

## EFFECT OF ADDING GINGER POWDER OR GINGER OIL ON PRODUCTIVE PERFORMANCE OF EWES DURING LACTATION PERIOD

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### SUMMARY

This experiment was carried out at Research Station of Maryout belonging to Desert Research Center to assess the effect of ginger forms (*Zingiber officinale*) on productive performance, rumen and blood parameters of Barki ewes. Forty Barki ewes at last pregnant stage, aged 3-4 year and average weighed  $40.47 \text{ kg} \pm 0.99$ , were fed concentrate mixture and alfalfa hay (as traditional ration) and divided into four equal groups. 1<sup>st</sup> group (T1) fed traditional ration without any supplementation as control group, the 2<sup>nd</sup> (T2) and 3<sup>rd</sup> (T3) groups fed control ration with 3 or 6 gm. Ginger powder (GP)/head/day, respectively. The 4<sup>th</sup> (T4) fed control ration plus 2 ml/head/days of ginger oil (GO). Rations offered were adjusted according to ewe's weight and nutrient requirements. Results revealed that treatments had no significant effect on live body weight changes and total dry matter intake. Milk yield affect significantly ( $P < 0.05$ ) of adding ginger forms. T2 (Low GP) recorded the highest ( $P < 0.05$ ) value of milk production compared to experimental groups and control which recorded the lowest value. Experimental treatments significantly ( $P < 0.05$ ) affect milk fat and total soiled percentage. Ewes in T2 (3 gm. GP/h/d.) group recorded the highest values of milk component except fat. Feeding ewes on experimental treated rations led to decrease saturated fatty acids (C 12:0 and C16:0), While, the experimental groups (except T2) insignificantly increased milk unsaturated fatty acids and conjugated linoleic acids. Treatments of ginger forms insignificantly affect pH and total volatile fatty acids. While, T4 decreased ( $P < 0.05$ ) ammonia concentration and protozoa population compared to other groups. Results of blood biochemical were differ significantly ( $P < 0.05$ ) as affected by experimental treatments. T3 recorded the highest values of total proteins and globulin as compared to other groups. Total lipids and triglyceride values were higher for T4 than other groups. Data of lamb's performance showed that birth and weaning weights of kids didn't appear any significant differences among groups. On the other hand, T3 and T2 lambs recorded the highest ( $P < 0.05$ ) daily gain. Finally, T3 was better economic evaluation than other groups, where recorded the best feed conversion and net revenue for farmers.

**Keywords:** Barki sheep, ginger powder, ginger oil, milk production and composition, rumen and blood parameters.

### INTRODUCTION

Small ruminants in Egypt serve as investment and insurance due to their characteristics such as high fertility, short generation interval and adaptation to the arid and semi-arid conditions (Khalil *et al.*, 2013). In the desert rangeland areas of Egypt Barki sheep are raised as a resource of income for the Bedouin and kept for meat production and numbered 470,000 heads (El-Bassiony 2016).

One of the most important challenges of animal production in the harsh desert conditions is the shortage of feed to meet the nutritional requirements of these herds as well as the high costs of transporting feed to the desert area (Helal *et al.*, 2018).

Many procedures have been used to enhance animal productivity such as feed additives (Nassar *et al.*, 2017). However, research indicated that chemical feed additives can cause unfavorable side-effects and hazards to animals and humans (Schwarz *et al.*, 2001). This may be due to their harmful residues in milk and meat, which threaten health (Russell and Houlihan 2003). For that, The World Health Organization (WHO)

recommends and encourages the using of natural feed additives to avoid side effect of unnatural additives (Mohamed *et al.*, 2003).

Medical plants (such as ginger) and their extracts are widely accepted and used as feed additives to improve productivity and immunity of livestock, without negative residues effects in milk and meat in addition to saving to human health and consumers (Zanouny *et al.*, 2013).

Ginger (*Zingiber officinale*) has been shown to have antioxidant, anti-inflammatory, and anti-bacterial properties (Williams and Lamprecht, 2008). Also, ginger natural plant extracts contain some secondary metabolites, which have shown antimicrobial activity (Zhang, *et al.*, 2011).

During early weeks of lambs' life, suckling milk considered the main source of nutrition for them (El-Ghousein, 2010). Moreover, colostrum is very important and considered the sole source of initial acquired immunity for offspring (Stelwagen *et al.*, 2009 and Alves *et al.*, 2015). Also, both rumen and blood parameters are very important indicators for animal productivity and immunity.

The objective of the present study was to evaluate the effect of using ginger forms (powder or oil) as feed additives on the productive performance of Barki sheep.

## MATERIALS AND METHODS

**Experimental location:** The present study was conducted in Maryout Research Station, Desert Research Center (DRC), Ministry of Agriculture and Land Reclamation, Egypt. This station located 35 km south of Alexandria governorate, Egypt. This study lasted for sixteen weeks (four weeks in late pregnancy period followed by other twelve weeks in lactation period).

**Animals and rations:** Forty pregnant Barki ewes, aged 3-4 year and average weighed  $40.47 \text{ kg} \pm 0.99$ , were allocated to four feeding regimes in a complete randomize (10 animals each). All experimental ewes were fed concentrate mixture design to live body weight and alfalfa hay according to physiological status as recommended by Kearn (1982). Roughage concentrate ratio was 40:60 in the last 4 weeks of pregnancy, 50:50 during first 4 weeks of lactation and 60:40 in the last 8 weeks of lactation. Animal groups received one of four dietary treatments. The treatments were: 1<sup>st</sup> group (T1) without any additives (Control). The 2<sup>nd</sup> (T2) and 3<sup>rd</sup> (T3) groups were treated with 3 and 6 gm. ginger powder (GP) /head/day, respectively. Ginger powder was mixed daily by concentrate mixture to offer for daily basis. The 4<sup>th</sup> (T4) group was orally administered by 2 ml ginger oil (GO) / head/ day. All experimental animals were weighed biweekly till the end of lactation period. Clean fresh water was offered twice daily. The kids were numbered and individually weighed biweekly from birth to weaning.

