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Effects of Organic Minerals Mixture Supplementation on Performance and Immune Status of Goats and Their Kids

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Abstract
The present study was carried out to investigate the effects of some organic minerals mixture supplementation during late gestation on the performance and immune status of Egyptian goat breeds and their kids. Animals (n=54) were assigned into three groups (18/group). The first group was kept as control. 2nd group was supplemented with organic mineral mixture plus starch. 3rd group was supplemented with organic mineral mixture plus bran. The results illustrated that birth weight, rectal temperature and weaning weight of kids supplemented group with mineral mixture plus bran were significantly high in compared to those of the control group. Similarly, kids of the 2nd group had significant higher rectal temperature than those of the control group. In addition, the serum globulin levels of goats in 2nd and 3rd groups were significantly higher than control group. These results suggested that supplementation of pregnant goats with organic minerals improved their immune status and their kids' performance.

1. Introduction

Trace minerals, needed in minute quantities, are essential nutrients for animal growth, reproduction and immunity. However, trace elements deficiency among ruminants is common. In addition, neonatal mortalities are associated with trace elements deficiencies [1].

Trace minerals are supplemented in the diet of the animals in two forms: inorganic and organic salts. Organic minerals have higher retention rate and relative bioavailability than their inorganic forms in kids [2] and lambs [3, 4]. In addition, the bioavailability of Zn and Cu from their methionine form was 133 and 151% relative to that of zinc sulphate in ewes [5].

Supplementation of animals with organic minerals enhances their growth and reproductive performances [6, 7] while it decreases mortality of newborn calves [8, 9]. Zn-methionine supplementation improves growth rate and body weight of lambs [3]. Moreover, Zn proteinate has higher immune response in lambs [10].

Inclusion of Cu, Mn and Zn as chelated in cow's ration enhances their immune response [11] and increases total immunoglobulin levels in their colostrum [12, 8] and

serum of newly born calves. Improvements in immune response in the organic mineral groups are also noted in poultry [13] and rams [14]. Therefore, the present study was carried out to investigate the effect of some Organic mineral mixture supplementation during late pregnancy on the performance and immune state of goats and their kids.

2. Material and Methods

This study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Ministry of Agriculture, Kafr El-Sheikh Governorate, Egypt.

2.1. Animals and Management

Fifty-fourpregnant goats were included in this study. Goats were allotted to 3 equal experimental groups of 18 animals each. Goats of each group were housed all together in a semi-covered large pen (6m ×20m).

These goats were given free access to green fodder (Trifolium Alexandrium) during the green season, hay in the dry one and fresh drinking water. Concentrate mixture (corn grains 45.3%, decorticated cotton seed 11%, soya bean meal 12%, wheat bran 29%, limestone 1.8%, 0.22% sod. bicarbonate, 0.4 common salt, 0.28% mineral mixture) containing 15.5% crude protein and 65% TDN was fed to control group and used as a basal diet for the other groups. The basal diet was provided during pregnancy at a rate of 1% of average body weight (500g daily / goat). This amount was increased gradually till reach 2% of average body weight (1000g / goat) at the late stage of pregnancy (last 4-6 weeks).

Kidding occurred in large straw-bedded pens (6 × 9 m), in groups of 10 goat / pen. Goats were transported to these pens 2 weeks before expected kidding date. Pregnant goats were accustomed to observer presence as they were regularly checked for signs of parturition from the outside of pen. They were subjected to continuous observation during the 10-14 days kidding period to ascertain the exact time of birth of each kid. All parturitions occurred naturally without assistant over a period of two months.

2.2. Experimental Design

Mineral mixture that used in this study is consisted of Zinc chelated of methionine 26.5%, Manganese chelated of methionine 17.5%, Copper chelated of methionine 9.2%, Cobalt chelated of methionine 2.5%, calcium carbonate 8.9% as carrier and ground corn cob 35.4% as carrier (Multivita Company, 6th October city, Egypt).

Pregnant does were divided into 3 equal groups. 1st group was kept as control. 2nd group was supplemented with 1.2g of the mineral mixture mixed well with 100g of starch per head per day. 3rdgroupwas supplemented with 1.2g of the mineral mixture mixed well with 100g of bran per head per day. All treatments started one month before kidding till 15 days after kidding.

2.3. Data Collection

Maternal live body weights were recorded before the starting of treatment and at kidding. Kids' live birth weight and kids' rectal temperature were recorded within two hours after birth. Kids weaning weights were recorded at 66 days in average.

