a]	8	54.276	8.553	.000
Intercept	6550.456	1	6550.456	1032.185	.000
DIETS	163.516	2	81.758	12.883	.000
TREATMEN	29.041	2	14.520	2.288	.130
DIETS * TREATM	241.651	4	60.413	9.520	.000
Error	114.232	18	6.346		
Total	7098.896	27			
Corrected Total	548.440	26			

a. R Squared = .792 (Adjusted R Squared = .699)

Phosphorus mg/dl at 3 hr.

Dependent Variable: phosphorus at 3hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	377.048[a]	8	47.131	11.152	.000
Intercept	5709.858	1	5709.858	1351.035	.000
DIETS	228.770	2	114.385	27.065	.000
TREATMEN	45.179	2	22.590	5.345	.015
DIETS * TREATM	103.099	4	25.775	6.099	.003
Error	76.073	18	4.226		
Total	6162.979	27			
Corrected Total	453.121	26			

a. R Squared = .832 (Adjusted R Squared = .757)

Magnesium mg/dl at 0 hr.

Dependent Variable: magnesum at zero hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.173[a]	8	.147	1.081	.418
Intercept	233.848	1	233.848	1724.306	.000
DIETS	1.065	2	.532	3.925	.038
TREATMEN	1.745E-02	2	8.726E-03	.064	.938
DIETS * TREATM	9.119E-02	4	2.280E-02	.168	.952
Error	2.441	18	.136		
Total	237.462	27			
Corrected Total	3.614	26			

a. R Squared = .325 (Adjusted R Squared = .024)

Magnesium mg/dl at 3 hr.

Dependent Variable: magnesium at 3 hour

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.393[a]	8	.174	.901	.536
Intercept	321.713	1	321.713	1664.605	.000
DIETS	.742	2	.371	1.920	.175
TREATMEN	.454	2	.227	1.174	.332
DIETS * TREATM	.197	4	4.929E-02	.255	.903
Error	3.479	18	.193		
Total	326.585	27			
Corrected Total	4.872	26			

a. R Squared = .286 (Adjusted R Squared = -.031)

Total dry matter intake (g/d)

Dependent Variable: dry matter intake

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	)6132.321[a]	5	79226.464	7.121	.000
Intercept	32158315	1	32158315	2890.519	.000
DIETS	77535.316	1	77535.316	33.934	.000
TREATMEN	935.551	2	467.776	.042	.959
DIETS * TREATM	17661.454	2	8830.727	.794	.460
Error	)0516.056	36	11125.446		
Total	32954963	42			
Corrected Total	)6648.378	41			

a. R Squared = .497 (Adjusted R Squared = .427)

Daily feed intake(g), TDN (g/d)

Dependent Variable: TDN

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	32745.554[a]	5	46549.111	8.136	.000
Intercept	16129923	1	16129923	2819.192	.000
DIETS	24098.408	1	24098.408	39.168	.000
TREATMEN	300.482	2	150.241	.026	.974
DIETS * TREATM	8346.664	2	4173.332	.729	.489
Error	)5972.961	36	5721.471		
Total	16568642	42			
Corrected Total	38718.515	41			

a. R Squared = .531 (Adjusted R Squared = .465)

Daily feed intake,DCP(g/d)

Dependent Variable: DCB

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4713.567[a]	5	942.713	5.853	.000
Intercept	63407.069	1	63407.069	2877.111	.000
DIETS	4429.040	1	4429.040	27.498	.000
TREATMEN	178.902	2	89.451	.555	.579
DIETS * TREATM	105.625	2	52.812	.328	.723
Error	5798.406	36	161.067		
Total	73919.042	42			
Corrected Total	10511.973	41			

a. R Squared = .448 (Adjusted R Squared = .372)

Initial body weight (kg

Dependent Variable: intial body weight

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.354[a]	5	.671	.057	.998
Intercept	14042.521	1	14042.521	1196.017	.000
DIETS	1.688	1	1.688	.144	.707
TREATMEN	1.542	2	.771	.066	.937
DIETS * TREATM	.125	2	6.250E-02	.005	.995
Error	493.125	42	11.741		
Total	14539.000	48			
Corrected Total	496.479	47			

a. R Squared = .007 (Adjusted R Squared = -.111)

Average daily gain (g)

Dependent Variable: average daily gain

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1498.878[a]	5	299.776	.398	.847
Intercept	1280191.7	1	1280191.7	1700.894	.000
DIETS	216.921	1	216.921	.288	.595
TREATMEN	969.985	2	484.993	.644	.531
DIETS * TREATM	311.971	2	155.985	.207	.814
Error	27095.697	36	752.658		
Total	1308786.2	42			
Corrected Total	28594.575	41			

a. R Squared = .052 (Adjusted R Squared = -.079)

Final body weight (kg)

Dependent Variable: final body weight

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	51.427[a]	5	10.285	.564	.727
Intercept	49152.149	1	49152.149	2693.212	.000
DIETS	16.783	1	16.783	.920	.345
TREATMEN	.671	2	.336	.018	.982
DIETS * TREATM	33.196	2	16.598	.909	.413
Error	565.762	31	18.250		
Total	50020.000	37			
Corrected Total	617.189	36			

a. R Squared = .083 (Adjusted R Squared = -.065)

Total gain (kg)

Dependent Variable: VAR00004

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	38.638[a]	5	7.728	.747	.593
Intercept	16265.235	1	16265.235	1572.502	.000
DIETS	3.188	1	3.188	.308	.582
TREATMEN	13.115	2	6.557	.634	.535
DIETS * TREATM	22.336	2	11.168	1.080	.349
Error	434.429	42	10.344		
Total	16738.302	48			
Corrected Total	473.067	47			

a. R Squared = .082 (Adjusted R Squared = -.028)