**Sampling and analysis of milk:** Five ewes from each group were randomly chosen to record milk parameters. In the next day of parturition, colostrum samples were taken and kept for analysis. Milk production was recorded biweekly starting from the second week of lambing till the 12<sup>th</sup> week of lactation using the hand-milking procedure after separation of lambs from their dams. Milk samples were taken and kept in plastic bottles under  $-20 \text{ }^{\circ}\text{C}$  for chemical analysis. Chemical compositions of milk, in terms of fat, protein, lactose, total solids and solids not fat were determined by using milk scan (MilkoScan, Bentley, Belgium).

**Sampling and analysis of rumen liquor:** Rumen liquor samples were collected from animals during the mid- lactation period by using a stomach tube at three hours post feeding. The rumen samples were filtered through two layers of cheese-cloth and pH values were recorded immediately by digital pH-meter. Rumen samples were stored frozen ( $-18^{\circ}\text{C}$ ) for later analysis. Samples of protozoal count were preserved and counted as described by the method of Dehority (1984).

**Sampling and analysis of blood:** During mid-lactation period blood samples were taken randomly from five animals from group. Blood samples were withdrawn. Then, centrifuged and separated blood serum was stored into a clean dried glass vial at  $-20 \text{ }^{\circ}\text{C}$  for analysis. Biochemical analyses (total proteins, albumin, urea, creatinine, aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), total lipids and cholesterol) were measured in serum using kits provided by Diamond Company. Immunoglobulin (IgG) was measured by ELISA kits after serum dilution and according to Abbott Laboratories instruction (Abbotta Park, IL 60064 USA. Gamma-Glutamyl Transferrase (GGT) was determined by using kinetic

colorimetric methods and commercial kits supplied by Spectrum-Diagnostics Egypt Company for Biotechnology. Lipid fraction in blood was assessed by measuring triglyceride concentration (Hatch and Lees, 1968 and Raltiff and Hall, 1973).

**Analytical methods:** Proximate analyses of concentrate mixture and alfalfa hay (Table 1) were determined according to AOAC (2007).

**Table (1): Chemical composition of concentrate mixture (CM) and alfalfa hay.**

Item	Composition % on DM							
	DM	OM	CP	EE	CF	NFE	Ash	TDN*
CM	91.08	91.05	16.11	2.70	16.54	55.70	8.95	67.99
Alfalfa hay	91.33	87.50	15.54	1.94	31.97	38.05	12.5	56.53

\*TDN: Total digestible nutrient for alfalfa hay and CFM were estimated according to Adams et al., 1964.

Ammonia nitrogen in the rumen fluid was determined according to A.O.A.C. (2007). Total volatile fatty acids (TVFA's) were determined according to Warner (1964).

**Statistical analysis:** Data obtained in this study was statistically analyzed by one way of variances according to SAS (2004) using the following model;  $Y_{ij} = \mu + T_i + e_{ij}$ , Whers;  $Y_{ij}$  = experimental observation,  $\mu$  = overall mean,  $T_i$  = effect of treatment,  $e_{ij}$  = experimental error. Differences among means were compared by Duncan's multiple range Test of Duncan (1955).

## RESULTS AND DISCUSSION

**Voluntary feed intake:** The present findings of total dry matter intake during different production periods showed that there were no differences among groups (Table 2), because nutrient requirements were given (restricted feeding) as a results of changing in body weight and physiological status according to kearl (1982). The results in the current study were in agreement with Noaman and Shujaa (2016) who observer that no significant differences in intake for lambs fed ration supplemented with different dosages of GP. Also, Aylin and Kocabali (2014) stated that DM intake was not affected by supplying different dosages of oregano oil to lambs rations.

On the other hand, Shams Al-dain, and Jarjeis (2015) observed significant increases in daily intake for cows fed rations supplemented with high and low doses of GP.

**Table (2): Voluntary feed intake of ewes fed tested rations during late pregnancy and lactation period.**

Item	Experimental group			
	T1	T2	T3	T4
Total intake* in last 4 weeks of pregnancy	1489.6	1489.4	1490.2	1510.2
Total intake in first 4 weeks of lactation	1764.0	1617.4	1637.6	1772.0
Total intake in last 8 weeks of lactation	1300.2	1177.2	1222.0	1310.4

T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

\*Roughage concentrate ratio was 40:60 in the last 4 weeks of pregnancy, 50:50 during first 4 weeks of lactation and 60:40 in the last 8 weeks of lactation.

**Live body weight changes of ewes:** Results of ewes live body weight changes revealed that there were no significant differences among the experimental groups (Table 3). Just before and after kidding, high weight

was recorded in T4 followed by T1. These may be due to higher birth weights of their lambs (Table 12). While, ewes received GP recorded less weights (T2 and T3, respectively) than others. During early lactation phase, all ewes lost their weight compared to weights at after kidding where, ewes of T1 showed the higher loss but their mates in T2 have lower loss weight.

Generally, it was noticeable that treated with ginger forms recorded the less lost weights in early lactation phase compared to their mates in control group. These results were in agreement with those obtained by Shams Al-dain and Jarjeis (2015) they indicated that control group was more lost weights than cows treated by 75 or 150 g of GP/h/d.