Blood samples were collected from does and kids after kidding and serum was collected and frozen at -20°C.

2.4. Biochemical Parameters

Serum levels of total protein, albumin and glucose were estimated by spectrophotometer (Spekol 11, Carl Zeiss Jena, Germany) according to the instructions of manufacture (Diagnostic diamond, Egypt) which referred by [15]. Serum globulin levels were calculated as the difference between total protein and albumin levels.

2.5. Statistical Analysis

Difference between treated and control groups for does and kids performance were subject to analysis of variance (ANOVA) and where significant differences were observed, means were further subjected to Duncan's multiple range. Most of data that collected from all treatment groups were compared to control group as well as total protein, albumin, globulin and glucose concentrations. The statistical package used for all statistical analysis was SPSS for Windows: 10.1, SPSS Inc. (1999). The results were expressed as LSmeans ± SE and considered as significant when P-values less than 0.05 and 0.01.

3. Results

The present study showed that dietary supplementation of organic mineral mixtures for does during late stage of pregnancy had no significant improving effect on final body weights or body weight changes (P>0.05) between goats of all treated groups and control group (Table 1). Dams supplemented with mixture of organic minerals plus bran or starch showed higher serum globulin levels than dams of untreated group. Moreover, pregnant goats supplemented with organic mineral mixture plus bran have increased significantly total protein at kidding in compared with goats supplemented with organic mineral mixture plus starch and untreated groups as showed in Table 2.

Table 1. *Effect of organic minerals mixture supplementation on dam body weight (BW, kg).*

Items	Control	OM+B*	OM+S**	*P*
Initial BW	37.58 ± 2.59	38.42 ± 2.59	34.50 ± 3.67	NS
Final BW	33.08 ± 2.59	32.83 ± 2.59	29.33 ± 3.66	NS
Changes BW	4.50 ± 0.87	5.58 ± 0.87	5.17 ± 1.23	NS

*OM+B: Organic minerals mixture plus bran.**OM+S: Organic minerals mixture plus starch. NS: Non significant

Table 2. *Effect of organic minerals mixture supplementation on serum total protein (TP), albumin (Alb) and globulin (Glob) of pregnant goats at kidding.*

Items	Control	OM+B*	OM+S**	*P*
TP (g/dl)	5.51 ± 0.29^{b}	6.52 ± 0.21^{a}	6.13 ± 0.20^{ab}	0.01
Alb (g/dl)	2.81 ± 0.15^{a}	2.81 ± 0.11^{a}	2.10 ± 0.10^{b}	0.001
Glob (g/dl)	2.70 ± 0.32^{b}	3.70 ± 0.23^{a}	4.06 ± 0.22^{a}	0.01

*OM+B: Organic minerals mixture plus bran. **OM+S: Organic minerals mixture plus starch.
The values marked with different letters (a–b) in the same row are significantly different.

Organic minerals mixture supplementation for does during late stage of pregnancy had positive significant effect on the birth weight of their kids. As kids born from goats supplemented with organic minerals mixture plus bran showed higher birth weight than kids born by control goats (3.24 ± 0.23, 1.99 ± 0.21 kg, respectively, P=0.001). However, goats fed an organic minerals mixture plus starch produced kids tends to be significantly heavier in compared to those born by control goats (2.64 ± 0.30, 1.99 ± 0.21 kg, respectively, P=0.06) as showed in Figure 1.

Kids born from goats fed organic minerals mixture plus bran or starch during late pregnancy had significantly high rectal temperature in compared to kids born from untreated goats (39.06±0.16, 38.73±0.13, 38.40±0.11°c respectively, P=0.01) (Figure 2).