Glucose, mg/dl

Dependent Variable: glucose,mg/dl

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	117.253[a]	5	23.451	.861	.534
Intercept	41867.498	1	41867.498	1536.297	.000
DIETS	32.994	1	32.994	1.211	.293
TREATMEN	31.366	2	15.683	.575	.577
DIETS * TREATM	52.892	2	26.446	.970	.407
Error	327.027	12	27.252		
Total	42311.778	18			
Corrected Total	444.280	17			

a. R Squared = .264 (Adjusted R Squared = -.043)

Total protein, mg/dl

Dependent Variable: total protein mg/dl

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	39.403[a]	5	7.881	36.188	.000
Intercept	684.747	1	684.747	3144.405	.000
DIETS	38.661	1	38.661	177.536	.000
TREATMEN	.185	2	9.229E-02	.424	.664
DIETS * TREATM	.557	2	.278	1.278	.314
Error	2.613	12	.218		
Total	726.762	18			
Corrected Total	42.016	17			

a. R Squared = .938 (Adjusted R Squared = .912)

AST, U/L

Dependent Variable: GOT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.111[a]	5	1.422	.178	.966
Intercept	14906.889	1	14906.889	1863.361	.000
DIETS	3.556	1	3.556	.444	.518
TREATMEN	1.778	2	.889	.111	.896
DIETS * TREATM	1.778	2	.889	.111	.896
Error	96.000	12	8.000		
Total	15010.000	18			
Corrected Total	103.111	17			

a. R Squared = .069 (Adjusted R Squared = -.319)

ALT, U/L

Dependent Variable: GPT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	144.500[a]	5	28.900	2.797	.067
Intercept	18624.500	1	18624.500	1802.371	.000
DIETS	1.389	1	1.389	.134	.720
TREATMEN	82.333	2	41.167	3.984	.047
DIETS * TREATM	60.778	2	30.389	2.941	.091
Error	124.000	12	10.333		
Total	18893.000	18			
Corrected Total	268.500	17			

a. R Squared = .538 (Adjusted R Squared = .346)

Creatinine, mg/dl

Dependent Variable: Creatinine, mg/dl

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.138[a]	5	2.757E-02	1.472	.269
Intercept	34.778	1	34.778	1857.017	.000
DIETS	5.120E-02	1	5.120E-02	2.734	.124
TREATMEN	7.323E-02	2	3.662E-02	1.955	.184
DIETS * TREATM	1.343E-02	2	6.717E-03	.359	.706
Error	.225	12	1.873E-02		
Total	35.140	18			
Corrected Total	.363	17			

a. R Squared = .380 (Adjusted R Squared = .122)

Alk. phosphatase, I.U/L

Dependent Variable: Alk. phasphatase, I.U/L

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34394.676[a]	5	6878.935	7.944	.002
Intercept	781058.345	1	781058.345	902.005	.000
DIETS	20734.625	1	20734.625	23.945	.000
TREATMEN	2478.090	2	1239.045	1.431	.277
DIETS * TREATM	11181.961	2	5590.980	6.457	.012
Error	10390.957	12	865.913		
Total	825843.978	18			
Corrected Total	44785.633	17			

a. R Squared = .768 (Adjusted R Squared = .671)

Calcium mg/dl

Dependent Variable: calcium mg/dl

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	36.037[a]	5	7.207	6.698	.003
Intercept	1828.512	1	1828.512	1699.203	.000
DIETS	19.344	1	19.344	17.976	.001
TREATMEN	12.006	2	6.003	5.578	.019
DIETS * TREATM	4.688	2	2.344	2.178	.156
Error	12.913	12	1.076		
Total	1877.463	18			
Corrected Total	48.951	17			

a. R Squared = .736 (Adjusted R Squared = .626)

Phosphorus mg/dl

Dependent Variable: Phosphorus mg/dl

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	126.847[a]	5	25.369	4.667	.013
Intercept	3394.880	1	3394.880	624.530	.000
DIETS	86.944	1	86.944	15.994	.002
TREATMEN	15.571	2	7.786	1.432	.277
DIETS * TREATM	24.332	2	12.166	2.238	.149
Error	65.231	12	5.436		
Total	3586.958	18			
Corrected Total	192.078	17			

a. R Squared = .660 (Adjusted R Squared = .519)

Magnesium, mg/dl

Dependent Variable: Magnesium mg/dl

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.967[a]	5	.193	2.345	.105
Intercept	111.901	1	111.901	1355.917	.000
DIETS	.358	1	.358	4.343	.059
TREATMEN	.252	2	.126	1.525	.257
DIETS * TREATM	.357	2	.179	2.165	.157
Error	.990	12	8.253E-02		
Total	113.859	18			
Corrected Total	1.958	17			

a. R Squared = .494 (Adjusted R Squared = .283)

Iron mg/ dl

Dependent Variable: Iron mg/L

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	285.655[a]	5	57.131	.155	.974
Intercept	)3198.432	1	)3198.432	1366.863	.000
DIETS	99.876	1	99.876	.271	.612
TREATMEN	112.886	2	56.443	.153	.860
DIETS * TREATM	72.894	2	36.447	.099	.906
Error	4417.694	12	368.141		
Total	)7901.781	18			
Corrected Total	4703.349	17			

a. R Squared = .061 (Adjusted R Squared = -.331)

Copper mg/ dl

Dependent Variable: Copper mg/L

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.124[a]	5	2.471E-02	.759	.596
Intercept	.677	1	.677	20.799	.001
DIETS	3.026E-02	1	3.026E-02	.930	.354
TREATMEN	2.901E-02	2	1.451E-02	.446	.650
DIETS * TREATM	6.428E-02	2	3.214E-02	.988	.401
Error	.390	12	3.253E-02		
Total	1.191	18			
Corrected Total	.514	17			

a. R Squared = .240 (Adjusted R Squared = -.076)