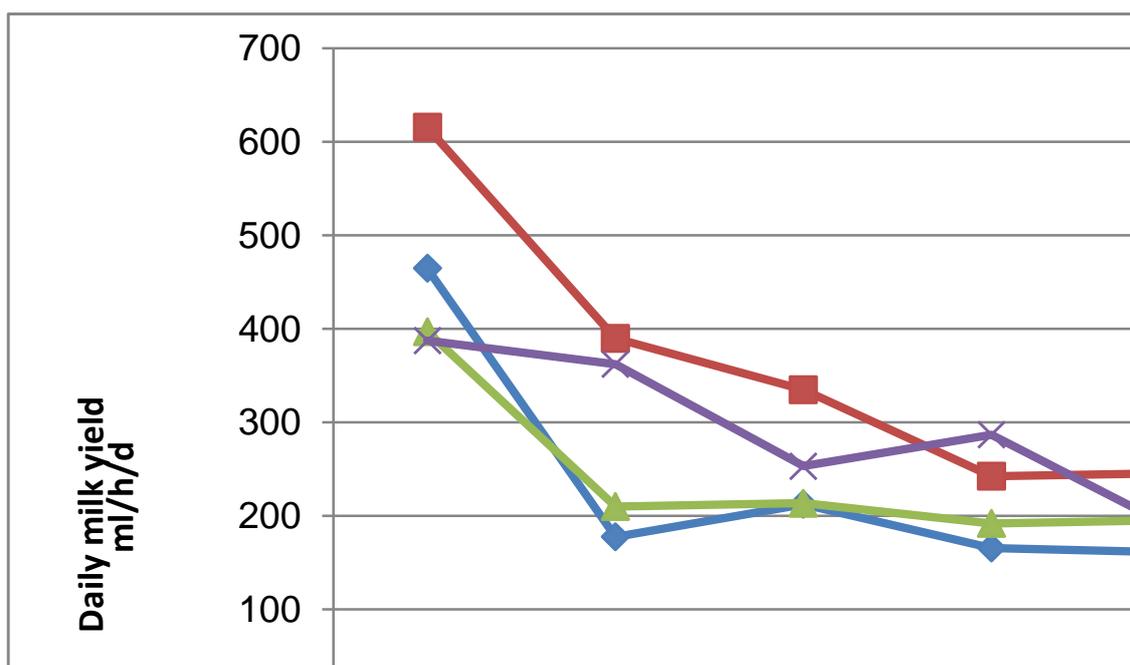
Average weights of ewes during milk production in all groups there did not differ significantly (Table 3). Generally, the data of ewes weights during different stages of lactation indicated that no significant effects on live weight. This might be due to the feeds were proposed to cover the requirements of milk production for each all animal. These results were in agreement with those obtained by Shams Al-dain and Jarjeis (2015) they indicated there were no significant effects of adding different dosages from GP to experimental rations on live weight without adverse effect on dairy cows during different periods.

**Table (3): Body weight changes (kg) of ewes fed tested rations during late pregnancy and lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
During late pregnancy period					
Initial body weight	40.26	40.25	40.27	40.82	1.19
Just before kidding	47.56	46.12	45.60	48.00	1.49
Just after kidding	42.00	38.51	38.98	42.19	1.59
Weight in early lactation	35.92	35.24	33.24	37.12	1.29
Weight in mid lactation	36.30	33.76	34.06	36.28	1.25
Weight in late lactation	33.98	29.92	32.02	34.58	1.18
Average weight during lactation period	35.40	32.94	33.10	36.00	1.18

T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

**Milk yield:** Results of milk yield during different weeks of lactation appeared that the first two weeks of lactation recorded the highest milk yield value as compared with other periods of lactation (Figure 1).



Average milk yield at 4,8, 12 week of lactation and during all periods (Table 4) demonstrated that addition of ginger forms to ewes' rations led to a significant ( $P<0.05$ ) increase in milk yield only during early lactation compared with control. However, during mid and late lactation periods, there were insignificantly increases. These increase in milk production of treated ewes may be due the addition of ginger products (GP or GO) which led to high propionate ratio and reducing methane production (Patra and Saxena, 2010). Moreover, Hameed *et al.* (2012) recorded increases in milk production of Holstein cows fed rations supplemented by different levels of GP as compared to those in control. Adding GO led to higher milk production than control group. These results were in agreement with those obtained by Kholif *et al.* (2012), who found increased milk production of goats fed ration added daily with 2 ml GO when compared to ration without addition.

**Table (4): Milk yield of ewes fed tested rations during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Average daily milk yield (ml/h/d)					
First 4 weeks	271.2 <sup>b</sup>	502.8 <sup>a</sup>	303.6 <sup>ab</sup>	375.0 <sup>ab</sup>	35.7
Second 4weeks	189.0	288.6	202.8	270.0	21.6
Third 4 weeks	148.2	218.8	175.8	191.4	14.3
Average during 12 weeks	202.8 <sup>b</sup>	336.8 <sup>a</sup>	227.4 <sup>ab</sup>	278.8 <sup>ab</sup>	22.1

<sup>a, b</sup> means at the same row with different superscript are significantly ( $P<0.05$ ) different.. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

The obtained results demonstrated that addition of different forms of ginger increased significantly ( $P<0.05$ ) average total milk yield as compared with control. Ewes fed 3 gm. of GP (T2) had the highest ( $P<0.05$ ) milk yield followed by ewes fed 2 ml of GO (T4) then those fed 6 mg of GP (T3). The lowest value was recorded for ewes fed control ration (T1).

Increasing milk yield with of ewes fed ginger forms (T2, T3 and T4) may be due to one or more of the following reasons which correlated to using ginger as a dietary additives; the degradability of DM and natural detergent fiber were improved with mixture of ginger and garlic oils compared with control (Nanon *et al.*, 2014), improvement of nitrogen, energy utilization, feed efficiency and ruminants healthy (Giannenas *et al.*, 2013) and finally, increasing saliva secretion and enhancement bile acids synthesis in the liver which have positive effects on digestion and absorption of lipids (Kumar *et al.*, 2014).

**Chemical composition of colostrum:** Addition of ginger to ewes' rations resulted in significant differences ( $P<0.05$ ) in all colostrum composition component except for protein percentage (Table 5). Regarding fat percentage, the 4<sup>th</sup> treatment (GO) had higher ( $P< 0.05$ ) fat (%) as compared to other experiment treatments. However, there were no significant differences among T1, T2 and T3 (Table 5). This result agreed with (Smeti *et al.* 2015) who found that increasing in fat colostrum for ewes was due to supplying essential oils compared to other groups

**Table (5): Chemical composition of colostrum for ewes fed tested rations during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Fat (%)	7.93 <sup>b</sup>	7.28 <sup>b</sup>	6.89 <sup>b</sup>	11.83 <sup>a</sup>	0.58
Protein (%)	11.17	9.15	10.27	8.47	0.45
Lactose (%)	2.66 <sup>c</sup>	4.63 <sup>b</sup>	2.25 <sup>c</sup>	6.71 <sup>a</sup>	0.27
Total Solids (%)	39.22 <sup>a</sup>	30.45 <sup>b</sup>	33.97 <sup>b</sup>	30.07 <sup>b</sup>	1.09
Solids Not Fat (%)	16.25 <sup>a</sup>	14.45 <sup>b</sup>	15.58 <sup>ab</sup>	14.25 <sup>b</sup>	0.28

<sup>a, b</sup> means at the same row with different superscript are significantly ( $P<0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

On an opposite trend, Hendawy *et al.* (2019) noted that adding 5 g/h/d of GP to ewes' rations do not affect colostrum composition except total solids which was higher with GP adding.

