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The Effect of Nano Bentonite Supplementation in Some Carcass Characteristics of Awassi Lambs

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ABSTRACT

This study was conducted at the College of Agricultural Engineering Sciences, University of Baghdad, to find out the effect of adding Nano-bentonite on the rations of lambs on the quantitative and qualitative characteristics of their carcasses. Five groups were placed in single cages and fed on five different rations made of concentrated and rough feeds, which is hay alfalfa. The first treatment (T_1) represents lambs feeding without addition, while in the second treatment (T_2), the lambs were fed with an addition of 2% natural bentonite/kg concentrated feed. Furthermore, the lambs were fed with adding 4% natural bentonite/kg concentrated feed in the third treatment (T_3), the fourth treatment (T_4) represents lambs feeding with adding 2 g Nano-bentonite / head per day, and in the fifth treatment (T_5), the lambs were fed by adding 4 g Nano-bentonite / head per day. Lambs were subjected to a similar diet throughout the entire period of the experiment at 120 days**,** where the animal was fed on a concentrated and rough diet by 3 % of live body weight. Moreover, live body weight was recorded weekly to measure the average daily weight gain and total gain, which leads to final body weight at the end of the experiment. All lambs were slaughtered, and carcasses were chilled at 2 ℃ for 24 hours, after that, several measurements were taken in including Carcass characteristics, physical composition, muscle distribution, and bones as well as fat deposition patterns in carcass and animal body, and some chemical characteristics. The study results showed that the T_5 treatment was superior (p <0.01) to other treatments in the average daily weight gain for each treatment (177gm/day) and average total gain (16kg). Also, the same treatment was significantly superior (P <0.01) with the final weight (pre-slaughter weight), and it recorded 30.33 kg. Generally, an arithmetic superiority in the efficiency of food conversion, empty body weight, hot and cold carcass weight, and the dressing percentage based on pre-slaughter weight between treatments. T_5 treatment was superior (p <0.01) significantly in the percentage based on the empty body and reached 52.93% compared to the control treatment 47.10%. On the other hand, T_2 treatment was recorded the lowest fat-tail percentage of cold carcass weight. Further, T_1 treatment was recorded at 5.74%, and the largest area of rib eye muscle was 12.50 cm² in treatment T_5 while treatment T_1 had the lowest area muscle, which was 9 cm². The treatments T_4, T_3, and T_1 showed a significant superiority (P <0.01) in the fat thickness, and it was 3.50, 3.63, and 3.43 mm for the three treatments, respectively, while the lowest fat thickness in treatment T_5 which reached 1.7 mm. All treatments exceeded in the characteristic of the carcass length compared to the control treatment, which amounted to 52.33, 61.66, 61.00, 61.33, 57.66 cm for treatments T_5, T_4, T_3, T_2, and T_1, respectively. Treatment T_5 showed a significant increase (P <0.01) in the percentage of meat for the excellent main cuts of the leg and shoulder, and an increase in the percentage of fat for the loin cuts and ribs. Treatment T_3 showed an increase (P <0.01) in the percentage of meat for the two cuts of loin and ribs and a decrease in the percentage of fat in the leg and loin the percentages of bone varied between the treatments. Finally, the highest percentage of meat in the secondary cuts was in treatment T_3 for the fore shank, breast, and flank Besides, the lowest percentage of fat was recorded in the neck, breast, and flank, and the lowest percentage of meat was in treatment T_1 in each of the neck cuts, the fore shank, the breast and the flank, and the highest percentage of fat in the neck and fore shank cuts.

Keywords: Nano Bentonite, Carcass Characteristics, Awassi Lambs

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INTRODUCTION

The academic research has tended to investigate several methods that all aspire to reach the issue of investing the fodder materials used in feeding local ruminants with high efficiency in light of further improving the efficiency of food conversion and reach a high quality of meat produced from these animals (Alrubeii *et al.*,2008 and Hassan *et al.*,2010). However, nutrition is the central axis around which most other animal and human-related sciences are both old and new. Medicinal plants and their extracts were used in the field of animal feeding and fattening as alternatives to toxic chemicals, food preservatives, as well as an economic factor. Besides, reducing the total cost of the concentrated and rough feed consumed by the animal (Tawfiq *et al.*, 2014). Studies indicated that the use of natural food additives such as black seed and rosemary in the rations of Awassi lambs recorded a significant improvement in the meat quality in the treatment of adding rosemary. A decrease in the deposition of carcass fat, fat-tail, subcutaneous fat, and an increase in fat deposition between muscles, kidney fat, pelvic, rumen fat, intestine, omental fat, and heart fat compared to control and black seed supplement treatment (AL-Rubeii, 2008). Al- Rubeii *et al.*, (2014) obtained a significant improvement in the performance of lambs slaughtered fed on the different sources of chromium feed additives to diet in all measurements of the carcass characteristics. Numerous studies showed that adding Saccharomyces cerevisiae to the rations of lambs achieved a significant improvement in weight gain, hot carcass weight, dressing percentage, carcass length, and quality of meat produced (Saeed, 2011 and Al Sudani, 2012). The addition of tannins to the diets of ruminants led to a significant increase in unsaturated fatty acids that beneficial to health and enhancing the stability of oxidation in animal products such as meat and milk (Jeronimo, 2015). (Mohammed *et al*., 2018) also achieved a significant improvement in the weight of hot and cold carcasses and some specific characteristics of karadi lambs with selenium added to their rations. The addition of canola oil and flax seeds to the rations of Australian sheep has led to a significant improvement in tenderness, qualitative characteristics of carcasses, and an increase in long-chain fatty acids (omega-3) in the healthy long Longissimus Dorsi muscle (Nguyen, 2018). Among the modern uses in light of the development of feed additives was the addition of clays, specifically the addition of bentonite. The European Food Safety Authority (EFSA) approved in a number of reports after conducting many experiments from various countries the use of bentonite as additives for humans as an additive with medicine and as a safe feed additive for animals because of its benefits. Besides, research is continuing in identifying and establishing its benefits (EFSA, 2017, 2016, 2012, 2011). Since food is the primary need for humans and animals, several modern technologies have been used to develop it and ensure its safety. From these modern technologies, the researchers' tendency to Nano-food technology, with some reservations about it, especially European countries (Al-Sharif, 2015). Due to the lack of studies and research that dealt with these clays and their benefits in feeding ruminants, the idea of this study aimed with the use of the latest modern technologies, which are nanotechnology. Therefore, the objectives of this study are summarized as observing. Examining the effect of adding natural and Nano clay to animal diets on the qualitative and quantitative characteristics of the Awassi lambs.

MATERIALS AND METHODS OF WORK

This study was conducted in the field of Animal production at the College of Agricultural Engineering Sciences / University of Baghdad, and the experiment lasted for 90 days during the period from 7/1/2019 to 7/5/2019.

- Preparation of bentonite

Bentonite was purchased from the Iraqi market, specifically from the Najaf region. Then, in order to identify the content of bentonite from the elements (oxides) and their proportions, the Spectro X-Labpro device in the Al-Germany Laboratory / Geology Department / College of Science, University of Baghdad, according to Table 1, carried out an analysis of a sample of bentonite.