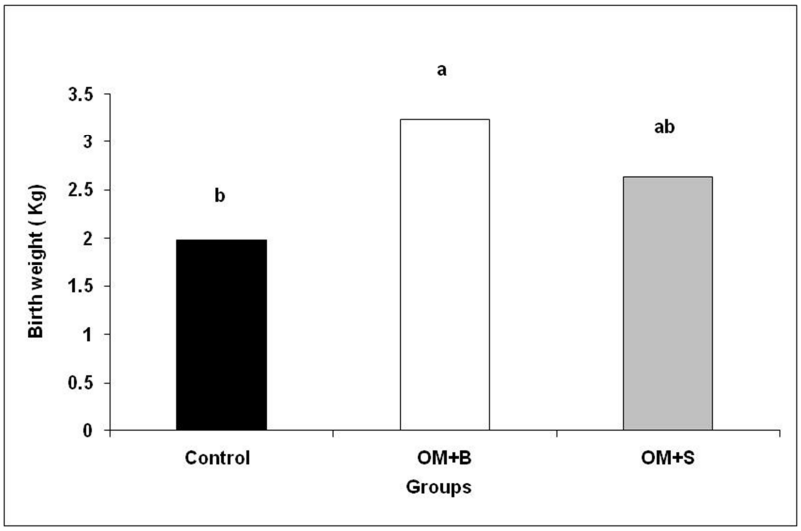

Figure 1. *Effect of supplementation of organic minerals mixture at late stage of pregnancy on birth weight of kids (OM+B: Organic minerals mixture plus bran, OM+S: Organic minerals mixture plus starch, Columns have different letters (a–b) are significantly different at 5% level).*

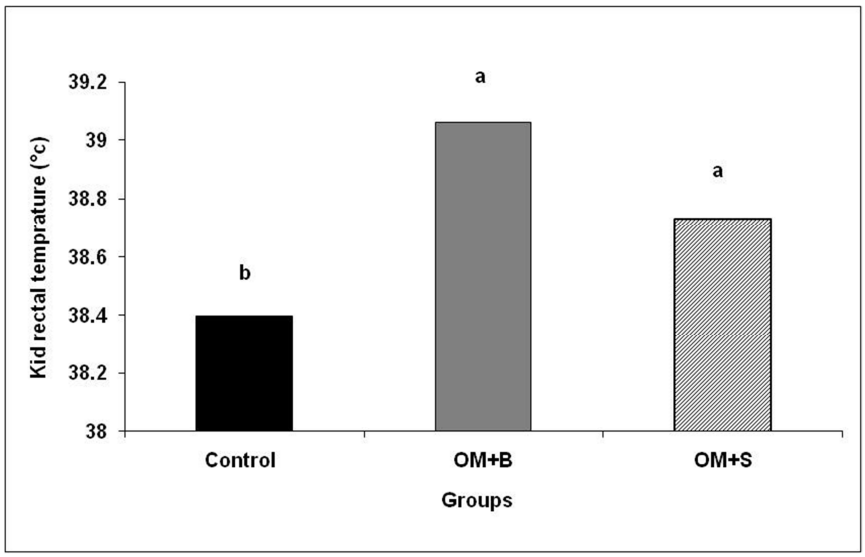

Figure 2. *Effect of supplementation of organic minerals mixtures at late stage of pregnancy on rectal temperature of kids at birth (OM+B: Organic minerals mixture plus bran; OM+S: Organic minerals mixture plus starch, Columns have different letters (a–b) are significantly different at 5% level).*

Weaning weight of kids born from goats supplemented with organic minerals mixture plus bran was higher than kids produced by control goats (10.71±0.70, 8.30±0.59 kg, respectively, P=0.01). In addition, kids born from goats fed with organic minerals mixture plus starch had numerically heavier weaning weight than kids of untreated goats (9.60±0.83, 8.30±0.59 kg, respectively, P>0.05) as mentioned in Figure 3.

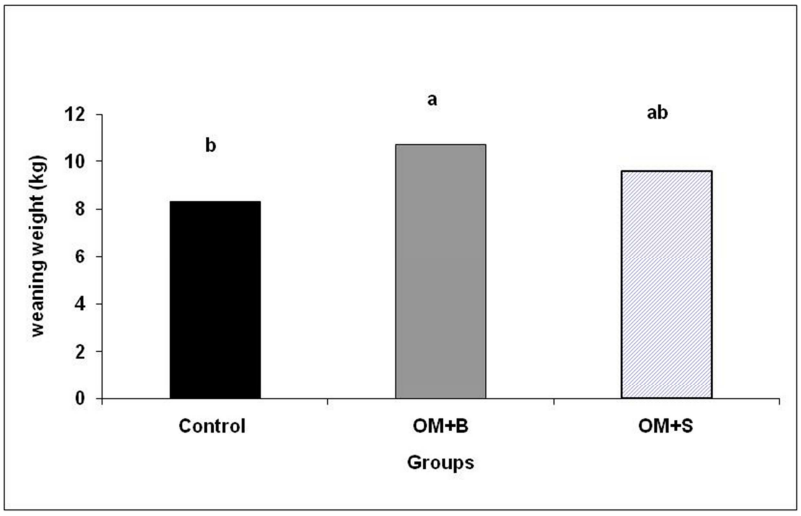

Figure 3. *Effect of supplementation of organic minerals mixture at late stage of pregnancy on weaning weight of kids (OM+B: Organic mineral mixture plus bran; OM+S: Organic minerals mixture plus starch, Columns have different letters (a–b) are significantly different at 5% level).*