Nevertheless, the obtained percentages of fat, protein and lactose were within the range reported by Banchero *et al.* (2004) with values being (8.2 to 10.6) for fat (%), (7.7 to 15.7) for protein (%) and (1.7 to 3.6) for lactose (%).

Generally, the composition and quality of colostrum was more affected by their nutrition (Hyrsova *et al.*, 2016).

**Chemical composition of milk:** Data in Table (6) showed significant ( $P < 0.05$ ) effect of GP and GO during the first four weeks of lactation on fat and solids not fat percentages compared to control group. However, no significant effects were noticed on protein, lactose, total solids and ash. Fat percentage differed ( $P < 0.05$ ) among groups and the highest value was recorded for T3. These results agreed with Hendawy *et al.* (2019) where adding 5g GP/h/d to ewes' ration increased fat of milk which may be due to high efficiency of ruminal activity and increasing acetic acid production and acetate propionate ratio in the rumen. On the other hand, the lowest value of fat percentage was in T4. Kholif *et al.*, (2012) concluded that reduction in milk fat for goats fed essential oils additives compared with the control group, which may be due to the lower ruminal acetate proportion and acetate to propionate ratio for control group.

On the other hand, solids not fat showed significant differences ( $P < 0.05$ ) among groups and the highest value was in T2 followed by T4. The data of milk composition in mid lactation didn't reflect any significant effects in all components for rations supplemented with ginger forms.

**Table (6): Chemical composition (%) of ewes milk fed tested rations during different lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
First 4 weeks					
Fat	2.96 <sup>b</sup>	2.58 <sup>c</sup>	3.40 <sup>a</sup>	1.87 <sup>d</sup>	0.05
protein	2.39	2.88	2.58	2.72	0.05
lactose	3.81	4.27	3.87	4.04	0.06
Total Solids	9.59	10.58	10.40	9.44	0.14
Solids Not Fat	6.63 <sup>b</sup>	8.00 <sup>a</sup>	7.00 <sup>ab</sup>	7.56 <sup>ab</sup>	0.11
Ash	0.42	0.84	0.54	0.79	0.01
Second 4 weeks					
Fat	2.65	2.49	2.07	1.47	0.17
protein	2.81	2.66	2.54	2.67	0.08
lactose	4.20	3.86	3.86	4.35	0.10
Total Solids	10.47	9.37	9.22	9.24	0.21
Solids Not Fat	7.82	7.24	7.15	7.76	0.22
Ash	0.80	0.72	0.74	0.73	0.07
Third 4 weeks					
Fat	2.15 <sup>a</sup>	2.51 <sup>a</sup>	2.50 <sup>a</sup>	0.82 <sup>b</sup>	0.15
protein	2.47	2.88	2.56	2.56	0.13
lactose	3.61	4.56	3.85	4.19	0.38
Total Solids	9.15 <sup>b</sup>	10.81 <sup>a</sup>	9.66 <sup>ab</sup>	8.08 <sup>b</sup>	0.58
Solids Not Fat	7.00	8.30	7.16	7.25	0.46
Ash	0.91 <sup>a</sup>	0.85 <sup>ab</sup>	0.75 <sup>ab</sup>	0.50 <sup>b</sup>	0.12
Average chemical composition during lactation period					
Fat	2.58 <sup>a</sup>	2.53 <sup>a</sup>	2.66 <sup>a</sup>	1.39 <sup>b</sup>	0.05
protein	2.56	2.81	2.56	2.65	0.06
lactose	3.87	4.23	3.86	4.19	0.14
Total Solids	9.74 <sup>ab</sup>	10.37 <sup>a</sup>	9.76 <sup>ab</sup>	9.82 <sup>b</sup>	0.14
Solids Not Fat	7.15	7.85	7.10	7.53	0.19
Ash	0.71	0.80	0.68	0.68	0.04

<sup>a, b, c, d</sup> means at the same row with different superscript are significantly ( $P < 0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

During late lactation period, there were significant differences in milk composition. T2 (Low GP) achieved higher values of all tested components than other groups while T4 (GO) had the lowest fat, total solids and ash percentages.

The date of milk composition during different periods reflected on average chemical analysis of milk. T2 (Low GP) recorded the highest values of all except fat. On the hand, T4 (GO) recorded lower fat ( $P < 0.05$ ) and total solids (%) and higher lactose, protein and solids not fat (%). The lower milk fat percentage may be due to the reduction ruminal acetate proportion and acetate to propionate ratio in ewes' rumen. While, improving milk protein with GO may be increasing microbial protein synthesis. Similar results were obtained by Spanghero *et al.* (2008) who reported that adding essential oils to animals feed had increased the milk protein percentage. Higher milk lactose in T2 and T4 may be due to ginger products addition led to decrease blood glucose (Ahmide and Abuzogaya, 2009).

The present results were in consistent with those of Hendawy *et al.* (2019). They stated that adding GP to ewes' ration improved milk fat and TS percentages with no effect on values of milk protein, SNF and lactose when compared to control group suggesting that the improvement in milk quality may be caused by the enhancement in the immune response of farm animals.

**Milk fatty acids profile:** The obtained data (Table 7) showed that feeding ewes low dosage of GP (T2) decreased both of C8:0 and C10:0 fatty acids. On the other hand, Benchaar *et al.* (2007) found no variations in milk fatty acids when supplementing the ration of dairy cows with a mixture of essential oils compounds.