- Prepara***tion and characterization of natural bentonite to nanoparticles***

The Work was carried out in the ceramic laboratory in the materials department of the Ministry of Science and Technology. The conversion process took place in three stages, where the first stage included milling the material by the jaw crusher for a period of three stages. The Ball Milling Methods for the second stage was used in the process of converting to nonmaterial as shown (Figure 1). Besides, this method produces nanomaterials in the form of powder, where the material is placed under very high energy. Then, milled by balls made of steel that move either in a planetary or vibratory or vertical, and a powder with a size ranging from 3-25 nm can be made (Wesley, 2014; Abdel Goad *et al*., 2017). The last stage includes drying the samples to a degree of 50 ℃, and the samples are prepared.

Table 1. Oxide contents in bentonite

Material	Element	Concentration %
SIO_2	Silicon	45.81
Al_2O_3	Aluminum	10.94
CaO	Calcium	9.181
Fe_2O_3	Iron	8.526
MgO	magnesium	7.727
Na_2O	Sodium	2.010
K_2O	Potassium	2.406
Cl	Chlorine	1.206
TiO_2	Titanium	0.799
Cd	Cadmium	0.00020
I	Iodin	0.00030
Pbo	Lead	0.00160
Hg	Mercury	0.00010

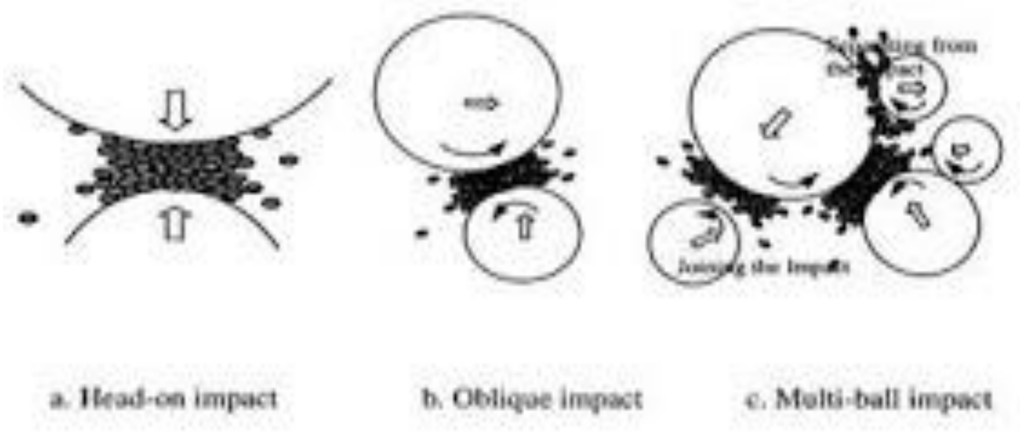

Figure 1. Method of milling with steel balls

- ***Spectral and physical measurements of bentonite***

Nanoparticle measurement

After completing the conversion of bentonite into Nano, a scanning probe microscope was performed to find out which measurements of the bentonite particles were reached, as described in Figures (2, 3, and 4).