Zinc mg/ dl

Dependent Variable: Zinc mg/L

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.873[a]	5	.175	7.860	.002
Intercept	60.500	1	60.500	2722.500	.000
DIETS	.142	1	.142	6.400	.026
TREATMEN	.130	2	6.500E-02	2.925	.092
DIETS * TREATM	.601	2	.301	13.525	.001
Error	.267	12	2.222E-02		
Total	61.640	18			
Corrected Total	1.140	17			

a. R Squared = .766 (Adjusted R Squared = .669)

الملخص العربى

أجريت هذه الدراسة بوحدة بحوث تغذية الحيوان بقسم التطبيقات البيولوجية – شعبة تطبيقات النظائر المشعة – مركز البحوث النووية – هيئة الطاقة الذرية بأنشاص.

تضمنت هذه الدراسة تجربتين، التجربة الأولى وهى عبارة عن تجارب هضم بهدف دراسة تأثير إضافة الطفلة والبنتوفارم وهى من معادن الطين الطبيعية على المأكول من المادة الجافة والمستهلك من الماء المشروب وعلى معاملات الهضم وبعض قياسات الكرش والدم والمحتجز من النيتروجين و بعض العناصر المعدنية.

أما التجربة الثانية وفيها تم إختيار أفضل نتائج تجارب الهضم السابقة لدراسة تأثير إضافة الطفلة والبنتوفارم على معدلات النمو وبعض قياسات الدم للحملان بعض الفطام.

التجربة الأولى (تجارب الهضم):–

وقد إستخدم لإجراء هذه التجربة عدد ٢٧ كبش بلدى تام النمو بمتوسط وزن ٤٥ كجم وزعت عشوائياً إلى ثلاث مجموعات رئيسية ثم قسمت كل مجموعة رئيسية إلى ثلاث معاملات بحيث كل معاملة بها ثلاث كباش وذلك لتقيم العلائق المختبرة.

١– المجموعة الرئيسية الأولى: والتى تم تغذيتها على عليقة ١٠٠% برسيم كعليقة أساسية والتى قسمت إلى ثلاث معاملات:

المعاملة الأولى: والتى تناولت العليقة الأساسية وهى ١٠٠% برسيم بدون أى إضافة (كنترول).

المعاملة الثانية: والتى تناولت العليقة الأساسية بالاضافة الى ٣% طفلة.

المعاملة الثالثة: والتى تناولت العليقة الأساسية بالاضافة الى ٣%بنتوفارم.

٢– المجموعة الرئيسية الثانية: والتى تناولت العليقة الأساسية وهى ٥٠% برسيم + ٥٠% مركز. والتى قسمت إلى ثلاث معاملات:

المعاملة الرابعة: والتى تناولت العليقة الأساسية وهى ٥٠% برسيم + ٥٠% مركز بدون أى إضافة (كنترول).

المعاملة الخامسة: والتى تناولت العليقة الأساسية بالاضافة الى ٣% طفلة.

المعاملة السادسة والتى تناولت العليقة الأساسية بالاضافة الى ٣%بنتوفارم.

٣- المجموعة الرئيسية الثالثة: وهى التى تناولت عليقة أساسية مكونه من ١٠٠% علف مركز + قش أرز حتى الشبع والتى قسمت إلى ثلاث معاملات.

المعاملة السابعة: والتى تناولت العليقة الأساسية بدون أى إضافة (كنترول).

المعاملة الثامنة: والتى تناولت العليقة الأساسية بالاضافة الى ٣% طفلة.

المعاملة التاسعة والتى تناولت العليقة الأساسية بالاضافة الى ٣%بنتوفارم.

علماً بأن الطفلة والبنتوفارم فى المجموعة الرئيسية الأولى والتى تناولت ١٠٠% برسيم إعطيت للحيونات عن طريقة التجريع بالفم فى حين تم إضافة الطفلة والنبتوفارم فى المجموعة الرئيسية الثانية والثالثة الى العليقة المركزة، وفى نهاية تجارب الهضم تم جمع عينات من سائل الكرش بواسطة اللى المعدى وذلك لتقدير رقم الحموضة (تركيز ايون الايدروجين) والأمونيا والأحماض الدهنية الطيارة والبروتين الميكروبى كما أخذت عينات الدم من الوريد الودجى لإجراء إختبارات الدم والسيرم.

وتتلخص نتائج هذه التجربة فيما يلى:

١- كمية المأكول من المادة الجافة محسوبة بالجم / الرأس / يوم، جم/ كجم و٠.٧٥ أزدادت معنوياً فى العليقة الثانية (٥٠% برسيم + ٥٠% مركز) والعليقة الثالثة (١٠٠% مركز + قش الأرز) مقارنتن بالعليقة الأولى (١٠٠% برسيم)، فى حين لم يكن هناك تاثير معنوى للمعاملة أو للتداخل بين المعاملة والعليقة على المأكول من المادة الجافة.

٢- زاد إستهلاك الماء (مل/ الرأس / يوم ، مل / و$^{٠.٧٥}$، مل/ جم مادة جافة مأكولة) معنوياً فى العليقة الأولى مقارنة بالعليقة الثانية والثالثة ولم يكن هناك أى تأثير معنوياً للمعاملة أو التداخل ما بين العليقة والمعاملة.