Also, data showed that feeding ewe's tested ration which contained GO (T4) led to decrease milk fatty acids; C<sub>12:0</sub> and C<sub>16:0</sub> compared with other rations. This reduction might be because of the potential inhibitory effect of the dietary polyunsaturated fatty acids (PUFA) or its metabolites on the nova fatty acids synthesis in the mammary gland (Allam *et al.*, 2012 and Kedegowda *et al.*, 2009) or a dilution effect.

Feeding ewes on GP or GO ration were insignificantly increased the content of milk from C<sub>18</sub> fatty acids. These results agree with findings of Allam *et al.*, (2012). The increase of C<sub>18:1</sub> for ewes milk fed experimental ration may be resulted from partial bio-hydrogenation of C<sub>18:2</sub> and C<sub>18:3</sub> fatty acids and the desaturation of C<sub>18:0</sub> in the mammary gland (Kennelly,1996).

Feeding GP (T2) and GO (T4) induced a higher content of C20:0 than control group, while T3 recorded the lowest value. This results were in agreement with Kholif *et al.* (2012) who reported that GO increased C20:0 fatty acid , unsaturated fatty acids and conjugated linoleic acid (CLA) in lactating goats fed ration supplemented with garlic, cinnamon or ginger oils.

**Table (7): Milk fatty acids profile of ewes fed tested rations during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
<b>Saturated fatty acids</b>					
C8:0(Caprlyic acid)	0.60 <sup>b</sup>	0.14 <sup>c</sup>	0.89 <sup>a</sup>	0.68a <sup>b</sup>	0.08
C10:0(Capric acid)	4.49 <sup>a</sup>	1.47 <sup>b</sup>	4.30 <sup>a</sup>	3.83 <sup>a</sup>	0.36
C12:0(Lauric acid)	3.25 <sup>b</sup>	4.33 <sup>a</sup>	2.69 <sup>b</sup>	2.38 <sup>b</sup>	0.25
C14:0(Myristi acid)	8.34 <sup>a</sup>	5.51 <sup>b</sup>	8.70 <sup>a</sup>	7.50 <sup>a</sup>	0.42
C15:0(Pentadecanoie acid)	1.79 <sup>a</sup>	0.67 <sup>b</sup>	1.07ab	1.36a	0.13
C16:0(Palmtic acid)	26.81 <sup>a</sup>	22.15 <sup>b</sup>	27.06 <sup>a</sup>	24.31 <sup>b</sup>	0.66
C16:1ω7(Palmitioleic acid)	1.37a <sup>b</sup>	1.46 <sup>a</sup>	1.27 <sup>b</sup>	1.30 <sup>b</sup>	1.83
C17:0(Heptadeeanoic acid)	1.55 <sup>a</sup>	0.80 <sup>b</sup>	0.88 <sup>b</sup>	0.99 <sup>b</sup>	0.10
C18:0(Stearic acid)	15.63a	12.93b	14.50ab	15.06ab	0.43
<b>Unsaturated fatty acids</b>					
C18:1ω9(Oleic acid)	23.57 <sup>b</sup>	33.42 <sup>a</sup>	28.25 <sup>ab</sup>	28.30 <sup>ab</sup>	1.36
C18:2ω6(Linoleic acid)	4.05 <sup>bc</sup>	12.92 <sup>a</sup>	3.70 <sup>c</sup>	5.73 <sup>b</sup>	1.14
C18:3ω3(Linolenic acid)	0.33	0.60	0.48	1.05	0.13
C20:0(Arechidic acid)	0.34 <sup>ab</sup>	0.43 <sup>a</sup>	0.26 <sup>b</sup>	0.39 <sup>a</sup>	0.02
C20:1ω5(Eicosaeonic acid)	0.38 <sup>a</sup>	0.34 <sup>a</sup>	0.36 <sup>a</sup>	0.23 <sup>a</sup>	0.02

<sup>a, b, c</sup> means at the same row with different superscript are significantly ( $P < 0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

In the present result, C18:1 $\omega$ 9, C18:2 $\omega$ 6 and C18:2 $\omega$ 3 were insignificantly increased compared with control group. In similar trend Boutoial *et al.* (2013) indicated that addition extracts of rosemary leaves to lactating goats increased Polly unsaturated fatty acids as the dosage of extracts increased.

#### Ruminal parameters:

**pH value:** Data in Table (8) declared that there were no significant differences in pH values as a result of feeding ewes on rations supplied with the experimental additives. In similar, Zhang *et al.* (2011) reported that no significant differences were observed as a result of feeding GP. Moreover, Kholif *et al.* (2012) found that ruminal pH levels didn't differ significantly between animals fed treated ration by 2 ml/h/d of GO and control. While, Al-Khayat (2011) reported a decrease in the rumen pH. Generally, the mean pH values of rumen liquor in the present study are within the ranges reported by Rakha (1988) and El Ashry *et al.*, (1997). Furthermore, the pH values were always above 6.0 which ensure of maximal cellulolytic activity and microbial protein synthesis as reported by Hungate (1966).

**Total volatile fatty acids concentration:** The concentrations of TVFA were not significantly affected by the tested rations. Also, Patra *et al.*, (2010) found that extracts of ginger had no effect on the TVFA concentration. On the other hand, Zhang *et al.* (2011) reported that TVFA concentration decreased by increasing the ginger powder dose in rations.

**Table (8): Effect of tested rations on rumen parameters during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Ph	6.13	6.33	6.25	6.20	0.28
TVFA <sub>s</sub> (meq/100 ml RL)	5.20	5.20	5.40	5.37	0.05
NH <sub>3</sub> -N (mg/100ml RL)	18.62 <sup>a</sup>	18.70 <sup>a</sup>	17.72 <sup>a</sup>	15.05 <sup>b</sup>	0.46
Protozoa (X 10 <sup>5</sup> cell ml <sup>-1</sup> )	4.85 <sup>a</sup>	4.72 <sup>a</sup>	4.37 <sup>a</sup>	2.17 <sup>b</sup>	0.35

<sup>a, b</sup> means at the same row with different superscript are significantly ( $P < 0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

**Ammonia nitrogen concentration:** Values of ruminal NH<sub>3</sub>-N (Table 8) showed significant ( $P < 0.05$ ) differences between T4 (which recorded the lowest value) and other groups. Generally, lower NH<sub>3</sub>-N concentration in T4 (GO group) This could be explained with the influence of essential oils additives as moderate in absorbing and subsequently releasing ammonia nitrogen in the rumen (Castillejos *et al.*, 2008). Furthermore, Ferme *et al.* (2004) found a reduction in NH<sub>3</sub>-N concentration by the essential oils that might be modified the microbial population profile in a continuous culture experiment and decreased the contribution of *Prevotella spp* which is mainly responsible for protein degradation and amino acids deamination suggesting a mode of action of essential oils on protein metabolism The present results agreed with those obtained by Busquet *et al.* (2006) when used GO.