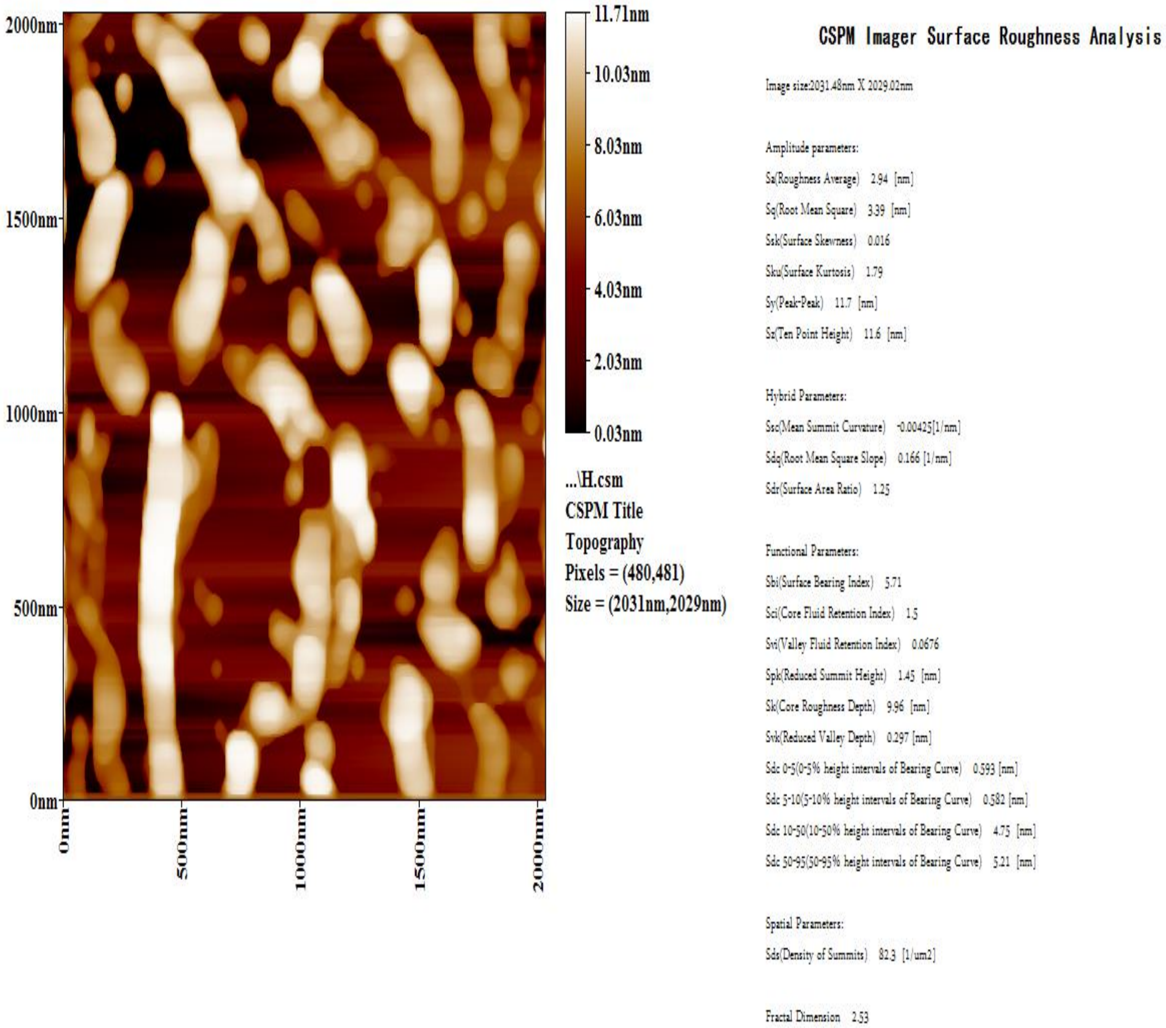

Figure 2. Dimensions of the Nano-bentonite

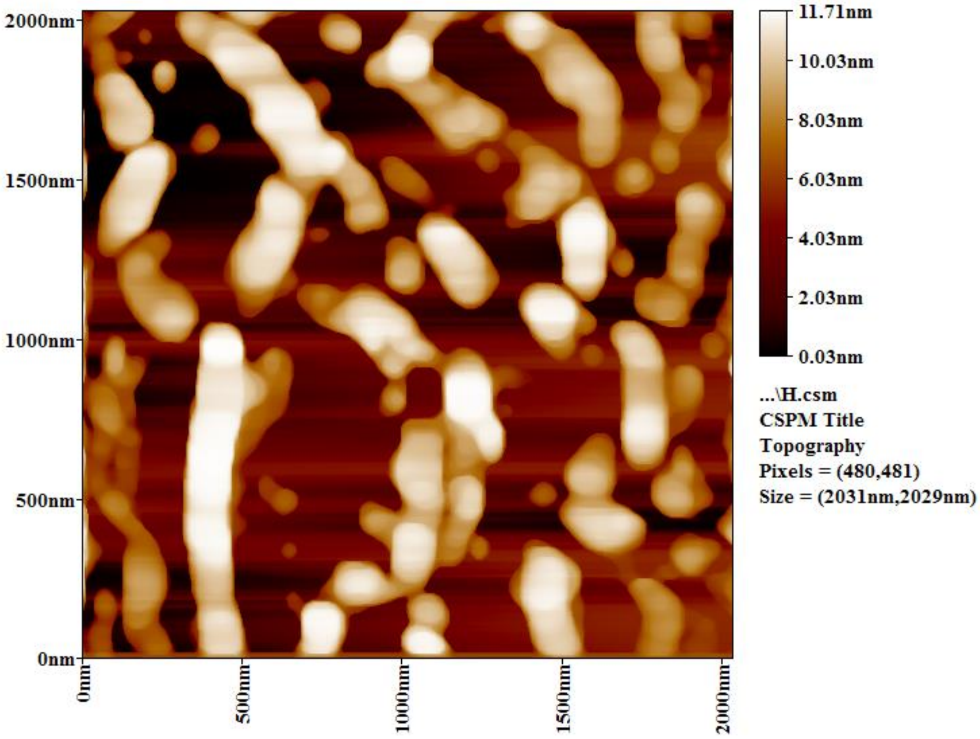

Figure 3. Dimensions of the Nano-bentonite particles

It can be concluded that the range of the bentonite grains differed in their measurements between 70-260 nm, and that the nanoscale ratio of 70-100nm was 36%. Generally, this ratio is good because of the steel ball method in the process of converting to nanoparticles compared to chemical activation, which affects the beneficial properties of bentonite, as shown in Table 2.

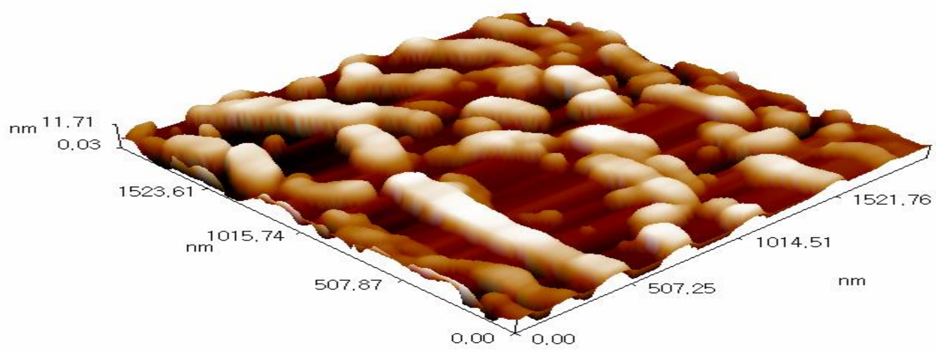

Figure 4. Dimensions of the Nano-bentonite particles

From the previous measurements, it can be observed that the area and volume of Nano-bentonite by the mechanical milling method of Iraqi bentonite is shown in Table 2. This considers as the first measurements are prepared in this way, according to the Iraqi researcher (Hamadi *et al*., 2015) that used the chemical activation method.

Table 2. The change in area and volume between natural and Nano-Bentonite by mechanical method

Characteristics	Area (m^2 / g)	Volume (cm^3 / g)
Natural bentonite	52.2	0.0593
Nano-pentonite	148.3523	0.00172

- ***IR spectrum of natural and Nano-Bentonite***

This test was performed for the purpose of accurate identification of bentonite and its active groups. However, a Fourier Transform Intra-Red Spectrophotometer (FTIR) was used for measuring by infrared, the vibrations (stretch) were found between 400-4000 cm ^{1}, which these were the measurements of the Iraqi bentonite (Jasim *et al*., 2013) as shown in Figure (5, 6). The stretching vibrations of the Al-o and Si-o bonds are between 700-1200 cm^{-1}, and water in montorillonite has a broad absorption spectrum at 3429 cm^{-1} and stretching vibrations near 532 cm^{-1} correlate with the bending vibration Al-o-si cm^{-1}. The results show that there are no differences in the effective groups between natural and Nano-Bentonite. Also, a phase of montorillonite, which is the predominant phase of Iraqi bentonite (Jasim *et al.*, 2013, Hamadi; others, 2015).

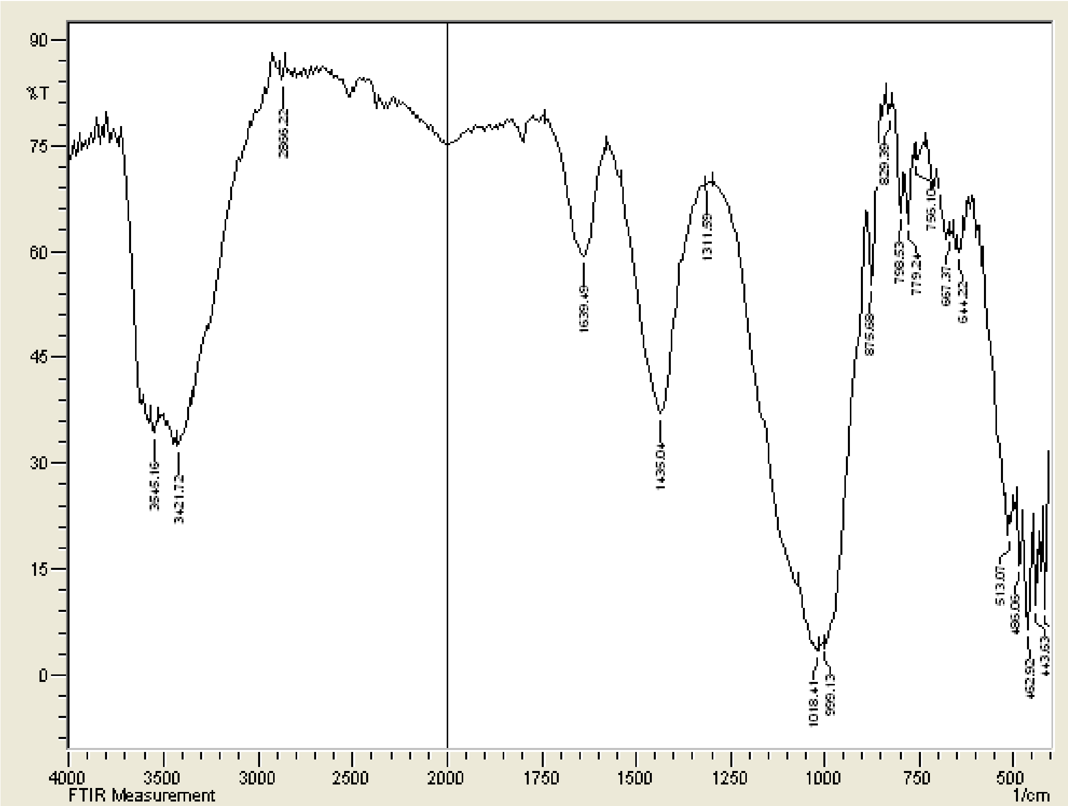

Figure 5. Shows FTIR of natural bentonite.