٣- أثرت العليقة معنوياً على معاملات هضم المادة الجافة والبروتين الخام حيث أزدادت معاملات الهضم لهما فى العليقة الثانية مقارنة بالعليقة الأولى والثالثة حيث أعطت العليقة الثانية لمعاملات هضم المادة الجافة والبروتين الخام أعلى قيمة ٦٩,٧٥ ، ٧٣,٦٦% بينما أعطت العليقة الأولى أقل قيمة (٦٣,٩٧ ، ٦٧,٣٦%)، أيضاً كان لتأثير المعاملة تأثيراً معنوياً حيث سجلت المعاملة الأولى (الكنترول) أعلى قيمة لمعاملات هضم المادة الجافة والبروتين الخام (٦٨,٦٦ ، ٧٢,٤٥%) بينما سجلت المعاملة الثالثة (البنتوفارم) أقل قيمة (٦٦,٣٨ ، ٧٠,١٩%) على الترتيب، ولم يكن لتأثير التداخل بين العليقة والمعاملة أى تأثير معنوى.

٤- أثرت العليقة معنوياً على معاملات هضم المادة العضوية والمستخلص الخالى من النيتروجين حيث سجلت العليقة الثانية أعلى قيمة بينما سجلت العليقة الاولى أقل قيمة، فى حين لم يكن لتأثير المعاملة والتداخل بين المعاملة والعليقة أى تأثير معنوى على معاملات هضم كلا من المادة العضوية والمستخلص الخالى من النيتروجين.

٥- أثرت العليقة معنوياً على هضم الألياف حيث أزداد معنوياً هضم الألياف فى العليقة الأولى مقارنة بكلا من العليقة الثانية والثالثة ، أيضا كان لتأثير العليقة على معامل هضم مستخلص الأثير تأثيرا معنوياً حيث أزداد معامل الهضم فى العليقة الثالثة مقارنة بكلا من العليقة الأولى والثانية ولم يكن لتأثير المعاملة أو التداخل بين العليقة والمعاملة أى تأثير معنوياً على كل من هضم الألياف ومستخلص الأثير.

٦- تأثرت القيم الغذائية كمجموع المركبات الغذائية المهضومة TND والبرتين الخام المهضوم DCP ومعادل النشا S.V تأثراً معنوياً بالعليقة حيث أظهرت العليقة الثالثة أعلى قيمة بالنسبة للـ TDN ، S.V تليها العليقة الثانية بينما أعطت العليقة الأولى أقل قيمة، كما أعطت العليقة الثالثة أعلى قيمة بخصوص البروتين الخام المهضوم DCP بينما أعطت العليقة الأولى أقل قيمة، أما عن تأثير المعاملة فلم يكن لها أى تأثيرا معنوياً على القيم الغذائية DCP , S.V , TDN، أما عن تأثير التداخل ما بين العليقة والمعاملة فإنه أظهر أختلافات معنوية بالنسبة S.V , TDN حيث سجلت المعاملة الخامسة (٥٠% برسيم + ٥٠% وكذا مضافاً إليها الطفلة) أعلى قيمة لل TDN (٧٢,٤٤%) والمعاملة السابعة ١٠٠% مركز بدون إضافة (كنترول) أعلى قيمة للS.V (٦١,٩٩%) بينما سجلت المعاملة

الثالثة أقل قيمة منTDN , S.V (٦٠,٠٥ ، ٤١,٨٦%) على التوالى فى حين لم يكن لتأثير التداخل أى تأثيرا معنويا على البروتين الخام المهضومDCP .

٧- زادت معنوياً قيم الأس الهيدروجينى قبل وبعد تناول الطعام بثلاث ساعات فى العليقة الأولى مقارنة بالعليقة الثانية والثالثة كنتيجة لتأثير العليقة، أما بالنسبة لتأثير المعاملة فقد أوضح أن هناك فروق معنوية حيث سجلت أعلى قيمة لقيم الأس الهيدروجينى قبل وبعد تناول الطعام بثلاث ساعات للمعاملة الثانية (الطفلة) ٧,٠٤ ، ٦,٦٩ بينما سجلت المعاملة الثالثة (البنتوفارم) والمعاملة الأولى (الكنتورول) أقل قيمة ٦,٩١ ، ٦,١٦ على الترتيب، وبالنسبة لتأثير التداخل بين العليقة والمعاملة فقد أوضح أيضاً أن هناك فروق معنوية بين المعاملات حيث سجلت أعلى قيمة لقيم الأسى الأيدروجين قبل وبعد ثلاث ساعات من تناول الطعام المعاملة الثانية (١٠٠% برسيم مع الطفلة) ٧,٤٦ ، ٧,٤٣ فى حين سجلت أقل قيمة للمعاملة الخامسة والسابعة ٦,٧٩ ، ٥,٦٩ على التوالى.

٨- أثرت العليقة معنوياً على تركيز الأمونيا فى الكرش قبل التغذية بثلاث ساعات حيث سجلت العليقة الثالثة أعلى قيمة (١٥,٠٢ملجم/١٠٠مل) مقارنة بالعليقة الأولى والثانية (١١,١٩ ، ١٢,١٥ملجم/١٠٠مل) وذلك قبل التغذية على التوالى فى حين سجلت العليقة الثانية أعلى قيمة (٢٧,٧٦ ملجم/١٠٠مل) مقارنة بالعليقة الأولى والثالثة (١٢,٠٠ ، ١٩,٢٩ملجم/١٠٠مل) وذلك بعد التغذية بثلاث ساعات على التوالى، أما عن تأثير المعاملة فكان واضح حيث كانت هناك فروق معنوية حيث أنخفض تركيز الأمونيا فى الكرش فى كل من المعاملة الثانية (الطفلة) والثالثة (البنتوفارم) مقارنة بالمعاملة الأولى (الكنترول) وذلك قبل التغذية، حيث كان تركيز الأمونيا فى الكرش قبل التغذية ١٥,٣٧ ، ١٢,٠٨ ، ١٠,٩١ملجم/١٠٠مل وبعد التغذية ٢٤,٢٨ ، ١٧,٤٦ ، ١٧,٣١ ملجم/١٠٠مل وذلك للمعاملة الأولى والثانية والثالثة على الترتيب وهذا يوضح دور معادن الطين فى أدمصاص الأمونيا عند زيادة تركيزها ثم إعادة إطلاقها فى الكرش عند إنخفاض تركيزها، أما عن تأثير التداخل ما بين العليقة والمعاملة أوضح أن هناك فروق معنوية بين المعاملات وذلك قبل التغذية حيث سجلت المعاملة السابعة أعلى قيمة (18.22 ملجم/١٠٠مل) بينما سجلت المعاملة الثانية أقل قيمة (9.54 ملجم/١٠٠مل).

