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RESEARCH ARTICLE

EFFECT OF BIOLOGICAL ADDITIVES SUPPLEMENTATION ON SKIN AND COAT CHARACTERISTICS OF BARKI SHEEP.

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Abstract

This study was planned to throw some lights on the effects of ZADO and ZAD as biological additives compounds with different doses on skin and coat characteristics of Barki sheep.

ZAD and ZADO as biological compounds are biotechnical solutions prepared from natural, multi/mix of the enzymes in addition to the related anaerobic bacteria. One hundred Barki ewes (2-3 years old and averaged 38.89 ± 1.02 kg) were assigned randomly into five equal groups (20 each). The 1st group was severed as control group fed on concentrates feed mixture (CFM) without any additives while the 2nd and 3rd groups were fed the same CFM with 6 and 10 g/head/day from ZADO, respectively. The 4th and 5th groups fed CFM with 6 and 10 ml/head/day from ZAD, receptively. All groups were offered bean (*Phaseolus vulgaris*) straw ad libitum as a sole source of roughage.

The study revealed that both ZADO and ZAD treatments had affected significantly the internal diameter, wall thickness and fibre diameter of the primary follicles whereas the external diameter was not affected. Concerning the secondary follicles, there was a significant increase in the external diameter of the treated groups compared to control one. On the other hand, a high significant increase ($p < 0.01$) were observed among the internal diameter and wall thickness in ZADO 6gm and ZAD 10gm. The histochemical study demonstrated that the presence of general carbohydrates in both primary and secondary follicles indicated an increase of follicle activity especially in the ZADO groups with the increased dose (10gm vs. 6mg). In general proteins, the higher values of both primary and secondary follicles were found in control and ZAD 10gm. While, the lowest one was reported for ZAD 6gm.

ZADO (10 mg) increased value of staple length, kemp fibre and medullated fibre and decrease fine fibre. While, ZAD (10 mg) produced a moderate value of staple length with increase of fine fibre percentage and decrease medullated fibre and kemp fibre percentage. Treated ZADO (6 mg) had lower Prickle factor (PF), while ZAD (10 mg) had higher one.

In general, using ZADO or ZAD as feeding additives for sheep could improve wool follicles activity as well as wool quality and quantity as a final product with suitable characteristics for wool industry.

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Introduction:-

In the tropics and subtropics, the productivity of ruminant livestock is constrained by the shortage of good quality feed, especially during the long dry season (Raghuvansi et al., 2007). A lot of attempts have been carried out to search for low price and high quality feeds by using traditional and non-traditional products, among which; ZAD and ZADO products. They have been shown to improve ruminal fermentation, nitrogen balance, nutrient digestibility, feed conversion and body gain (Gado et al., 2007 and Salem et al., 2007 a & b).

ZAD compound is a biotechnical solution prepared from natural, multi/mix of the enzymes cellulases (8.2u/gm), hemicellulases (6.2u/gm), amylase (64.4u/gm), and protease (12.3u/gm). In addition to those enzymes ZAD contains the related anaerobic bacteria which produce same listed enzymes. ZADO compound is similar to ZAD but its enzyme contents are much higher per gm fed and contained *Sacchromycescerevisiae* yeast. ZADO was directly fed to animals just before feeding because its activity starts immediately in the rumen.

A commercial exogenous enzyme mixture (ZADO®), prepared from anaerobic bacterium, has been shown to improve ruminal fermentation, N balance and nutrient digestibility, (Gado et al., 2007; Soliman, 2006), Feeding enzymes is often accompanied by increased feed intake, which may partly due to increased palatability of the diet as sugars released by pre-ingestive fiber hydrolysis. However post-ingestive enzyme effects such as increased digestion rate and/or extent of digestion (Beauchemin and Rode, 1996; Feng et al., 1996; Gado and Salem, 2008; Krueger et al., 2008) may increase hydrolytic activity in the rumen to reduce gut fill and enhance feed intake (Adesogan, 2005).

Abd El-Aziz (2007) stated that the improvement of digestibility of ration supplemented by ZAD compound attributed to many factors, a) improvement in absorption during digestion by increasing the reactive surface areas of nutrients. b) improving feed utilization by slowing feed passage time out of the digestive tract which was reflected in better absorption. ZADO supplementation also increased rumen ammonia nitrogen and total short chain fatty acid concentration (Gado et al., 2009).

However, both of them have been shown to improve nutritional status of the animals but there is a lack of information's about their effects on wool follicles activity as well as wool production (quality and quantity). So, this study was planned to throw some lights on the effect of ZADO and ZAD as biological additives with different doses on skin and coat characteristics of Barki sheep.

Materials and Methods:-

The present study was carried out at Animal Production Research Unit at the Sustainable Development Center for Matrouh Resources (SDCMR), Matrouh Governorate, which belongs to the Desert Research Center (DRC), Ministry of Agricultural and Land Reclamation, Egypt.