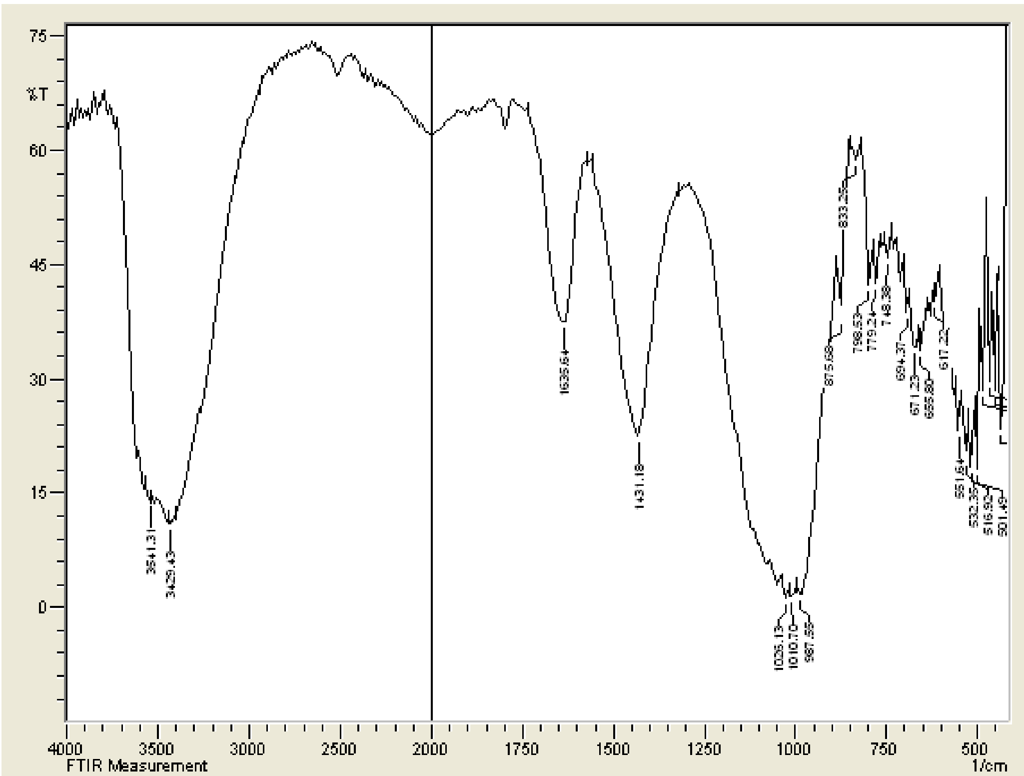

Figure 6. Shows FTIR for Nano-bentonite

- **Experimental design**

In the experiment, 25 male lambs of the local Awassi sheep breed were used, their ages ranged between 3-4 months, with an average live weight of 14-15 kg. The lambs were placed in individual pens, the lambs were distributed randomly into five treatments, and they were fed five types of concentrated diets at a rate of 3% of the body weight. These treatments include: The first treatment (T_1) was considered a control without any addition, while the second treatment (T_2) contained 2% of natural bentonite/head / day for concentrated feed. The third treatment (T_3) contained 4% of the natural bentonite, the fourth treatment (T_4) contained 2 g / head of Nano-bentonite daily, and the fifth treatment (T_5) contained 4 g / head of Nano-bentonite daily.

- ***Animals management and feeding***

The lambs were fed a basal ration of concentrated feed containing barley, wheat, wheat bran, maize, soybean meal, lime, and salt at a percentage of (35, 10, 28, 10, 15, 1, and 1%) respectively, Besides, the chemical composition of the concentrated diet components was calculated mathematically by (Al-Khawaja *et al.*, 1978). Then, the (ME) of the diet was calculated according to the equation of the Ministry of Agriculture Scots (MAFF, 1975) which states: Metabolized energy (Mj / kg DM) = 0.012 x crude protein + 0.031 x crude fat + 0.005 x crude fiber + 0.014 x dissolved carbohydrates, as shown below in Table (3).

The concentrated feed was given at a percentage of 3% of the live body weight and the rough feed (alfalfa) once a day at eight o'clock in the morning. Furthermore, the chemical composition of the alfalfa was in Table (4), and the remaining feed is collected on the next day for each lamb before providing the new meal to calculate the amount of daily feed consumption throughout the experiment. The amount of feed provided to the lambs was adjusted weekly according to the new weekly weight of the lambs, along with monitoring the daily feed consumption by providing clean water throughout the experiment. The lambs were weighed weekly after feeding was stopped for no less than (12) hours, to obtain an accurate weight for the lamb.

Table 3. The chemical composition of the basal ration % *, it's content of metabolized energy (Mj / kg DM) **

Feed material	%C.P	%C.F	%E.E	%NFE	%Ash	M.E (Mj/kg DM)
Maize	0.774	0.174	0.348	6.159	0.113	1.069
Barley	2.838	1.206	0.424	14.885	0.625	2.618
wheat	2.362	0.465	0.340	12.512	0.34	2.162
Wheat bran	5.904	3.600	1.620	19.116	2.196	4.066
Soybean meal	45.9	2.51	7.21	38.24	6.14	1.332

* The chemical compositions of the ration were calculated based on dry matter by (Al-Khawaja *et al.*, 1978). ** (ME) of the ration was calculated according to the (MAFF 1975) equation.

The average total weight gain and average daily weight gain according to (Al-Tamemmy *et al*,2009) Twelve lambs were slaughtered, at a rate of three lambs from each treatment chosen randomly after stopping the feed for (12) hours while leaving water available in front of them. The live weight was recorded before slaughter, then the weights of the slaughtered residues were taken, and the measurements of the carcass characteristics were studied. Hot carcass weight, Chilled carcass weight, Empty body weight and Dressing percentage, The dressing percentage was calculated in two ways, the first being the weight of the cold carcass to the weight of the animal pre-slaughter, and The second is that the weight of the cold carcass is calculated to the weight of the empty body according to the (Al-Tamemmy *et al*,2009)

The fat-tail weight and the fat deposited around the kidneys and pelvic, the fat-tail percentage to the carcass weight, carcass length,fat thickness and rib eye area (Al-Tamemmy *et al*,2009)

- ***carcasses cutting and dividing process.***

The process of cutting the carcass was carried out by separating it into two equal halves, right and left from the center of the spine. The left half of the carcass was cut homogeneously into eight cuts, four of which are main cuts (leg, loin, ribs, and shoulder) and four others are secondary cuts (neck, fore shank, breast, and flank). After weighing all eight pieces using the electronic scale, the pieces were placed in polyethylene bags that were closed tightly and placed in the freezer at a temperature (-18°). Then, the physical separation of these pieces is performed into their components (lean, fat, bone) (Al-Rubeii *et al.*, 2000)

The statistical analysis

The statistical analysis of the studied traits was performed using the commercial statistical analysis system SAS (2001) with a completely random design (CRD). Significant differences between the averages were compared using the Duncan new multiple range (1955) test.