**Ruminal Protozoa population:** In this study, there was a significant ( $P < 0.05$ ) difference between T4 (highly decrease in protozoa count) and other groups (Table 8). A reduction in total protozoa number in G4 may be due to the presence of antiprotozoal activities of ginger components (Agarwal, *et al.* 2009) and also, essential oils ingredient in GO reduced methane produced by selectively inhibiting protozoa (Sallam *et al.*, 2011). Regardless of T4, results showed that no significant differences were occurred between control and other groups (T2 and T3). These results were in harmony with those observed by Al-Azazi *et al.* (2018).

#### Blood biochemical parameters:

Data in Table (9) showed that total proteins, albumin, globulin and A/G ratio differed significantly ( $P < 0.05$ ) as affected by experimental rations as compared to control group. Total proteins increased in T3 which may be due to that GP enhanced the secretion of saliva, the efficiency of digestion enzymes, the digestion and metabolism and slow the time of feed passage which increased the absorption of protein in small intestine (Platel and Srinivasan, 2001 and Suresh and Srinivasan, 2007). Furthermore, Shams Al-dain, and Jarjeis (2015) and El-Gohary *et al.* (2012) found that total proteins tended to be higher with GP addition for Friesian dairy cows and goats rations, respectively. Alternatively, Al-Azazi *et al.*, (2018) concluded that

addition of herbal mixture to sheep feed had no consequence effects on total serum proteins. The lowest value of total proteins recorded via T4 (GO addition), which might be attributed to that the essential oils modified the microbial population profile, decreasing the contribution of *Prevotella spp.*, which is mainly responsible for protein degradation and amino acids deamination suggesting a mode of action of essential oils on protein metabolism (Ferme *et al.* 2004).

The values of albumin showed significant ( $P<0.05$ ) differences among rations (Table 9). The highest serum albumin value was in ration supplemented with GO (T4) while the lowest value recorded by control group (T1). These results may be owing to the improvements of ruminal microbial protein synthesis or to the decrease in milk non protein nitrogen which increased milk protein and blood albumin (Kholif *et al.*, 2012).

**Table (9): Effect of tested rations on blood biochemical parameters of ewes during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Total protein (g/dl)	7.84 <sup>ab</sup>	7.55 <sup>b</sup>	8.68 <sup>a</sup>	6.36 <sup>c</sup>	0.25
Albumin (g/dl)	4.01 <sup>b</sup>	4.47 <sup>ab</sup>	4.36 <sup>ab</sup>	4.98 <sup>a</sup>	0.14
Globulin (g/dl)	3.82 <sup>ab</sup>	3.06 <sup>b</sup>	4.31 <sup>a</sup>	1.38 <sup>c</sup>	0.31
A:G Ratio	1.07 <sup>b</sup>	1.54 <sup>b</sup>	1.02 <sup>b</sup>	3.70 <sup>a</sup>	0.30
IgG* (IU/L)	0.97 <sup>b</sup>	1.12 <sup>b</sup>	2.28 <sup>a</sup>	1.50 <sup>b</sup>	0.15

<sup>a, b, c</sup> means at the same row with different superscript are significantly ( $P<0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

\*IgG: Immunoglobulin .

Concerning globulin values, the results demonstrated that T3 had higher ( $P<0.05$ ) globulin value than other treated (T2 and T4) groups. This increment in GL of T3 might be attributed to the presence of active components in ginger powder which brought about boom cellular antioxidant defenses activity, act as anti- lammation and induced improved immune response of the body and subsequently globulin was increased (Zancan *et al.* 2002 and Fawzi *et al.* 2009). On the other hand, the lowest values of globulin were in T4. This result agreed with Kholif *et al.* (2012) who found that decreasing globulin value with adding GO compared to control group.

Animals fed experimental ginger rations had higher IGG than control group. The highest value was recorded in T3 followed by T4 while the lowest value recorded for T1 (control group). This might be attributed to the effect of medicinal plants which improve the immunity and able to cause changes of the duodenal mucosa with beneficial effects for the animal (Lavinia *et al.*, 2009).

**Lipids profile:** The results of total lipids (TLs) values showed significant ( $P<0.05$ ) increase in animals fed ration contained GO (T4). There were no significant differences among other groups. The control group had higher TLs values than that of T2 and T3 (Table 10). These results were in agreement with those reported by Zeweil *et al.* (2016) that adding linseed oil plus GP lowered total lipids values than control group.

**Table (10): Effect of tested rations on lipids profile of ewes during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Total lipids (mg/dl)	37.18 <sup>b</sup>	25.67 <sup>b</sup>	24.78 <sup>b</sup>	101.79 <sup>a</sup>	9.37
Triglyceride(mg/dl)	37.92 <sup>b</sup>	30.52 <sup>b</sup>	33.03 <sup>b</sup>	48.17 <sup>a</sup>	2.04
Cholesterol(mg/dl)	54.41	59.33	50.64	52.59	2.85

<sup>a, b</sup> means at the same row with different superscript are significantly ( $P<0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil,

The values of triglyceride had the same trend of TLs where animals fed GO (T4) had higher ( $P<0.05$ ) triglyceride concentration than those for other experimental groups. Moreover, control group also, exceeded insignificantly the concentrations of triglyceride of T3 and T2, as showed in Table (10). The reduction

observed in triglyceride for rations supplemented with GP (T2 and T3) may be due to the influences of GP on liver tissues and benefit in metabolism. The same results were clarified with Noaman and El-Rawy (2013). Whilst, increasing value of triglyceride in T4 may be due to the negative effect of GO on rumen microflora activity (as indicated early in Table 8) and digestion. Bianchi *et al.* (2014) found significant increase in triglyceride level in dairy sheep fed different level of palm oil.