Animals and Management:-

One hundred Barki ewes (2-3 years old and averaged 38.89 ± 1.02 kg) were assigned randomly into five equal groups (20 of each). The 1st group was served as control group fed on concentrates feed mixture (CFM) without any additives while the 2nd and 3rd groups were fed the same CFM with 6 and 10 g/head/day from ZADO, respectively. The 4th and 5th groups were fed CFM with 6 and 10 ml/head/day from ZAD, respectively. All groups were offered bean (*Phaseolus vulgaris*) straw *ad libitum* as a sole source of roughage. Biological additives were mixed well with concentrate rations before feeding and rations were adjusted biweekly to cover their requirements during their different physiological status according to Kears (1982). All groups were clinically healthy and free from internal and external parasites.

Biological Additives:-

For the biological additives, ZAD is a patent No. 22155 of Egyptian Official Authority; it was manufactured and produced according to the procedure of Gado (1997) in the molecular biology lab, Animal Production Department, Ain-Shams University, Cairo, Egypt.

Sampling and Measurements:-

Skin samples were taken from the mid-side position from all animals by a curved scissor with a suitable depth to represent all skin layers. The skin samples were fixed on foam to get flattened in calcium formol for about 24 hours, and then washed and left for 24 hours in distilled water before moving them into 70% ethanol (Barker, 1958).

Skin specimens were then dehydrated in an ascending series of ethanol (30 minutes in each of 70%, 80% and 90% ethanol and finally two changes each for 15 minutes in absolute ethanol). The specimens were cleared in benzene for about 30 minutes, infiltrated in paraffin wax of a melting point of 60° C (4 changes, 20 minutes each) and then embedded in the same paraffin to prepare the blocks. Transverse sections (6-8 microns in thickness) were prepared for histological and histochemical studies. For general histological observations of the wool follicles and fibre diameters, skin sections were stained by Haematoxylin and Eosin stain (Drury and Wallington, 1980). For the histochemical investigations, Mercury Bromophenol blue according to Chapman (1975) was used for the demonstration of general proteins and Periodic acid Schiff's reaction was used for the detection of general carbohydrates (Mc-Manus and Cason, 1950).

Wool samples were taken from mid-side position as close as possible to the skin surface. Ten staples were taken randomly from each wool sample to measure staple length to the nearest mm using a ruler. Length measured from the bottom till the dense part of the staple. Five hundred fibers from each sample were used to calculate the average fiber diameter and its distribution percentage using a microscope and image captured by image analysis software (Zen 2012, Blue edition) and device (Carl Zeiss Micro-Imaging GmbH).

Statistical Analysis:-

Data were analyzed by the general linear model (GLM) procedure using SAS software (2004). Then, Duncan's multiple range test (Duncan, 1955) was used for detecting the significant differences between means.

Results and Discussion:-

Barki sheep skin has two wool follicle types, primary and secondary. The primaries are usually the largest and found often three in the skin. While the secondaries are the smallest size, more numerous and lie on one side of the primaries (Fig. 1). The main difference between the primary and secondary follicles was the presence of both sweat and sebaceous glands and erector pili muscle accompanying the primary follicles while the secondaries have only the sebaceous glands.

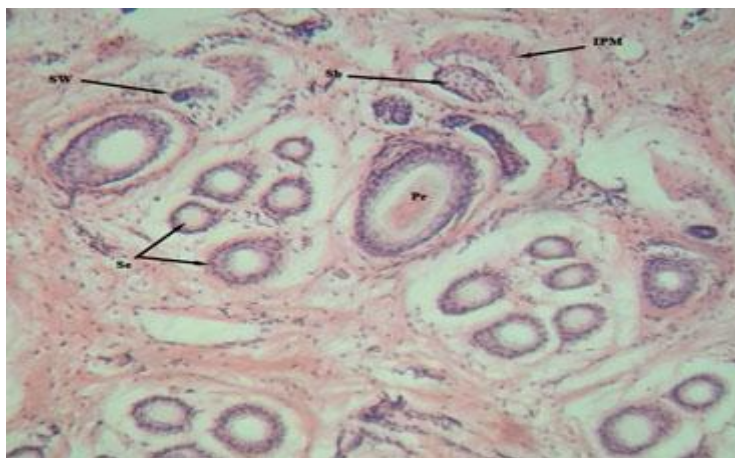


Fig 1:- Transverse section in skin of Barki sheep showing follicle group structures. EPM, erector pili muscle; Pr, primary follicle; Sb, sebaceous gland; Sc, secondary follicle; Sw, sweat gland (X100).

The present results showed that both ZADO and ZAD treatments possessed a significant effect on the primary follicles (Table 1). The internal diameter (78.60 and 85.17 vs. 74.89 μ), wall thickness (84.04 and 78.22 vs. 72.36 μ) and fibre diameter (54.25 and 61.03 vs. 55.94 μ) were affected significantly ($P < 0.05$) in treated groups compared to control group, respectively. While external diameter didn't affected significantly with the same treatments.

Regardless, the type of biological treatments, doses levels (6 and 10 mg) had a significant effect on external (169.89 and 171.93 vs. 147.25) and internal diameters (75.13 and 95.64 vs. 74.89), wall thickness (94.75 and 76.28 vs. 72.36) and fibre diameter (47.33 and 69.65 vs. 55.94) compared to the control group, respectively.