RESULTS AND DISCUSSION

- Total and daily weight gain

Table 4 included the effect of adding natural and Nano-Bentonite on the final weight, the total and daily weight gain, the efficiency of the food conversion, and the empty body weight. It was noticed that there are significant differences ($P < 0.01$) in the total weight gain between the treatments. Also, the results showed significant superiority ($P < 0.01$) for the treatments T_5 which recorded 16.00 kg, while the control treatment recorded 12.00 kg compared to the rest of the treatments. Table 6 showed that there were significant differences ($P < 0.01$) in the daily weight gain for all the treatments the results also showed a clear increase in the treatment T_5 compared to the control treatment T_1.

Table 4. The effect of adding natural and Nano-bentonite on final weight, total and daily weight gain, and empty body weight (Means± SE)

Treatments / Characteristics	T_1	T_2	T_3	T_4	T_5
Initial weight (kg)	a 14.33±0.33	a 15.00±0.57	a 15.00± 0.57	a 15.00±0.57	a 14.33±0.66
Final weight (kg)	b 26.33±0.42	ab 29.66 ±0.66	a 30.00±0.73	a 30.00±0.73	a 30.33±0.70
Total weight gain (kg)	b 12.00±0.57	ab 14.66 ±1.20	ab 15.00±1.15	ab 15.00±1.15	a 16.00±0.57
Daily weight gain (g)	b 133.0 ±6.55	ab 162.3±13.22	ab 166.0±12.70	ab 166.0±12.70	a 177.0±6.35
Food conversion efficiency	a 6.56±0.47	a 5.50±0.17	a 5.43±0.10	a 5.43±0.1o	a 5.92±0.84
Empty body weight (kg)	a 22.16±00.60	a 23.00±1.00	a 23.00±1.20	a 23.00±0.88	a 23.83±0.92

The different letters within the same row indicate significant differences between the averages and at a significant level ($P<0.01$).

T_1 = Control treatment without addition. T_2 = adding 2% natural bentonite / head daily.
T_3 = adding 4% natural bentonite / head per day. T_4 = adding 2 g of Nano- bentonite / head per day.
T_5 = adding 4 g of Nano- bentonite / head per day.
The reason may be attributed to improving the pH of the rumen due to the effect of adding natural bentonite (Aazami *et al*., 2017), maintaining the amount of water inside the gut, and reducing ammonia toxicity. (Azam *et al*. 2002). As well as, eliminating or reducing the effect of mycotoxins (EFSA, 2011) and improving the rumen environment that helped stimulate and grow microorganisms and thus raised the digestibility factor and led to an increase in feed utilization. These results agreed with (Al-Dbaisi, 2019) finding, they found that adding natural bentonite increase the overall weight gain of Arrabi lambs amounted to 17.71, 20.85, 19.50 kg for control treatments, 2% and 4% respectively. As well, these results were agreed with (Muhammad *et al*., 2018), as the total weight gain of the karadi lambs was 23.43, 25.42 kg for control and the addition of 20 g bentonite/head per day, respectively. The reason for the superiority of additional Nano-Bentonite treatment may be that the Nano clay particles from a larger area of mass compared to the volume, as the large effective surface area will increase the chemical catalysis. Moreover, the size of a substance does not affect its properties to the micrometer, while the materials acquire new physical, chemical, and biological properties once they are transformed into the nanoscale, but rather acquire new properties that were not known even in the parent material (Hamadi *et al*., 2015).

- ***Lambs weights at slaughter, empty body weight, and feed conversion efficiency***

The results in Table 5 indicated the effect of adding natural and Nano- bentonite on the final lambs 'weights, empty body weight, the food conversion efficiency. These results showed significant differences at ($p<0.05$) in the final lambs' weights, where the treatment T_5 recorded the highest final weight for the lambs, which reached 30.33 kg. treatment T1 recorded the lowest final weight for the lambs, which reached 26.33 kg, whereas the treatments T_4, T_3, T_2 were 29.66, 30 0, 30,0, respectively. The results agreed with Jik *et al*., (2017) finding, as the addition of bentonite at rates of 1 and 3% as an addition to Hanwoo calves' diets led to a significant improvement ($p<0.05$) in the total weight and final weight of calves. There was no significant improvement, and it showed an arithmetic improvement reached 22.16, 23.00, 23.33, 33.23, 23.83 for the treatments (T_5, T_4, T_3, T_2, and T_1) respectively as shown in Table 6. Furthermore, Table 5 showed that an arithmetic improvement in the efficiency of food conversion occurred. These results agreed with Mohamed *et al*., (2012), as there were no significant differences in the average daily consumption of dry matter and the efficiency of the feed conversion of sheep. Mohammed *et al*., (2018) found that using yeast with bentonite on karadi lambs a slight significant improvement in the efficiency of food conversion.

- ***Carcass characteristics***
- Hot and cold weight of the carcass

Table 6 included the effect of adding natural and Nano-bentonite on the carcass characteristics, the hot carcass weight, and the cold carcass weight. It was observed that an arithmetic improvement was recorded between the treatments in the hot carcass weight. Further, the cold carcass weight reached 10, 43, 11,65, 11,93, 11,73, 12,63 kg for treatments T_4, T_3, T_2, T_1, and T_5 respectively for the hot and cold carcass weight. These results agreed with Mohammad *et al*., (2018) as obtained an arithmetic improvement in the hot and cold carcass weight.

Table 6. The effect of adding natural and Nano-Bentonite on carcass characteristics (Mean ± standard error)

Treatments / Characteristics	T_1	T_2	T_3	T_4	T_5
Hot carcass weight (kg)	a 10.83±0.33	a 12.00±0.50	a 12.33±0.66	a 12.16±0.92	a 13.06±0.69

Cold carcass weight (kg)	a 10.43±0.28	a 11.65±0.47	a 11.93±0.71	a 11.73±0.94	a 12.63±074
Dressing percentage based on pre-slaughter weight%	a 41.16±1.09	a 40.66±0.88	a 41.10±1.17	a 40.46±1.18	a 42.69±0.63
Dressing percentage based on the empty weight %	b 47.10±1.40	ab 50.66±0.14	ab 51.65±1.27	ab 50.13±2.13	a 52.93±1.52
Fat-tail percentage to cold carcass weight%	b 5.74±0.63	a 10.21±0.97	ab 7.40±0.97	ab 8.63±	a 9.14±1.03
Rib eye area of muscle (cm^2)	d 9.00±0.0	c 11.00±0.0	b 11.83±0,33	b 11.50±0.0	a 12.50±0.0
Fat thickness (mm)	a 3.50±0.05	b 2.66±0.06	a 3.63±0.29	a 3.43±0.03	c 1.70±0.05
Carcass weight (cm)	b 52.33±1.45	a 61.66±1.20	a 61.00±1.00	a 61.33±1.33	a 57.66±1.45

The different letters within the same row indicate significant differences between the averages and at a significant level ($P<0.01$).