The present findings demonstrated that the lowest value of serum cholesterol level was in T3 followed by T4 compared to other experimental groups. Decreasing cholesterol in T3 may be due to higher dosage of GP. Shewita and Taha (2018) found that adding ginger (6 g GP/kg diet) lowered cholesterol concentrations. Kholif *et al.* (2012) reported that essential oil supplementation to goat's rations decreased cholesterol concentrations compared with those fed control.

On the other hand, Al-jubori (2017) suggested that addition of 25g/h/d ginger powder to ewes ration led to increase the cholesterol concentration in blood.

**Kidney and liver function:** Serum urea concentration in this study decreased significantly ( $P<0.05$ ) in T4 and insignificant differences among control, T2 and T3 (Table 11). Nassar *et al.* (2017) reported that decrease in urea concentration as a result of inhibition effect of garlic oil on deamination and lower ruminal ammonia concentration. On the other hand, Noaman and Al-Rawe (2013) recoded no significant differences between urea concentrations of Awassi lambs fed rations with or without different dosages of ginger powder.

Animal fed control ration recorded significant ( $P<0.05$ ) decrees for creatinine value (1.80) compared with the experimental rations (Table 11). The present results are in accordance with Ibrahim (2015) who reported that insignificant increasing in creatinine value for ewes which given water with ginger extract in comparison to control.

**Table (11): Effect of tested rations on Kidney and liver function of ewes during lactation period.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Urea (mg/dl)	81.40 <sup>a</sup>	76.34 <sup>a</sup>	82.41 <sup>a</sup>	67.76 <sup>b</sup>	1.74
Creatinine (mg/dl)	1.80 <sup>c</sup>	2.39 <sup>b</sup>	2.63 <sup>ab</sup>	2.92 <sup>a</sup>	0.11
ALT(IU/L)	41.00 <sup>c</sup>	49.00 <sup>a</sup>	48.00 <sup>ab</sup>	47.00 <sup>b</sup>	0.08
AST(IU/L)	62.00 <sup>b</sup>	70.00 <sup>a</sup>	72.00 <sup>a</sup>	65.00 <sup>b</sup>	0.13
ALP(IU/L)	4.59 <sup>b</sup>	6.15 <sup>a</sup>	5.08 <sup>a</sup>	5.81 <sup>a</sup>	0.44
GGT(IU/L)	24.07 <sup>b</sup>	26.13 <sup>ab</sup>	30.65 <sup>a</sup>	28.92 <sup>ab</sup>	0.95

<sup>a, b, c</sup> means at the same row with different superscript are significantly ( $P<0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil, ALT: Alanine Transaminase, AST: Aspartate Transaminase, ALK: Alkaline Phosphatase, GGT:Gamma-Glutamyl Transferrase

The obtained results of AST, ALT and ALP activity in blood serum of ewes demonstrated that there were significant ( $P<0.05$ ) decreases for T1 compared to other treated groups (Table 11). Ibrahim (2015) reported that ewes given ginger extract have higher AST and lower ALT than control. On the other hand, Kholif *et al.* (2012) mentioned that no significant effects of adding ginger on the activity of AST and ALT enzymes were recorded.

**Lamb's performance:**

Birth and weaning weights of kids are present in Table (12). The birth weight of lambs didn't appear any significant differences and ranged from 3.34 to 3.82 for T3 and T1, respectively. Generally, birth weight of lambs is affected by different factors such as year of birth, sexing, maternal litter size (Gardner *et al.*, 2007) and other such as body condition score of dams, previous nutritional status of ewes.

Also, the weaning weight was insignificant among groups. But weaning weights for T2 and T3 groups (rations with GP) were over than T1 by 12.0 and 24.5%, respectively. While the lowest weaning weights recoded by T1 and T4. This variation may be due to variation in milk production as shown in Table (4).

**Table (12): Effect of tested rations on birth, weaning weight and daily gain.**

Item	Experimental group				±SE
	T1	T2	T3	T4	
Birth weight (Kg)	3.82	3.69	3.34	3.73	0.10
Weaning weight(Kg)	12.59	14.10	15.67	12.68	0.55
Total gain (Kg)	8.77 <sup>b</sup>	10.41 <sup>ab</sup>	12.33 <sup>a</sup>	8.94 <sup>b</sup>	0.54
Average daily gain(gm.)	125.40 <sup>b</sup>	148.76 <sup>ab</sup>	167.21 <sup>a</sup>	127.67 <sup>b</sup>	0.35

<sup>a, b</sup> means at the same row with different superscript are significantly ( $P < 0.05$ ) different. T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

Higher weaning weight of ewe fed ginger powder levels (T3 and T2) reflected on total gain and average daily gain. Hence, T3 and T2 ewes varied significantly and exceeded their counterparts of control group by 40.5 % and 18.7 % (for total gain), 33.3 % and 18.6 % (for average daily gain), respectively, compared with control ones. These findings may be due to that ginger increased the absorption of essential nutrients for ewes and reflected on improving the growth of the kids (Belewu, 2006) or higher milk production in the same groups as presented in Table (4). It is little known about the effect of adding ginger forms on offspring birth weight and daily weight gain from birth to weaning.

Commonly, the observed data of average daily gain was within the normal range on Barki lambs weight observed by Ibrahim *et al.* (2018) and El-Bassiony (2016) being 173 and 157 g/h/d respectively. Also, Nassar *et al.* (2017) reported that minimum average daily gain for the same breed was 105g/h/d. The results of the present study revealed that addition of ginger products had a positive effect on growth performance of lambs.

**Economical Evaluation:**

The obtained findings revealed that the best feed conversions expressed as DMI/gain were recorded for T3 followed by T2 then the worst by T4. Also, the best milk conversion expressed as litter suckling milk /kg gain were better for experimental ration than control group (Table 13).

It was worthy to mention that T3 was the cheapest feed cost per kg gain. This result may be due to higher gain of the animals of this group compared with others, while T4 showed the highest feeding cost as a result of the price of GO and the lowest total gain.