Table (1) revealed that ZADO (6gm) and ZAD (10gm) had highly significant changes ($p < 0.01$) in both external diameter and wall thickness of primary follicle with corresponding values (187.50, 190.66) and (115.71, 88.51), respectively. The internal diameter of the same follicles showed significant difference ($P < 0.05$) between ZADO (10mg) and ZAD (10mg) with values being 89.14 and 102.14, respectively.

Concerning secondary follicles, the external diameter of the treated groups was significantly higher than their partners in the control one (Table 2). The internal diameter as well as wall thickness were found to be affected ($P < 0.05$) significantly due to dose level where ZADO (6gm) and ZAD (10gm) scored the highest values. Helal and fayed (2013) confirmed these results and stated that addition of cellulitic bacteria to Barki rams diet had higher effects on follicle dimensions values and suggested that these changes in the dimensions are the principal cause of variation in fibre output. They outlined that the rate-limiting step in wool production per follicle is the proliferative (i.e. cell division) phase and not keratinization (i.e. protein synthesis) phase of fibre formation.

Table (1) demonstrated that, groups supplemented with high level (10 g/h/d) either from ZADO or ZAD were greater in fiber diameter compared to their partners supplemented with the low level (6 g/h/d). Group with 10 g/h/d from ZAD had the highest fiber diameter among all studied groups. These results might be related to that wool influenced by the nutrients available to the wool follicle (Abdel-Salam, et al., 2014). Abdelaziz et al. (2000) cleared out that, better nutrients resulted in low grade and high diameter. Jafari et al. (2005) studied the effects of treated wheat straw with exogenous fibre-degrading enzymes (EFDE) on wool characteristics of ewe lambs and found that replacing 20%, and 30% of treated wheat straw with EFDE caused numerical increases in final wool diameter (34.40, and 34.89, respectively, vs. 30.49 μm). Also, feeding untreated wheat straw compared to alfalfa hay, tended to increase wool diameter (34.97 vs. 30.49).

Anyhow, the changes in wool growth and characteristics are associated with quality and relative mixture of absorbed amino acids, adding fibrolytic enzymes to the diets, increased viable rumen bacteria (Nsereko et al. 2002), rate of ruminal bacteria growth and flow, then greater absorption of amino acids in small intestine, which would have significant impact on the supply of metabolizable protein to the animal. Reis et al. (1992) provided sheep with most of their nutrients as abomasal infusions, and found that the rate of wool growth was markedly altered by protein supply.

Table 1:- Means \pm SE of primary follicles dimensions (μm) and their fiber diameters of the different experimental groups

Primary follicles		Control	6Mg	10Mg	Overall mean
External diameter	Zado	147.25 \pm 4.440	187.50 \pm 4.440	153.20 \pm 6.704	162.65 \pm 3.061 ^a
	Zad	147.25 \pm 4.440	152.28 \pm 5.925	190.66 \pm 4.997	163.40 \pm 2.977 ^a
	Overall mean	147.25 \pm 3.139 ^b	169.89 \pm 3.702 ^a	171.93 \pm 4.180 ^a	
Internal diameter	Zado	74.89 \pm 2.739	71.78 \pm 2.739	89.14 \pm 4.137	78.60 \pm 1.889 ^b
	Zad	74.89 \pm 2.739	78.48 \pm 3.656	102.14 \pm 3.083	85.17 \pm 1.837 ^a
	Overall mean	74.89 \pm 1.937 ^b	75.13 \pm 2.284 ^b	95.64 \pm 2.579 ^a	
Wall thickness	Zado	72.36 \pm 3.261	115.71 \pm 3.261	64.06 \pm 4.924	84.04 \pm 2.248 ^a
	Zad	72.36 \pm 3.261	73.79 \pm 4.352	88.51 \pm 3.670	78.22 \pm 2.187 ^b
	Overall mean	72.36 \pm 2.305 ^c	94.75 \pm 2.719 ^a	76.28 \pm 3.070 ^b	
Fibre diameter	Zado	55.94 \pm 2.437	38.53 \pm 2.437	68.27 \pm 3.680	54.25 \pm 1.680 ^b
	Zad	55.94 \pm 2.437	56.13 \pm 3.252	71.02 \pm 2.743	61.03 \pm 1.634 ^a
	Overall mean	55.94 \pm 1.723 ^b	47.33 \pm 2.032 ^c	69.65 \pm 2.295 ^a	

Means with different letters in the same row or column differ significantly at $p < 0.05$.