٩- أثرت العليقة معنوياً على تركيز الأحماض الدهنية الطيارة فى الكرش قبل التغذية وبعد التغذية بثلاث ساعات حيث سجلت العليقة الأولى أعلى قيمة (١٢,٦١ملجم/١٠٠مل) مقارنة بالعليقة الثانية والثالثة (11.92 ، 9.83 ملجم/١٠٠مل مليمكافى) وذلك قبل التغذية على التوالى فى حين سجلت العليقة الثانية أعلى قيمة (20.88 ملجم/١٠٠مل) مقارنة بالعليقة الأولى والثالثة (16.33 ، 17.77 مليمكافى /١٠٠مل) وذلك بعد التغذية بثلاث ساعات على التوالى، أما عن تأثير المعاملة فكان واضح بوجود فروق معنوية بين المعاملات وذلك قبل التغذية حيث سجلت المعاملة الثالثة أعلى قيمة (١٤,٠٥ مليمكافئ /١٠٠مل) فى حيث سجلت المعاملة الأولى أقل قيمة (٩,١٤ مليمكافئ /١٠٠ مل سائل كرش) وذلك قبل التغذية، أما عن تأثير التداخل ما بين العليقة والمعاملة فكان واضح بوجود فروق معنوية بين المعاملات وذلك قبل التغذية حيث سجلت المعاملة الثالثة اعلى قيمة (15.33مليمكافئ/١٠٠ مل) فى حين سجلت المعاملة الثامنة أقل قيمة(7.33مليمكافئ/١٠٠ مل)على الترتيب.

١٠- أثرت نوع العليقة معنوياً على نسبة البروتين الميكروبى فى سائل الكرش حيث سجل البروتين الميكروبى قيم (٠,٦٧ ، ٠,٩٩ ، ٠,٨١جم/١٠٠مل سائل كرش) قبل التغذية بينما سجل البروتين الميكروبى قيمم (٠,٨١ ، ٠,٦٦ ، ١,٤١جم/١٠٠مل سائل الكرش) وذلك بعد التغذية بثلاث ساعات وذلك للعليقة الأولى والثانية والثالثة على التراتيب، وتأثير المعاملة أوضح أن هناك فروق معنوية حيث كانت أعلى قيمة للبروتين الميكروبى قبل وبعد التغذية بثلاث ساعات هى (٠,٩٠ ، ١,٠٧ جم/١٠٠مل سائل) وذلك للمعاملة الأولى و الثالثة على التوالى بينما كانت أقل قيمة للبروتين الميكروبى قبل وبعد التغذية سجلتها المعاملة الثانية والأولى (٠,٦٨ ، ٠,٧٨ جم/١٠٠مل) على الترتيب، وبالنسبة لتأثير التداخل بين العليقة والمعاملة فكان واضح حيث كان هناك فروق معنوية حيث سجلت المعاملة الرابعة (٥٠% برسيم + ٥٠% مركز بدون إضافة أعلى قيمة للبروتين الميكروبى (١,١٤جم/١٠٠مل) فى حين سجلت المعاملة الثانية (١٠٠% برسيم + الطفلة) أقل قيمة للبروتين الميكروبى (٠,٤٨جم/١٠٠مل) وذلك قبل التغذية فى حين سجلت المعاملة التاسعة (١٠٠% مركز + البنتوفارم) أعلى قيمة للبروتين الميكروبى (١,٧٣جم/١٠٠مل) بينما سجلت المعاملة الرابعة (٥٠% برسيم + ٥٠% مركز

بدون إضافة الكنترول) أقل قيمة (٠,٥٣جم/١٠٠مل) وذلك بعد التغذية بثلاث ساعات.

١١- أثرت العليقة معنوياً على المحتجز من النيتروجين حيث سجلت العليقة الثانية والثالثة أعلى قيم (٩,٥٤ ، ١٠,٠٩حم / الرأس /يوم) مقارنة بالعليقة الأولى (٣,١٢جم/ الرأس /يوم)، فى حين لم يكن لتأثير المعاملة أو التداخل ما بين العليقة والمعاملة أى تأثيراً معنوياً على ميزان النيتروجين.