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Dressing percentage

Table 6 showed the effect of adding natural and Nano-Bentonite on the dressing percentage that calculated in two ways, as the dressing percentage based on weight at slaughter. As for the dressing percentage that calculated based on the cold carcass weight to the empty body weight. The results showed a significant improvement ($P<0.01$), the highest dressing percentage was in the treatment T_5, the reason may be the reduction of the energy lost due to the production of methane gas in the ruminant rumen. However, it is believed that clay minerals affect the production of volatile fatty acids, especially Acetate, by reducing the number of bacteria that convert Pyruvate and then reduce the availability of hydrogen ions inside the rumen. Thus, reducing the production of methane gas (Wallace *et al*., 1991), where the proportion of methane gas produced is estimated to be about 8-10% of the energy used, and that reducing this lost energy leads to improved food conversion efficiency (Taghizadeh *et al*., 2015). Moreover, Nano-Bentonite can also improve the bioavailability of the elements.

- ***The fat-tail percentage to the carcass weight***

Table 6 showed the effect of adding natural and Nano-bentonite on the fat-tail percentage to the cold carcass weight, where a significant improvement ($P<0.01$) was shown in this percentage, and its value reached 5.74, 10.21, 7.40, 8.63, 9.14% for T_1, T_2, T_3, T_4, T_5, respectively. Nevertheless, the treatment T_1 was the lowest and amounted to 5.74%, while the highest percentage was in treatment T_2. The reason for this difference and variation in the distribution of fat deposition in the carcass may be due to the effect of bentonite, as the effects of bentonite on the characteristics of meat for fattening are still unknown.

- ***Rib eye area and fat thickness***

Table 6 showed the effect of adding natural and Nano-bentonite to the treatments on the rib eye area and fat thickness. It was evident that the rib eye area was significantly affected ($p<0.01$) with the addition of natural and Nano-Bentonite. Besides, the lowest rib eye area of was in treatment T_1, and the largest area was in the treatment T_5. It is believed that bentonite maybe has a great ability to reduce the rate of passaging the digestion in the rumen, and thus to increase the opportunity for nitrogen absorption. As well as, to maintain a suitable rumen environment for microorganisms to increase the utilization of nutrients. All these processes can be reflected in the performance of animals in which the final products (nitrogen compounds) are available and reach a high level in animal tissues (Salem *et al*., 2001). These results agreed with Jik *et al*., (2017) findings during the feeding of castrated Hanwoo calves on rations containing bentonite. Furthermore, the fat thickness was significantly affected ($p<0.01$) by the addition of natural and Nano-bentonite. The results showed that the lowest fat thickness was in treatment T_5, it was 1.70 mm, and the highest thickness of fat was in treatment T_3. Although the effects of adding bentonite on the characteristics of the meat quality for fattening are still unknown (Jik *et al*., 2017), the nanomaterials have a much higher surface to mass ratio compared to the non-nano materials (Peter *et al*., 2014). As for the effect of using bentonite at different rates, it kept the pH inside the rumen from being low, and this limits the formation and production of propionic acid, which has a major role in body fat deposition. These results agreed with both (Khadem *et al*., 2007 and Lee *et al*., 2010) by finding a significant decrease in the thickness of the fat when bentonite was used with different proportions.

- Carcass length

Table 6 showed the effect of adding natural and Nano-Bentonite to the treatments on the carcass length. The treatment T_1 was recorded the lowest length of 52.33 cm, and the longest carcass was in the treatment T_2, which recorded 61.66 cm, this indicates that the addition of bentonite improved the length characteristic of the carcasses.

- **The physical dissection of the carcass cuts components**

Table 7 showed the effect of adding natural and Nano-Bentonite to the treatments on the ratios of the three components, meat, fat, and bone in the main cuts (loin, ribs, shoulder, and leg) of excellent quality of the carcasses in the treatments. The results showed that there were significant differences (p <0.01) for the treatment of adding Nano-Bentonite on meat percentage in the treatment cuts T_5 and T_4, as they reached 66.50 and 66.66% for the leg respectively. Besides, the lowest meat percentage was in the treatment T_1, as it reached 47.77%, moreover, the highest meat percentage in the shoulder was in the treatment T5, while the highest meat percentage in the ribs and loin was in the treatment T_3. It reached (55.11, 65.83%) compared with the rest of the treatments, treatment T_1 recorded the lowest meat percentage 47.77, 56.52, 50.39, 42.01% in the leg, loin, shoulder, and ribs, respectively. The results showed a significant improvement (p<0.05) in the fat percentage, as treatment T_1 recorded the highest fat percentage by 13.33 and 13.66% in the leg and shoulder, respectively. In addition, the lowest fat percentage obtained by T_3, was 8.17% for the leg, and the lowest fat percentage in the shoulder was in treatment T_2, it was 9.36%, and the highest fat percentage in loin in treatment T_4, which was 19.30 %, and the lowest fat percentage in loin was in treatment T_3. The treatments showed an arithmetic improvement of the fat of ribs, as the highest percentage was in treatment T_5, as it reached 25.08%, and the lowest percentage in treatment T_2 was 17.50%. Table 7 showed a significant improvement (p<0.01) in the percentage of bone to the main cuts, where the highest percentage of bone was in treatment T_1 in the percentage of bone in leg, shoulder, loin, and ribs, which reached 38.88, 35.97, 32.03, 39.21% respectively. Treatment T_4 recorded the lowest percentage of bone for the leg and loin cuts, as it reached 21.27 and 17.08% respectively, and the lowest percentage of shoulder bone was in treatment T_2, which reached 21.95%, while the lowest percentage of rib bone was in treatment T_3, as it was 19.04%. The clear effect of natural and Nano-Bentonite on the increase in fat percentage and a significant increase in meat percentage, which affected the bone percentage in the main cuts. The reason may be attributed to the protein mixture is alkaline and the bentonite suspension is alkaline, and both are negatively charged, as a result, the two substances are not mutually attracted, the Montmorillonite (MMT) remains negatively charged, while the proteins become positively charged when the pH is below the degree of electrical neutralization. Thus, the Montmorillonite is attracted to the protein and reciprocally, and this allows the maximum absorption of protein molecules, and the cations are absorbed by the bentonite to satisfy the excess negative charge (Colling, 1975) and that affects the percentages of meat, fat, and bone. The results in Table 8 showed the effect of adding natural and Nano-bentonite to the secondary cuts, with significant differences (P <0.01) between the treatments in the percentages of the three components, meat, fat, and bone in the four secondary cuts: the neck, fore shank, breast, and flank of the treatment carcasses. The results showed that the treatment T_3 exceeded significantly (P<0.01) in the percentage of meat, and the highest percentage of meat was (64.04, 62.53, 56.65%) in the three cuts, breast, fore shank, and flank, respectively, with an arithmetic difference for the flank only and without a significant improvement from the rest of the treatments. However, the neck had the highest percentage of meat with a significant difference (P <0.05) amounted to (57.14%) in treatment T_2, while the lowest meat percentage was recorded (40.06, 43.85, 43.47, 53.34%) in the breast, neck and loin cuts, respectively, in the treatment T_1. As for the fat percentage, the highest fat percentage (46.20%) in the fore shank for treatment T_1 with a significant difference (P <0.01) from the rest of the treatments. As well as the highest fat percentage in the breast and neck parts in the treatment T_1, but with an arithmetic difference and without significant superiority, it was (22.08, 17.81%), as for the flank cut, the highest fat percentage was recorded 46.81% in the treatment T_2. However, the lowest fat percentage was (16.90, 13.58, 44.01%) in the secondary cuts of the breast, neck and flank, respectively in the treatment T_3 compared with the rest of the treatments, and in the fore shank cut, the lowest fat percentage was (9.44%) in treatment T_2. Whereas the highest bone percentage (22.08, 35.67, 38.64%) showed in the breast, fore shank and the neck cuts in treatment T_1 with a significant difference (P <0.01) for the fore shank cut only. Also, an arithmetic improvement for the breast and neck cuts, and the lowest bone percentage (24.45, 19.04%) in treatment T_3 for the fore shank and breast cuts, respectively, as for the lowest bone percentage in the neck (28.57%) was in treatment T_2. These results may be attributed to the same reasons that were mentioned in the previous paragraph.