Table 2:- Means \pm SE of secondary follicles dimensions (μ m) and their fiber diameters of the different experimental groups

Secondary follicles		Control	6Mg	10Mg	Overall mean
External diameter	Zado	70.72 \pm 1.940	88.33 \pm 2.264	76.49 \pm 2.634	78.51 \pm 1.326 ^a
	Zad	70.72 \pm 1.940	78.97 \pm 3.051	89.95 \pm 2.513	79.88 \pm 1.468 ^a
	Overall mean	70.72 \pm 1.372 ^b	83.65 \pm 1.900 ^a	83.22 \pm 1.820 ^a	
Internal diameter	Zado	31.01 \pm 0.808	27.11 \pm 0.944	31.90 \pm 1.098	30.00 \pm 0.552 ^b
	Zad	31.01 \pm 0.808	32.57 \pm 1.272	37.72 \pm 1.048	33.77 \pm 0.612 ^a
	Overall mean	31.01 \pm 0.571 ^b	29.84 \pm 0.792 ^c	34.81 \pm 0.759 ^a	
Wall thickness	Zado	39.71 \pm 1.517	61.22 \pm 1.771	44.58 \pm 2.060	48.50 \pm 1.037 ^a
	Zad	39.71 \pm 1.517	46.39 \pm 2.387	52.22 \pm 1.966	46.11 \pm 1.148 ^b
	Overall mean	39.71 \pm 1.073 ^c	53.80 \pm 1.486 ^a	48.40 \pm 1.424 ^b	
Fibre diameter	Zado	21.997 \pm 0.741	15.445 \pm 0.865	23.98 \pm 1.006	20.47 \pm 0.506 ^b
	Zad	21.99 \pm 0.741	24.71 \pm 1.165	27.14 \pm 0.960	24.62 \pm 0.560 ^a
	Overall mean	21.99 \pm 0.524 ^b	20.08 \pm 0.725 ^c	25.56 \pm 0.695 ^a	

Means with deferent letters in the same raw or column differ significantly at $p < 0.05$.

Carbohydrates are considered the sign of follicle activity according to the assumption of Montagna (1956) that the carbohydrates in the outer root sheath is the source of energy for protein synthesis during fibre growth.

Table 3:- Carbohydrates concentration (Means \pm SE) of primary and secondary follicles in both outer and inner root sheath.

General Carbohydrates			Control	6Mg	10Mg	Overall mean
Primary follicles	Outer	Zado	0.47 \pm 0.013	0.53 \pm 0.013	0.73 \pm 0.010	0.58 \pm 0.007 ^a
		Zad	0.47 \pm 0.013	0.56 \pm 0.009	0.49 \pm 0.010	0.51 \pm 0.006 ^b
		Overall mean	0.47 \pm 0.009 ^c	0.55 \pm 0.008 ^b	0.61 \pm 0.007 ^a	
	Inner	Zado	0.43 \pm 0.012	0.48 \pm 0.012	0.70 \pm 0.009	0.54 \pm 0.006 ^a
		Zad	0.43 \pm 0.012	0.49 \pm 0.008	0.48 \pm 0.009	0.47 \pm 0.005 ^b
		Overall mean	0.43 \pm 0.008 ^c	0.49 \pm 0.007 ^b	0.59 \pm 0.006 ^a	
Secondary follicles	Outer	Zado	0.52 \pm 0.012	0.57 \pm 0.014	0.65 \pm 0.010	0.58 \pm 0.007 ^a
		Zad	0.52 \pm 0.012	0.54 \pm 0.011	0.54 \pm 0.011	0.53 \pm 0.006 ^b
		Overall mean	0.52 \pm 0.008 ^c	0.55 \pm 0.009 ^b	0.60 \pm 0.007 ^a	
	Inner	Zado	0.44 \pm 0.011	0.59 \pm 0.013	0.63 \pm 0.009	0.55 \pm 0.006 ^a
		Zad	0.44 \pm 0.011	0.50 \pm 0.010	0.52 \pm 0.010	0.49 \pm 0.006 ^b
		Overall mean	0.44 \pm 0.007 ^c	0.55 \pm 0.008 ^b	0.57 \pm 0.007 ^a	

Means with deferent letters in the same raw or column differ significantly at $p < 0.05$.

The presence of carbohydrates in both primary and secondary follicles showed an increase in follicle activity with both doses of ZADO (Table 3 and Fig.2). Gado et al. (2009) stated that stimulation of rumen microbial numbers using enzymes could be referred to the increase of microbial biomass, which would provide more total polysaccharides activity to digest feedstuffs. The microbial treatment utilized soluble and structural carbohydrates (Abo Baker, 2012). The present results might be due to the mode of action of ZADO which, increased rumen ammonia nitrogen and total short chain fatty acid thus enhance the production of volatile fatty acids which is the source of energy (Gado, 2009). From another point of view, the improvement in fiber fraction digestibility as a result of biological treatment might be related to the effect of the cellulose enzyme which responsible for the stepwise hydrolysis of cellulose to glucose (Aziz, 2009). Added enzymes made the fermentation more gluconeogenic, and thereby improved the energetic efficiency of fermentation. This shift in short chain fatty acids (SCFA) proportions could increase precursor availability, and improve nutrient utilization possibly due to fermentation of sugars released by cell wall hydrolysis by enzymes (Eun et al., 2007). This agrees with Dawson and Tricarico (1999) and Krueger and Adesogan (2008), who noted that enzyme mixtures containing cellulose were more inclined to alter the relative proportions of SCFA thereby resulting in more acetate and less propionate and butyrate.