١٢- المحتجز من الكالسيوم تأثر معنوياً بنوع العليقة حيث سجلت العليقة الأولى (١٠٠% برسيم) أعلى قيمة (٤,٨٧جم/ الرأس /يوم) يليها العليقة الثانية (3.70 جم/ الرأس /يوم) أما العليقة الثالثة فقد سجلت أقل قيمة (٢,٦١جم رأس يوم)، أما بالنسبة لتأثير المعاملة فكان واضح حيث كانت هناك فروق معنوية بين المعاملات حيث أدت إضافة الطفلة (المعاملة الثانية) والبنتوفارم (المعاملة الثالثة) الى زيادة فى ميزان الكالسيوم مقارنة بالمعاملة الأولى(الكونترول), حيث سجلت المعاملة الثانية أعلى قيمة تليها المعاملة الثالثة (٤,١٤ ، ٣,٨٩جم/رأس/يوم) على الترتيب ثم أقلهم المعاملة الكنترول (٣,١٥جم رأس يوم)، وبالنسبة لتاثير التداخل ما بين العليقة والمعاملة فكان واضح حيث كان هناك فروق معنوية بين المعاملات حيث سجلت المعاملة الثانية (١٠٠% برسيم مضافا إليها الطفلة) أعلى قيمة (٦,٠٨جم / الرأس /يوم) فى حين سجلت المعاملة السابعة والتى تناولت (١٠٠% مركز بدون إضافة) أقل قيمة (١,٣٦جم /راس/يوم).

١٣- أثرت نوع العليقة معنويا على المحتجز من الفوسفور حيث سجلت العليقة الثالثة والتى تتناول ١٠٠% مركز أعلى قيمة ٢,٤٣ جم /رأس /يوم يليها العليقة الثانية والتى تتناول ٥٠% مركز + ٥٠% برسيم ١,٧٢جم /راس /يوم ثم أقلهم العليقة الأولى التى تتناول ١٠٠% برسيم (١,١٤جم / الرأس /يوم) أيضاً كان تأثير المعاملة واضح حيث كانت هناك إختلافات معنوية بين المعاملات حيث أظهرت المعاملات التى تناولت الطفلة والنبتونارم قيمة أقل (١,٧٩ ، ١,٢٦جم راس يوم) على التوالى مقارنة بالكنترول (٢,٢٤جم/ الرأس /يوم) ،أما عن تأثير التداخل بين العليقة والمعاملة على على المحتجز من الفوسفور فكان واضح حيث كان هناك فروق معنوية بين المعاملات حيث سجلت المعاملة السابعة والتى تتناول ١٠٠% مركز بدون إضافة أعلى قيمة (٤,٢١ جم/ الرأس /يوم) فى حين سجلت

المعاملة الأولـــى والتـــى تتنـــاول ١٠٠% برســـيم بـــدون إضـــافة أقـــل قيمـــة (٠,٩٠جم/راس/يوم).

١٤- لم يكن لتأثير العليقة أو تأثير التداخل ما بين العليقة والمعاملة علي المحتجـــز من المغنسيوم أى تأثيراً معنوياً فى حين أظهرت المعاملة وجود فروقٍ معنوية بين المعاملات حيث إزداد المحتجز من المغنسيوم معنوياً بإضافة كـــلا مـــن الطفلـــة والبنتوفارم حيث سجلت المعاملة الثالثة أعلى قيمة (2.11جم/ الرأس /يـــوم) فـــى حين سجلت المعاملة الاولى أقل قيمة (١,٠٤جم/ الرأس /يوم).

١٥-المحتجز من الحديد تأثر معنوياً بكل من نـــوع العليقـــة والمعاملـــة وكـــذلك والتداخل ما بين العليقة والمعاملـــة،حيث ســـجلت العليقـــة الثانيـــة أعلـــى قيمـــة (٥٤٤,٥٠ملجم/ الرأس /يـــوم) مقارنـــة بالعليقـــة الأولـــى والثانيـــة (٤٩٠,٦٥ ، ٤٧١,١٧٢ ملجم/ الرأس /يوم) على الترتيب، أما عن تاثير المعاملة فكـــان هنـــاك فروق معنوية بين المعـــاملات حيـــث أظهـــرت المعاملـــة الثالثـــة أعلـــى قيمـــة (٨٥١,١٨ملجم/ الرأس /يوم) يليها المعاملة الثانية (٤٤٩,٨٧ ملجم/ الرأس /يـــوم) فى حين سجلت المعاملة الأولى أقل قيمة وهى (٢٠٥,٢٦ملجم/ الرأس /يوم)، أما عن تاثير التداخل ما بين العليقة و المعاملة فقد سجلت المعاملـــة الـــسادسة والتـــى تتنـــاول ٥٠% برســـيم + ٥٠ مركـــز مـــضافاً اليهـــا البنتوفـــارم أعلـــى قيمـــة (٩٢٥,٩٤ملجم/راس/يوم) ١٠٠% مركز فى حين سجلت المعاملة الاولى أقل قيمة (١٨٠,٩٧ملجم/ الرأس /يوم) وذلك ربما يكون راجع لزيادة محتـــوى البنتوفـــارم والطفلة من عنصرالحديد فى تركيبهما.

١٦- المحتجز من النحاس لم يتأثر معنوياً بنوع العليقـــة أو المعاملـــة أو التـــداخل بينهما.

١٧- المحتجز من الزنك تأثير معنوياً بنوع العليقة حيث إزداد معنوياً المحتجز من الزنك فى كل من العليقة الثانية والثالثة على الترتيـــب (٢٥,٣٤ ، ٢٦,٥٦ ملجـــم/ الرأس /يوم) مقارنة بالعليقة الأولى   ٩,٠٢ملجم/ الرأس /يوم، أما عن تاثير المعاملة فكان هناك فروق معنوية بين المعاملات حيث سجلت المعاملة الأولى أعلى قيمة (٢٤,٤٥ملجم /راس/يوم) تليها المعاملة الثانية (١٨,٧٧ملجم/ الـــرأس / يوم) ثم أقلهم المعاملة الثالثة (١٧,٧٠ملجم/ الرأس /يوم)، أما بالنسبة لتأثير التداخل ما بين العليقة والمعاملة فلا توجد اختلافات معنوية بين المعاملات.