Table 7. Shows the effect of natural and Nano-bentonite on the main cuts, thigh, shoulder, ribs, and cotton (mean ± standard error)

Treatment	Loin			Ribs			Shoulder			Leg		
	Meat %	Fat%	Bone %	Meat %	Fat%	Bone %	Meat %	Fat%	Bone %	Meat %	Fat%	Bone %
T_1	b 0.0±56.52	b 0.0±11.44	a 0.0±32.03	d 0.0±42.01	a 0.0±18.76	a 0.0±39.21	a 0.0±50.39	a 0.0±13.66	a 0.0±35.97	c 0.0±47.77	a 0.0±13.33	a 0.0±38.88
T_2	ab 0.0±62.0	a 1.12±16.40	b 0.20±21.60	b 0.0±50.0	a 0.0±17.50	ab 0.0±32.50	a 0.37±68.66	b 0.31±9.36	b 0.68±21.95	ab 0.92±63.70	ab 0.88±11.77	c 1.58±24.29

T3	a 4.16±6 5.83	b 0.0±10 .0	b 0.0±21 .94	a 0.11±5 5.11	a 2.24±2 2.24	c 0.47±1 9.04	B 1.32±6 2.86	b 0.97±1 0.56	b 0.35±2 6.56	b 039±6 1.80	b 0.17±8 .17	b 0.07±2 9.92
T4	ab 3.05±6 3.60	a 0.97±1 9.30	c 2.08±1 7.08	bc 2.27±4 6.67	a 0.73±2 2.93	b 2.97±3 0.33	b 0.27±6 7.20	b 1.73±9 .86	b 1.46±2 2.92	a 2.0±66 .50	ab 2.22±1 2.22	c 0.22±2 1.27
T5	ab 2.31±5 8.17	a 1.98±1 9.23	b 0.69±2 4.47	c 1.02±4 6.24	a 5.02±2 5.08	b 4.0±28 .66	a 6.39±6 9.39	b 0.43±1 0.57	b 6.09±2 2.43	a 2.24±6 6.66	ab 1.74±9 .85	c 2.85±2 3.25

Table 8. Shows the effect of natural and Nano-bentonite on the secondary cuts, neck, front ulnar, breast and loin (mean ± standard error)

Treatment	Neck			Fore shank			Breast			flank	
	Meat%	Bone%	Fat%	Meat%	Bone%	Fat%	Meat%	Bone%	Fat%	Meat%	Fat%
T1	b ±0.0 43.47	a 38.46± 0.0	a 17.81± 0.0	d 43.81± 0.0	a 35.67± 0.0	a 20.46± 0.0	c 40.06± 0.0	ab 37.85± 0.0	a 22.08± 0.0	b 53.34± 0.0	a 46.66± 0.0
T2	a 57.14± 0.0	a 28.57± 0.0	a 14.28± 0.0	a 55.11± 0.44	c 35.44± 0.11	c 9.44±0. 56	c 43.05± 0.94	a 38.92± 1.08	a 16.90± 4.05	a 53.81± 0.24	a 46.81± 0.24
T3	a ±4.85 54.85	a 31.35± 5.96	a 13.58± 1,08	d 62.53± 0.03	b 24.45± 0.54	b 13.0±0. 50	a 64.04± 4.52	d 19.04 ±0.47	a 16.90± 4.05	a 56.65± 2.38	a 44.01± 2.64
T4	ab ±0.02 52.02	a 33.96± 4.03	a 14.0±4. 0	c 54.77± 0.78	a 32.63± 0.69	b 12.61± 1.50	c 41.95± 0.04	b 36.31± 0.31	a 21.30± 0.30	a 53.81± 0.78	a 46.18± 0.87
T5	ab 50.78± 3.79	a 33.54± 3.17	a 15.36± 2.69	a 59.06± 0.47	a 28.85± 0.48	b 11.51± 0.19	b 54.36± 2.61	c 25.56± 0.08	a 20.05± 2.68	a 55.29± 0.29	c 44.70± 0.29

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REFERENCES

1. Aazami, M. H., Tahmasbi, A. M., Forouhar, V & Naserian, A. A. (2017). Effects of sodium bentonite on blood parameters feed digestibility and rumen fermentation parameters of male Baluchi sheep fed diet contaminated by diazinon, an organophosphate Pesticide. Iranian Journal of Applied Animal Science,7 (3):421 -428.
2. Abdel Goad, Mahmoud, Hamad, Rahma,2017 Synthesis of Nano-fillers from Local Materials by Two Different Methods. Faculty of Engineering, Minia University. International Journal of Engineering and Information Systems (IJEAIS). 1(5):14-21.
3. Al-Dbisi, Abbas Nasser Khalaf Shabeel, Nasser Khalaf Shabeel, 2019. The effect of adding different proportions of bentonite mineral clay on the performance of Arabian lambs. Master Thesis, Faculty of Agriculture, University of Basra.
4. Al-Khawaja, Ali Kazem and Abdullah, Ilham and Abdul Ahad, Samir, 1978. The chemical composition and nutritional value of Iraqi feed materials, a bulletin issued by the Nutrition Department. Directorate of wealth.
5. Al-Rubeii, A.M.S., Hani N. Hermiz, A.A. AL- Rawi. 2000.Chemical composition and palatability traits of ovine carcasses in differnt gentic groups..The Iraqi Journal of Agricultural Science. VOI 31, NO 3, PP. 669-680.
6. Al-Rubeii, Amera M. S.2008. Effect of some medicinal plants supplementation on Muscles Weight, Chemical Composition, Carcass Fat Partitioning And Distribution of Awassi lambs.J.of Agri. Rese. Kafrelsheikh Univ.VOL 34, No 2, pp 445-463.
7. Al-Rubeii, Amera M. S.and Shaker A. Hassan.2008. Effect of some medicinal plants supplementation to ration of Awassi lambs in Quality, Sensing Properties and The Shelf-Life of meat of their carcasses at cold storage.The 3rd International Conference on Food Science and Nutrition . 3-5/11/2008 Cairo,Egypt.
8. Al-Rubeii,Amera M.S., Al-Obaidi, A.S.A. and Al-Doory, M.K.A.2014. Effect of different sources of chromium feed additives to Awassi lambs' diet on productive and some meat quantity characteristics. The Iraqi Journal of Agricultural Sciences. 45(3) (Special Issue): 299-305.
9. Al-Sharif, Walaa Mahmoud Ali Ahmed 2015: Nanotechnology in the food industry. Researcher at the Animal Health Research Institute, Assiut. Assiut Journal of Environmental Studies - (2) July.
10. Al-Sudani, Howayda Muhammad Khalaf, 2012. Effect of adding bread yeast (Saccharomyces cerevisiae) with different percentages of coarse feed to concentrate on Awassi lamb carcasses. Master Thesis, Faculty of Agriculture, University of Baghdad.
11. Al-Tamemmy, M.J.H.; Al-Rubeii, Amera M.S. and Hassan,S.A. 2009. Effect of Nigella Sativa supplementation and different levels rumen degradable nitrogen on quantty characteristcs of Karadi lambs meat. Egyption J. Nutrition and Feeds, Vol. 12 (3) ,549-561.
12. Azzam, M.H. (2002). Performance and carcass traits of growing lambs fed rations containing dried poultry manure and bentonite. Ph.D. Thesis, Fac. of Agric. Mansoura University – Egypt.
13. Colling, Daniel P.1975. Sodium Bentonite in Ruminant Rations. Thesis. The Graduate College in the University of Nebraska –Lincoln.
14. Duncan, D. B. 1955. Multiple range and multiple tests. Biometrics. 11: 1 – 42.
15. EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed).