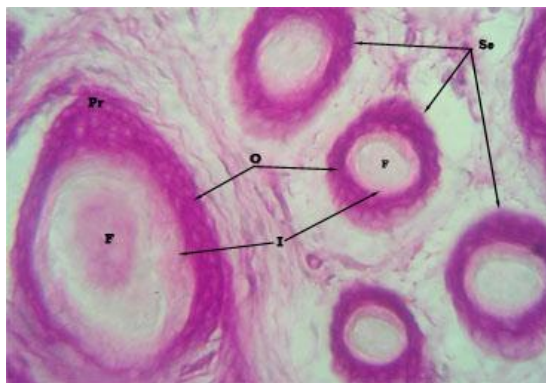


Fig 2:- Transverse section in the wool follicles of Barki sheep stained with PAS method showing the distribution of general carbohydrates in the different follicle sheaths. I, inner root sheath; O, outer root sheath; Pr, primary follicle; Sc, secondary follicle (X400).

Table 4:- Means of primary and secondary follicles general proteins concentrate in both outer and inner root sheath.

General protein			Control	6Mg	10Mg	Overall mean
Primary follicles	Outer	Zado	0.75±0.021	0.64±0.009	0.63±0.015	0.67±0.009 ^b
		Zad	0.75±0.021	0.64±0.012	0.71±0.012	0.70±0.009 ^a
		Overall mean	0.75±0.015 ^a	0.64±0.007 ^c	0.67±0.009 ^b	
	Inner	Zado	0.68±0.019	0.64±0.008	0.59±0.013	0.64±0.008 ^a
		Zad	0.68±0.019	0.59±0.011	0.67±0.011	0.65±0.008 ^a
		Overall mean	0.68±0.013 ^a	0.61±0.007 ^b	0.63±0.009 ^b	
Secondary follicles	Outer	Zado	0.78±0.012	0.61±0.009	0.75±0.022	0.71±0.009 ^a
		Zad	0.78±0.012	0.56±0.011	0.61±0.0128	0.65±0.007 ^b
		Overall mean	0.78±0.009 ^a	0.59±0.007 ^c	0.68±0.012 ^b	
	Inner	Zado	0.75±0.012	0.60±0.009	0.73±0.021	0.69±0.008 ^a
		Zad	0.75±0.012	0.49±0.010	0.61±0.012	0.62±0.006 ^b
		Overall mean	0.75±0.008 ^a	0.54±0.007 ^c	0.67±0.012 ^b	

Means with deferent letters in the same raw or column differ significantly at $p < 0.05$.

The distribution of the general proteins as demonstrated by the bromophenol blue stain in wool follicles of the different groups showed that both outer and inner root sheaths of the wool follicles possessed high amounts of proteins (Table 4). The higher values of general proteins in the outer root sheath of primary follicles were found to be 0.75 ± 0.021 and 0.71 ± 0.012 for control and ZAD 10gm, respectively (Table 4). While the lowest one was reported for ZAD 6gm. The same trend was found in the outer and inner root sheaths of secondary follicles (Table 4 and Fig

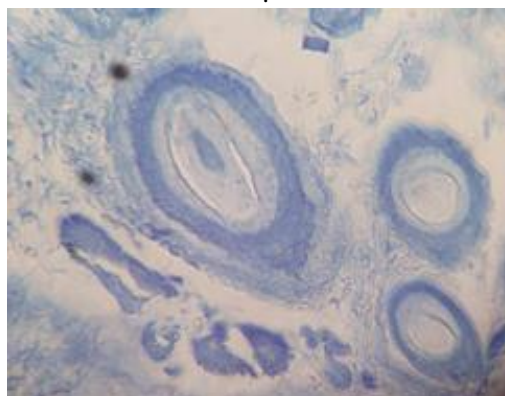


Fig 3:- Transverse section in the wool follicles of Barki ewes stained with bromophenol blue showing the distribution of general proteins in the different follicle sheaths. I, inner root sheath; O, outer root sheath; Pr, primary follicle; Sc, secondary follicle (X400)

ZADO contains some specific enzymes such as protease that induces protein catabolism by hydrolysis of the peptide bonds that link amino acids together in the polypeptide chain forming the protein, which absorbed through the intestinal wall. Ado et al. (2009) found that addition of enzymes increased rumen microbial N synthesis.

In primary follicles, the total amount of general proteins was varied significantly between ZADO and ZAD with values being 0.67 ± 0.009 and 0.70 ± 0.009 in outer root sheath, respectively. Meanwhile, the secondary follicles showed a reversible trend which was 0.71 ± 0.009 and 0.65 ± 0.007 , 0.69 ± 0.008 and 0.62 ± 0.006 for outer and inner root sheaths, respectively. Animals in ZAD(10gm) group showed the highest ($P < 0.05$) protein contents in the outer and inner root sheaths of the primary follicles (0.71 ± 0.012 and 0.67 ± 0.011) respectively. Elmostafa, (2013) reported that ZADO improved significantly total protein. However, Helal and Fayed (2013) found that cellulytic bacteria had insignificant effect on the protein contents of the outer and inner root sheaths. In Mohair production many authors illustrated that nutrition was a major determinant of follicle activity (McGregor, 1988; Doyle et al., 1995 and Scobie et al., 1998).