١٨- أظهرت تحاليل عينات الدم أن نوع العليقة كان له تأثيراً معنوياً على كل من اليوريا البروتين الكلى والألبيومين والكرياتينين وذلك قبل التغذية وبعــدها بــثلاث ساعات، أما تأثير المعاملة فكان واضح حيث كان هناك فــروق معنويـــة بالنـــسبة لليوريا والألبيومين قبل وبعد التغذية بثلاث ساعات والكرياتينين قبل التغذيـــة فـــى حين لم يكن لتأثير المعاملة أى تاثير معنوى بالنسبة للبروتين الكلـــى قبـــل وبعـــد التغذية والكرياتينين بعد التغذية بثلاث ساعات، أيضاً فقد كان لتأثير التداخل ما بين العليقة والمعاملة فروق معنوية بالنسبة لليوريا والبروتين الكلى والكريـــاتينين قبـــل التغذية والألبيومين بعد التغذية فى حين لم يكن لتاثير التداخل أى فـــروق معنويـــة على اليوريا والبروتين الكلى والألبيومين والكرياتنسين بعد التغذية بثلاث ســـاعات والألبيومين قبل التغذية.

١٩- أيضاً أظهرت تحاليل عينات الدم لنشاط إنزيمات وظـــائف الكبـــد (ALT، AST) وهرمونات الغدة الدرقية(T_4 , T_3) أن لنوع العليقة لة تأثيراً معنوياً على أنزيمات وظائف الكبد الـــ AST قبل وبعد التغذية والـــ ALT قبل التغذية و T_4, T_3 بعد التغذية بثلاث ساعات فى حين لم يكن لتأثير العليقة أى تأثيراً معنوياً علـــى ALT بعد التغذية بثلاث ساعات، أما عن تأثير المعاملة فكان هناك فروق معنوية بين المعاملات بالنسبة لـــT_4 , AST بعد الأكل بثلاث ساعات فى حين لـــم يكـــن لتأثير المعاملة على الـــALT قبل التغذية بثلاث ساعات و T_4 بعد ثلاث ساعات من التغذية، أما بالنسبة لتأثير التداخل بين العليقة والمعاملة أوضح أن توجد فـــروق معنوية بين المعاملات لكل القياسات قبل وبعد التغذية (T_4, T_3, AST, ALT).

٢٠- وبتقدير المعادن فى سيرم الدم فقد أظهرت نتائج التحاليل أن نـــوع العليقـــة قدأوضح أنة توجد فروق معنوية على مستوى الكالسيوم والمغنسيوم قبـــل التغذيـــة والفوسفور قبل وبعد التغذية بثلاث ساعات فى حين لم توثر العليقة معنوياً على كلا من الكالسيوم والماغنسيوم بعد التغذية بثلاث ساعات، أما بالنسبة لتأثير المعاملة فقد أوضح انة توجد فروق معنوية للكالسيوم قبل التغذية والفوسفور بعد التغذية بـــثلاث ساعات فى حين لم يكن للمعاملة أى تأثيراً معنوياً على المغنسيوم قبل وبعد التغذية بثلاث ساعات، وبالنسبة لتأثير التداخل ما بين العليقة والمعاملة فكان هناك فـــروق معنوية بين المعاملات بالنسبة للكالسيوم قبل التغذية والفوسفور قبل وبعـــد التغذيـــة بثلاث ساعات فى حين لم يكن لتأثير التداخل أى فروق معنوية بـــين المعـــاملات

بالنسبة للكالسيوم بعد التغذية بثلاث ساعات والماغنسيوم قبل وبعد التغذية بـــثلاث ساعات.

التجربة الثانية (تجربة النمو):-

وقد استخدم لإجراء هذه التجربة عدد ٤٨حمل ذكر عمر ٢ شهر تقريبا متوســط الوزن١٧ كجم وزعت عشوائياً على حسب وزن الجسم إلى٦ مجموعــات كــل مجموعة تحتوى على ٨حملان وقد استمرت فترة التجربة ١٢٠يوم لدراسة تــأثير إضافة الطفلة و البنتوفارم على الاداء الانتاجى والاقتصادى للحملان النامية.

علائق التجربة المقدمة للحملان كانت كالتالى:

١- معاملة (١) وفيها تناولت الحملان عليقة مكونة مــن ٥٠% برســيم + ٥٠% مركز كعليقة أساسية وبدون أى إضافة (الكونترول).

٢- معاملة رقم (٢) وفيها تناولت الحملان العليقة الأساسية مضافاً إليها ٣% طفلة.

٣- معاملة (٣) وفيها تناولت الحملان العليقة الأساسية مضافاً إليها ٣%بنتوفارم.

٤- معاملة (٤) وفيها تناولت الحملان عليقة مكونه مــن ١٠٠% مركــز + قــش الإرز حتى الشبع كعليقة أساسية وبدون أى إضافة (كونترول).

٥- معاملة (٥) وفيها تناولت الحملان العليقة الأساسية مضافاً إليها ٣% طفلة.

٦- معاملة (٦) وفيها تناولت الحملان العليقة الأساسية مضافاً إليها ٣%بنتوفارم.