2011.Scientific Opinion on the safety and efficacy of bentonite (dioctahedral montmrillonite as a feed additive for all species1 EFSA Journal;9(2):2007.

16. EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed), 2012. Scientific Opinion on the safety and efficacy of bentonite as a technological feed additive for all species. EFSA Journal,10 (7):2787.
17. EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed). 2017.Scientific Safety and efficacy of bentonite as a feed additive for all animal species EFSA Journal;15(12):5096.
18. EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP). 2016. Safety and efficacy of a natural mixture of illite, montmorillonite, and kaolinite (Argile Verte du Velay) as a feed additive for all animal species. EFSA Journal,14 (1):4342 -4360.
19. Hamadi, Adel Sharif. Riyadh M. Noaman. Thamera Kidher. Ghassan Rokan. Maan Ali. 2015.Beneficiation Pretreatment and Chemical Activation Method for Preparation and Characterization of Nano Structure Bentonit. Engineering and Technology Journal 33 (9 Part (B) Scientific), 1683-1692.
20. Hassan, S.A, Hassan,K.M. and Al-Rubeii,Amera M.S.2010. Carcass characteristics of karadi lambs as affect by different levels of dietary supplement of rumen degradable nitrogen fed with Nigella sativa. African J.of Biotechnology .Vol.9,No.27,pp: 4295-4299.
21. Jassim, Alwan Nassif, Abbas, Zuhair Khudair and Abbas, Zainab Ismail, Abdul Amir, Zahra Ali and Ibrahim, Anwar Shaker and Kazem, Quraysh Abbas 2013. Activation of Iraqi bentonite: Part IV - Activation with different acids, Chemical and Petrochemical Research Center - Public Authority for Industrial Research and Development - Iraqi Ministry of Industry and Minerals. Al-Mustansiriya Journal of Science Volume 24, (1) 59-68.
22. Jeronimo, Eliana. Pinheiro, Cristina. Lamy, Elsa. Dentinho, Maria Teresa. Sales-Baptista, Elvira. Lopes, Orlando and Capelae Silva, Fernando.2015. Tannins in ruminant nutrition: impact on animal performance and quality of edible products in ruminant. Chapter. Animal Production and Health Research Unit, National Institute for Agricultural Research and Veterinary, I.P., Vale de Santarém, Portuga. 6Department of Biology, University of Évora, Évora, Portugal.
23. Jik, Kim Young, K., Woo-Whan, J., Tae-Ho, C. & In-Hag, C. (2017). Growth performance, meat quality, and carcass characteristics in growing and fattening Hanwoo steer fed bentonite. Acta Scientiarum. Animal Sciences, 39(3): 309-313.Morales, Rodrigo, and Ungerfeld, Emilio M. .2015. Use of tannins to improve fatty acids profile of meat and milk quality in ruminants: A review. Chilen Journal of Agricultural Research 75(2)239-248.
24. Khadem, A. A., Soofizadeh, M. & Afzalzadeh, A. (2007). Productivity blood metabolites and carcass characteristics of fattening Zandi lambs fed sodium bentonite supplemented total mixed rations. Pakistan Journal of Biological Sciences,10 (20): 3613-3619.
25. Lee, S., Youngil, K. & Wansup K. (2010). Effect of dietary addition of bentonite on manure gas emission, health, production, and meat characteristics of Han woo (Bos Taurus Coreanae) steers. Asian Aus. J. Anim. Sci.23(12):1594-1600.
26. MAFE. 1975. Ministry of Agriculture and Fisheries/ Foot Dept. of Agric. and Fisheries for Scotland: Energy Allowances and Feed Systems for Ruminants. Technical Bulletin,33. st, Published.
27. Mohamed, A. K., Bassiony, S. M. Abd El –Baki, S. M. & Saffa A. S. (2012). Effect of Tafla and Bentonite on digestion and growth of sheep. Zagazig Journal of Agricultural Research, 39(2):229-239.
28. Mohammed, Muthanna Ahmed. Yassin, Mohsen Shaker. 2018. The effect of using dry yeast and bentonite as food additives on growth and some characteristics of lamb's carcasses. Al-Rafidain Agriculture Journal 46 (3): 17-32.
29. Mohammedd, A. B, Arif, M.K., Sadq, S. M., Alhoby.A.A.and Abdurahman, S.A.2018.Effect of different levels of Selenium on the carcass characteristics of Karadi lambs. Iraqi Journal of Veterinary Sciences,2(1)41-4
30. Nguyen, Don Viet (2018) Nutritional supplementation with dietary omega-3 PUFA-rich flaxseed and canola oils enhances prime lamb performance and meat quality. Ph.D. Thesis, James Cook University.
31. Peters, Ruud. Brandhoff, Puck. Weigel, Stefan. Marvin, Hans, Bouwmeester, Hans 2014.Inventory of Nanotechnology applications in the agricultural, feed, and food sectors. EFSA supporting publication 2014: EN-621.
32. Saeed,A.A. 2011.Effect of level and degradability of dietary protein fed with or without yeast*(Saccharomyces cerevisiae*) on awassi lambs performance. College of agriculture. University of Baghdad.
33. Salem, F.A., and A.A. El-Shewy (2001). Supplementation of bentonite and dolomite to lactating goats' rations. Egyptian J. Nutrition and Feeds, 4(1): 11.
34. SAS, Institute .2001. SAS User's Guide: Statistics version. 6. 12end., SAS Institute, Inc., Cary, Nc., USA.
35. Taghizadeh, A., Besharati, M. & Hesni, V. (2015). The effect of monensin supplementation on ruminal fermentation parameters of sheep. Journal of Livestock,3: 15-18
36. Tawfiq, Jamal Abdul-Rahman, and Al-Attar, Shaker Abdul-Amir Hassan. 2014. Nutrition Science. University House for Printing, Publishing, and Translation, Ministry of Higher Education and Scientific Research, University of Baghdad, First Edition.
37. Wallace, R. J., and Newbold, C. J. (1991). Effects of bentonite on fermentation in the rumen simulation technique (Rusitec) and on rumen ciliate protozoa. The Journal of Agricultural Science,116 (1):163 - 168.
38. Wesley, Liam. R. 2014.Clays and clay minerals mechanochemical treatment of clay minerals by dry grinding nanostructured materials with enhanced surface properties and reactivity. In book: Clay and Clay Minerals: Geological Origin, Mechanical Properties, and Industrial Applications (Pp.67-114).