Generally, the application of exogenous enzymes to the diets of small ruminants has had little impact on production performance. Miller fed a barley-based diet treated with a commercial exogenous enzyme to Dorset-cross ewe lambs and observed no effects on wool growth.

Results demonstrated that using both ZADO and ZAD, with two doses (6 and 10 mg/h/day) had a significant effect on wool characteristics especially staple length (Table 5). Animals fed ZADO (10 mg) recorded higher value of staple length (10.73 ± 0.355 cm) with lowest value of fine fibre diameter percentage (83.92 ± 2.197), higher value of medullated fibre percentage (15.09 ± 1.992) and kemp fibre percentage (0.97 ± 0.438). Ten mg ZAD produced a moderate value of staple length (8.17 ± 0.375) with higher value of fine fibre diameter percentage (90.43 ± 2.197), lowest value of medullated fibre percentage (9.13 ± 1.992) and kemp fibre percentage (0.42 ± 0.438). Abdou, et al. (2016) in sheep feeding propionibacteria, reported increase in wool production as a result of increasing both fibre diameter and staple length and this was in accordance with (Abdel-Salam et al., 2014)

Table 5:- Least squares means \pm SE of fibre diameter, staple length, fine fibre%, coarse fibre% and kemp fibre%.

		Control	6Mg	10Mg	Overall mean
Staple length (cm)	Zado	5.88 ± 0.375	6.82 ± 0.375	10.73 ± 0.355	7.81 ± 0.213^a
	Zad	5.88 ± 0.375	8.50 ± 0.400	8.17 ± 0.375	7.51 ± 0.221^a
	Overall mean	5.88 ± 0.265^c	7.66 ± 0.274^b	9.45 ± 0.258^a	
Fine fibre (%)	Zado	89.42 ± 2.197	88.80 ± 2.197	83.92 ± 2.197	87.38 ± 1.268^a
	Zad	89.42 ± 2.197	86.45 ± 2.197	90.43 ± 2.197	88.77 ± 1.268^a
	Overall mean	89.42 ± 1.553^a	87.63 ± 1.553^a	87.18 ± 1.553^a	
Medullated fibre (%)	Zado	9.82 ± 1.992	10.65 ± 1.992	15.09 ± 1.992	11.85 ± 1.150^a
	Zad	9.82 ± 1.992	13.22 ± 1.992	9.13 ± 1.992	10.72 ± 1.150^a
	Overall mean	9.82 ± 1.408^a	11.93 ± 1.408^a	12.11 ± 1.408^a	
Kemp (%)	Zado	0.74 ± 0.438	0.53 ± 0.438	0.97 ± 0.438	0.75 ± 0.253^a
	Zad	0.74 ± 0.438	0.32 ± 0.438	0.42 ± 0.438	0.50 ± 0.253^a
	Overall mean	0.74 ± 0.310^a	0.43 ± 0.310^a	0.70 ± 0.310^a	

Fineness of wool fibre has long been recognized as an important factor in evaluating sheep fleeces (Sharaf El-din and Ghoneim, 1963). As stated by Wilson (1940), fiber diameter is the basic trait for determining wool quality. Quality increases as wool becomes finer in diameter. Thus, the trait and its distribution were given more attention. Using ZADO in feeding produced finer fibre (25.28 and 27.56) than that obtained from sheep feeding with ZAD (28.18 and 29.62) at level 6mg and 10mg, respectively. Also, all treated groups were finer than control (Table, 6).

Mean fibre diameter is considered as a very important factor in determining spinning performance and fabric properties including skin comfort. Meanwhile, the over width of the fibre diameter distribution, measured either as standard deviation or coefficient of variation, also has an effect on both spinning and skin comfort (de Groot, 1992, Lamb, 1992 and Naylor, et al., 1995).

Prickle factor is a term generally used to indicate the frequency of fibres at the coarse end of the fibre diameter distribution (Phillips et al. 1991). In table (6) Prickle factor (PF) which defined as the percentage of fibres with

diameters exceeding 30µm from the total number of fibres indicated that the highest value of PF was found in ZAD (10 mg), while ZAD (6 mg) was the lowest one. To improve skin comfort it is thus expedient to concentrate on reducing Prickle factor. During wearing these coarse fibre ends press hard enough against the skin before buckling to trigger nerve ends lying just below the skin surface (Naylor, 2000). In this respect, the contribution of synthetic fibres in wool blends to obtain expected properties of performance, comfort, and handle has become more important (Onderet al., 2003). ZAD (6 mg) had the highest amount of fibres with fibre diameter more than 42µm (14.6 %) of total fibres which is really huge unless it has low Prickle factor.

Table 6:- Fibre diameter subclasses, their percentage, means, standard deviations and coefficients of variation of wool clipped from sheep in different treatments, in comparison with the spinning count system.