وتتلخص نتائج التجربة الثانية فيما يلى:

١- نوع العليقة لم يؤثر معنوياً على كلا من وزن البداية ووزن النهايــة والزيــادة الكلية ومعدل الزيادة اليومية حيث كانت معدلات الزيادة اليومية هــى ١٧٦,٦٦ ، ١٧٢,٣١ جم/يوم للعليقة الأولى (٥٠% برسيم + ٥٠% مركز) والعليقــة الثانيــة (١٠٠% مركز) على الترتيب، أيضاُ لم يكن للمعاملــة أى تــأثيراً معنويــاً الا أن إضافة الطفلة (المعاملة الثانية) والبنتوفارم (المعاملة الثالثة) حسنت مــن معــدلات الزيــادة اليوميــة وكــان معــدل الزيــادة اليوميــة هــو ١٦٨,٣٣ ، ١٧٥,٤، ١٨٠,٠١جم/يوم للكنترول والطفلة والبنتوفارم على الترتيب ، وكذلك لم يكن أيضاً لتأثير التداخل ما بين العليقة والمعاملة أى تأثير معنوى إلا أن المعاملــة الرابعــة والتى تتناول عليقة مكونه من ٥٠%برسيم + ٥٠% مركز مضافاًاليها البنتوفــارم

أعطت أعلى معدل زيادة يومية (١٨٦,١١جم/يوم) فى حين أعطت المعاملة الأولى والتى تتناول ٥٠% برسيم + ٥٠% مركز بدرت إضافة (الكنترول) أقل قيمة ١٦٨,٢٩جم/يوم.

٢- أثرت العليقة معنوياً على المأكول اليومى كمادة جافة و TDN وDCP حيث زادت معنويا قيمة المأكول فى العليقة الثانية عن العليقة الاولى فى حين لم يكن لتاثير المعاملة او لتاثير التداخل مابين العليقة والمعاملة اى تأثيراً معنوياً.

٥-كفاءة التحويل الغذائى تأثرت معنوياً بنوع العليقة حيث زادت معنوياً فى العليقة الاولى عن العليقة الثانية، أما بالنسبة لتأثير المعاملة فكان واضح حيث ان اضافة الطفلة والبنتوفارم حسنت من كفاءة التحويل الغذائى ولكن لم تصل الفروق بين المعاملات الى درجة المعنوية، أما عن تأثير التداخل ما بين العليقة والمعاملة أوضح أنه لا توجد هناك فروق معنوية

٣- أظهرت تحاليل عينات السيرم للحملان أن نوع العليقة قد أثر معنوياً على كل من البروتين الكلى والألبيومين والأكالين فوسفاتيز فى حين لم يكن لنوع العليقة أى تأثيراً معنوياًعلى كلا من الجلكوز وإنزيمات وظائف الكبد (ALT,AST) والكرياتينين، أما عن تأثير المعاملة فقد أوضح أنه لا توجد فروق معنوية بين المعاملات بخصوص كلا من الجلوكوز والبروتين الكلى الألبومين، AST والكرياتينين والأكالين فوسفاتيز فى حين كان للمعاملة تأثيراً معنوياً على إنزيم الـ ALTأما عن تأثير التداخل ما بين العليقة والمعاملة أوضح أنه لا توجد هناك فروق معنوية بخصوص كلا من الجلوكوز البروتين الكلى والألبومين وإنزيمات الكبد والكرياتينين فيما عدا الألكالين فوسفاتيزفقد تأثر معنوياً بالتداخل ما بين العليقة والمعاملة حيث سجلت المعاملة الأولى والتى تتناول عليقة أساسية ٥٠%برسيم + ٥٠% مركز أعلى قيمة (٢٥٧,٧٥ وحدة دولية/لتر) فى حين سجلت المعاملة الرابعة والتى تتناول عليقة أساسية مكونه عن ١٠٠% مركز + قش الأرز حتى الشبع وبدون أى إضافة أقل قيمة (١٣٣,٠٥ وحدة دولية/ لتر).

٤- وبتقدير المعادن فى سيرم دم الحملان فقد أظهرت نتائج الدراسة أن نوع العليقة قد أثر معنوياً على كلا من تركيز الكالسيوم والفوسفور والزنك فى سيرم الدم فى حين لم يكن للعليقة أى تأثيراً معنوياً على تركيز كلا من الماغنسيوم والحديد والنحاس فى السيرم، أما بالنسبة لتأثير المعاملة فكان واضح حيث كانت

هناك فروق معنوية بين المعاملات بخصوص تركيز كلاً من الكالسيوم والنحـــاس والزنك أما بالنسبة لتركيز الفوسفور الماغنسيوم والحديد والــسيرم فلــم يتـــأثروا معنوياً، أما بالنسبة لتأثير التداخل ما بين العليقة والمعاملة على تركيــز كـــلا مـــن الكالسيوم والفوسفور الماغنسيوم والحديد فلا توجد فروق معنوية بين المعاملات أما بالنسبة لتأثير التداخل على تركيز النحاس والزنك فقد أوضـــح أن هنـــاك فـــروق معنوية بين المعاملات.

ومن هذه الدراسة يمكن استخدام بعض أنواع معادن الطين مثل الطفلة والبنتوفـــارم فى حدود ٣% فى علائق الحيونات المجترة والتى يعتمــد فيهــا علـــى الأعـــلاف المركزة فقط أو الأعلاف المركزة والخضراء معا نظرا لتأثيرتها الإيجابيـــة علـــى الأداء الإنتاجى وعدم حدوث أية آثار جانبية على الحيونات.

تأثير معادن الطين على إستخدام بعض
العناصر المعدنية فى تغذية المجترات

رسالة مقدمة من

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ماجستير العلوم الزراعية (إنتاج حيواني) - كلية الزراعة - جامعة الزقازيق (٢٠٠٥)

للحصول على درجة

دكتور الفلسفة في العلوم الزراعية
(إنتـاج حـيواني)

قسم الانتاج الحيوانى
كلية الزراعة - جامعة الزقازيق

٢٠١٢

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للحصول على درجة

دكتور الفلسفة فى العلوم الزراعية – انتاج حيوانى

وقد تمت مناقشة الرسالة والموافقة عليها

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تاريخ الموافقة: ٢٠١٢/٣/١٤