**Table (13): Feed efficiency and economical evaluation of ewes during lactation periods.**

Item	Experimental group			
	T1	T2	T3	T4
Feed conversion				
Kg DMI/litter milk	2.57	2.44	2.40	2.80
Litters of suckling milk/kg gain	4.35	3.48	3.56	3.85
Daily feed and additives cost LE/h/d				
Roughage	2.49	2.27	2.33	2.51
CFM	3.15	2.88	2.94	3.17
Ginger powder	0	0.21	0.42	0
Ginger oil	0	0	0	4.00
Total cost	5.65	5.36	5.69	9.68
Price of ADG	8.78	10.41	11.70	8.94
Return from selling ADG	3.13	5.05	6.01	-0.74
Feed cost / kg gain	45.06	36.03	34.03	75.82
Return from selling kg gain	24.94	33.97	35.97	-5.82
Net revenue as %	100	136	144	-23

T1: control ration, T2: control ration plus 3 gm. of GP/h/d, T3: control ration plus 6 gm. of GP/h/d, T4: control ration plus 2 ml/h/d of ginger oil.

Besides, the obtained resulted demonstrated that the highest feed cost.kg gain was recorded for T4 due to higher price of GO (2000 LE/L), however, the obtained gain in live weight didn't cover this cost. On the

other hand, the ration of control group (T1) (without any additives) had lower feed cost but it also had lower in total gain. Subsequently, higher price of GO reflected on the profit from gain and led to negative return from selling live weight and the highest gain in T3 and T2 led to higher the profit. The present results are in accordance with Hameed *et al.* (2012) who found that higher net revenue for treated cows (50 gm. GP/h/d) by 25% than untreated cows.

## CONCLUSION

From the previous data it can be concluded that addition of ginger powder could be used to improve milk production, and its positively effect on milk fatty acids, had positive effects on blood parameters, improve the immunity of animals, led to higher total and average daily gain and increase the net revenue for farmers. However, a lot the nutritional effects of ginger (meat production and carcasses) need to be validated using proper studies.

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## تأثير إضافة مسحوق الزنجبيل أو زيت الزنجبيل على الأداء الانتاجي للنعاج خلال فترة الرضاعة

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قسم تغذية الحيوان والدواجن - شعبة الإنتاج الحيواني والدواجن - مركز بحوث الصحراء - المطرية - القاهرة - مصر .

أجريت هذه الدراسة في محطة بحوث مريوط التابعة لمركز بحوث الصحراء وذلك بهدف دراسة تأثير إضافة الزنجبيل (مسحوق أو زيت) على الأداء الإنتاجي وقياسات الدم والكرش للنعاج البرقي خلال فترة الرضاعة . تم تغذية عشرة نعاج في كل مجموعة تتراوح أعمارها من 3-4 سنوات في فترة الثلث الأخير من الحمل (وزن الجسم 40,47 كجم  $\pm$  0,99). غذيت النعاج على مخلوط العلف المركز ودريس البرسيم الحجازي. قسمت النعاج بالتساوي لأربع مجموعات تجريبية، المجموعة الأولى: غذيت على عليقة المقارنة بدون أى إضافة، المجموعة الثانية: غذيت على عليقة الكنترول مضافا إليها 3 جم مسحوق زنجبيل/رأس/يوم، العليقة الثالثة: غذيت على عليقة الكنترول مضافا إليها 6جم مسحوق زنجبيل/رأس/يوم في حين تغذت نعاج المجموعة الرابعة على عليقة المقارنة مضافا إليها 2 ملى زيت زنجبيل/رأس/يوم. تم تقدير محصول اللبن كل أسبوعين لعمل التحليل الكيماوى له، وأخذت عينات سائل الكرش والدم في منتصف فترة الحليب لعمل التحليلات اللازمة.

أظهرت النتائج عدم وجود اختلافات معنوية لكلا من التغير في وزن النعاج خلال فترة التجربة وكذلك للمأكول الكلى. أظهرت نتائج تقدير محصول اللبن وجود اختلافات معنوية ( $P<0.05$ ) نتيجة اضافة الزنجبيل (مسحوق أو زيت) أثناء مرحلة الحليب المبكرة. سجلت المعاملة الثانية أعلى محصول لبن مقارنة بباقي المجموعات ، في حين سجلت مجموعة المقارنة أقل محصول لبن . نتائج تحليل اللبن أظهرت اختلافات ( $P<0.05$ ) معنوية فقط في كلا من نسبة دهن اللبن والجوامد الكلية وسجلت المجموعة الثانية أعلى قيم في مكونات اللبن مقارنة بباقي المجموعات. أدت التغذية على إضافات الزنجبيل الى نقص محتوى اللبن من الأحماض الدهنية المشبعة في حين زاد محتواه من الأحماض الدهنية غير المشبعة.

أظهرت قياسات الكرش إختلافات معنوية ( $P<0.05$ ) فقط في كلا من تركيز الأمونيا وتعداد البروتوزا والتي كانت أقل في المجموعة الرابعة (2 ملى زيت زنجبيل/رأس/يوم) مقارنة بباقي المجموعات. سجلت قياسات الدم إختلافات معنوية بين المجموعات، وسجلت المجموعة الثالثة أعلى قيم لكلا من البروتينات الكلية والجلوبولين، ومن ناحية أخرى سجلت أقل قيم لكلا من الليبيدات الكلية والجليسيريدات الثلاثية.

أداء المواليد (وزن الميلاد والفظام) لم يظهر أى إختلافات معنوية بين المجموعات، في حين سجلت مجموعتى مسحوق الزنجبيل أعلى زيادة وزنية مقارنة بباقي المجموعات. أظهرت بيانات التقييم الإقتصادي أفضلية المجموعة الثالثة (6 جم مسحوق زنجبيل/رأس/يوم) من حيث معامل التحويل وصافي الدخل للمزارعين في حين كانت المجموعة الرابعة هي الأسوأ. لذا توصى الدراسة باستخدام مسحوق الزنجبيل في علائق الأغنام لما لها من تأثيرات ايجابية على أداء الحيوانات.