Type of wool	Spinning count	Subclass*	Control				ZADO 6mg				ZADO 10mg				ZAD 6mg				ZAD 10mg			
			%	M	S D	C V	%	M	S D	C V	%	M	S D	C V	%	M	S D	C V	%	M	S D	C V
Fine	Finer than 80s	<=10	0.3	8.86	1.10	12.37	0.9	9.38	0.54	5.81	0.3	8.23	2.19	26.65	0.7	9.67	0.22	2.51	0.973	-	-	-
		>10	0.5	11.45	0.09	0.75	1.6	11.20	0.39	3.45	0.7	11.18	0.47	4.16	2.1	11.26	0.52	4.65	0.2	11.02	0.55	5.00
		>12	1.6	12.92	0.71	5.50	3.1	13.33	0.50	3.76	3.1	13.30	0.58	4.33	6.9	12.97	0.61	4.70	1.1	13.13	0.57	4.31
		>14	2.0	15.34	0.22	1.46	4.1	15.18	0.37	2.44	5.1	15.16	0.35	2.35	8.2	15.08	0.52	3.47	2.1	15.11	0.47	3.11
	80s	>16	5.1	17.27	0.52	2.99	12.2	17.10	0.57	3.35	10.1	17.11	0.52	3.06	7.2	17.10	0.57	3.33	4.1	17.01	0.57	3.34
		>18	9.1	19.11	0.47	2.43	13.5	18.97	0.54	2.84	9.8	19.08	0.49	2.59	7.7	19.09	0.50	2.61	5.7	18.99	0.45	2.37
	64s	>20	8.7	20.96	0.47	2.23	12.5	20.92	0.46	2.18	11.6	20.96	0.49	2.33	7.7	20.91	0.43	2.35	6.1	21.01	0.48	2.27
		>22	11.1	22.91	0.48	2.07	11.7	22.91	0.43	1.89	9.5	22.83	0.46	2.03	7.3	23.02	0.48	2.02	8.1	23.01	0.44	1.92
		>24	11.9	24.95	0.58	2.30	8.8	24.95	0.53	2.11	9.7	24.97	0.57	2.30	8.9	24.90	0.61	2.43	9.1	25.01	0.63	2.52
		>26	6.8	26.98	0.39	1.43	4.8	26.90	0.31	1.16	6.2	26.83	0.36	1.33	4.8	26.97	0.40	1.47	7.3	26.95	0.42	1.56
		>28	7.7	28.82	0.55	1.92	5.2	28.70	0.46	1.59	6.1	28.84	0.54	1.87	5.9	28.77	0.53	1.88	1.8	28.90	0.59	2.05
		>30	4.6	30.80	0.48	1.56	2.7	30.90	0.52	1.69	3.9	30.82	0.53	1.71	5.4	30.87	0.54	1.74	6.8	30.86	0.56	1.82
Coarse	48s	>32	4.6	32.87	0.57	1.74	2.9	32.83	0.52	1.59	1.9	32.79	0.52	1.58	4.0	32.85	0.60	1.80	1.2	32.87	0.60	1.82
		>34	5.3	35.45	0.80	2.26	1.6	34.63	0.42	1.23	2.3	34.96	0.56	1.59	2.5	35.02	0.61	1.73	6.7	35.07	0.52	1.48
	44s	>36	1.5	37.65	0.22	0.58	1.8	37.21	0.62	1.67	1.7	36.96	0.61	1.65	2.3	37.02	0.63	1.70	5.2	36.59	0.58	1.59
		>38	2.5	38.96	0.61	1.58	1.6	39.23	0.73	1.87	1.4	39.10	0.69	1.77	2.5	38.77	0.57	1.48	3.8	39.08	0.62	1.60
	36s	>40	2.7	40.90	0.64	1.56	1.2	41.18	0.79	1.91	1.8	41.03	0.59	1.45	1.4	41.17	0.65	1.57	3.3	40.97	0.63	1.53
		>42	13.5	58.99	17.41	29.51	9.1	53.23	9.81	18.43	14.2	53.74	11.36	21.14	14.6	56.83	12.68	22.31	7.8	50.52	10.86	21.50
Very coarse	Coarser than 36s																					

+ obtained from Mathis and Faris (2007)

* This classification approximately matches the grades of the spinning count system.

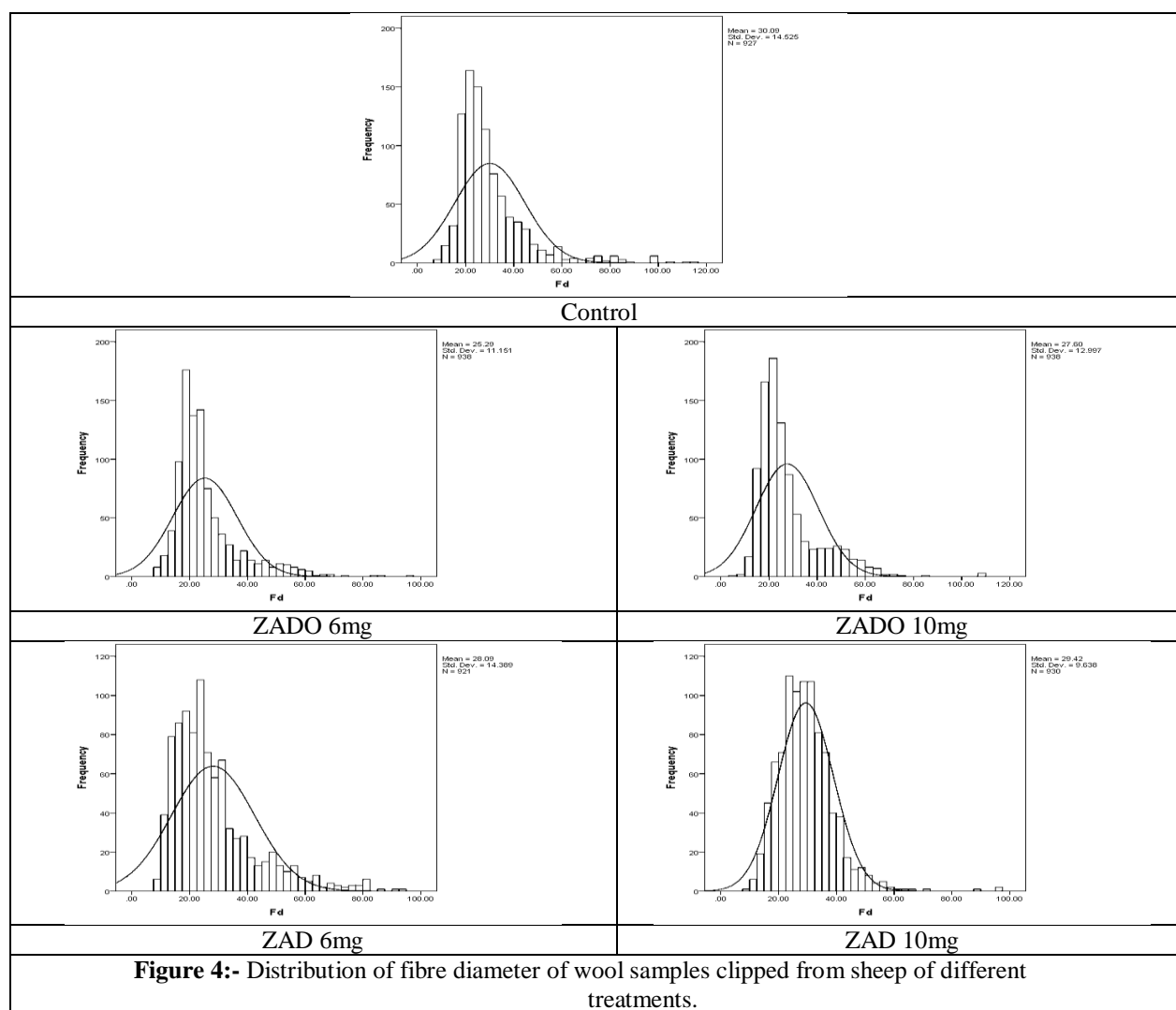
% percentage were calculated out the total number of observations per treatment.

M, mean of fibre diameters.

SD, standard deviation of the mean.

CV, the coefficient of variation.

Percentages of wool fibres with diameters larger than the means (30.09, 25.28, 27.56, 28.8 and 29.62 μm) were 34.7, 30.9, 33.3, 38.6 and 43.3% in control, ZADO 6mg and 10mg, ZAD 6mg and 10mg, respectively. There were 13.5, 9.1, 14.2, 14.6 and 7.8% of fibres with average diameters equal to 58.99, 53.23, 53.74, 56.83 and 50.52 μm coupled with markedly higher coefficients of variation accounting for 29.51, 18.43, 21.14, 22.31 and 21.50 for control, ZADO 6mg and 10mg, ZAD 6mg and 10mg, respectively. These wool characteristics are considered of poor quality (Mathis and Faris, 2007). Based on spinning count system, less hanks of yarn could be spun of this type of coarse wool. Naylor (1997) noted that the coefficient of variation increase as the number of coarse fibre increase. Unexpectedly, high coefficients of variation were obtained for fibres with means less than 10 μm , accounting for 12.37 and 26.65 in control and ZADO 10mg, respectively. Decreasing fibre diameter is the most effective way to reduce the coarse fibre content. Meanwhile, reducing coefficient of variation will also reduce the number of coarse fibres, which improves comfort of wool garments.



Distribution of fibre diameter is illustrated in Figure (4). Obviously showed higher percentage of coarse fibres, i.e. wool with fiber diameter higher than mean. There was great variation among diameters of fibres sampled. The coefficients of variation of fibre diameter were 48, 44, 47, 51 and 38% in control, ZADO 6mg and 10mg, ZAD 6mg

and 10mg, respectively. This variation may be due to the higher percentages of coarse fibres as indicated from Table (6).

Conclusion:-

It was concluded that compared with the control group, Both Zad and Zado with dose of 10 mg tended to increase the external, internal and fiber diameter of both primary and secondary follicles, as well as Carbohydrates concentration. The same effect was found with wool staple length and medullated fiber percent. On the other hand opposite trend was found for the effect of Both Zad and Zado with dose of 10 mg on proteins concentration in both outer and inner root sheath. Results also declared that Zado increased kemp%, while Zad tended to decrease it and the opposite trend was found with fine fibre%.

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