No significant differences were recorded in serum total protein and globulin levels of kids between treated and untreated groups. However, albumin level in kids born from goats of control and organic minerals mixture plus bran groups than those fed organic minerals mixture plus starchas showed in Table 3.

Table 3. *Effect of organic minerals mixture supplementation on serum total protein (TP), albumin (Alb) and globulin (Glob) of kids.*

Items	Control	OM+B*	OM+S**	*P*
TP (g/dl)	5.68 ± 0.19	6.04 ± 0.07	5.79 ± 0.42	NS
Alb (g/dl)	2.30 ± 0.07^{a}	2.25 ± 0.12^{a}	1.57 ± 0.16^{b}	0.05
Glob (g/dl)	3.38 ± 0.22	3.78 ± 0.48	4.22 ± 0.33	NS

*OM+B: Organic minerals mixture plus bran. **OM+S: Organic minerals mixture plus starch. NS: Non significant. The values marked with different letters (a–b) in the same row are significantly different.

Table 4. *Effect of organic minerals mixture supplementation on serum total protein (TP), albumin (Alb) and globulin (Glob) of kids in relation to birth rank.*

Groups	Birth-rank	TP (g/dl)	Alb (g/dl)	Glob (g/dl)
	1	6.30 ± 0.36	2.09 ± 0.13^{b}	4.21 ± 0.35^{a}
Control	2	5.57 ± 0.40	2.26 ± 0.14^{ab}	3.31 ± 0.38^{ab}
	3	4.98 ± 0.59	2.60 ± 0.21^{a}	2.37 ± 0.56^{b}
P		NS	0.05	0.01
	1	6.23 ± 0.50	2.04 ± 0.18	4.19 ± 0.48
OM+B*	2	5.78 ± 0.59	2.55 ± 0.21	3.22 ± 0.56
	3	5.12 ± 0.65	2.40 ± 0.23	2.72 ± 0.62
P		NS	NS	NS
	1	6.43 ± 0.46	1.71 ± 0.17	4.71 ± 0.45
OM+S**	2	5.34 ± 0.59	1.34 ± 0.21	4.00 ± 0.56
	3	5.07 ± 0.66	1.57 ± 0.24	3.49 ± 0.63
P		NS	NS	NS

*OM+B: Organic minerals mixture plus bran. **OM+S: Organic minerals mixture plus starch. NS: Non significant. The values marked with different letters (a–b) in the same column are significantly different.

In relation to birth rank, first born kids had high levels of serum globulin in compared to third ones in control group. Furthermore, serum globulin concentrations in second born kids were numerically higher than third kids. On contrary, level of albumin was significantly higher in the third kid born from untreated group than first one (P=0.05). On the other hand, there were no significant differences in serum total protein, albumin and globulin levels amongfirst, second and third born kids that born from treated goats with dietary organic minerals mixture supplementations(P>0.05, Table 4).

The first kids born by goats supplemented with organic minerals mixture plus starch had significantly higher serum glucose level than other kids produced by other goats that either treated with organic minerals mixture plus bran or untreated. In the same time, there were no significant differences between all groups in both second and third kids (P>0.05). Also, within the kids of organic minerals mixture plus starch group there were significant increase in glucose level in serum of first born kids than second ones as in Table 5.

Table 5. *Effect of organic minerals mixture supplementation on serum glucose (mg/dl) of kids in relation to birth rank.*

Birth rank	Control	OM+B*	OM+S**	P
1	92.58 ± 6.04^{b}	100.31 ± 5.51^{ab}	113.98 ± 5.10$^{a\ A}$	0.01
2	91.95 ± 6.04	104.51 ± 6.04	88.23 ± 6.04^{B}	NS
3	100.56 ± 7.78	101.51 ± 6.04	95.30 ± 9.55^{AB}	NS
P	NS	NS	0.01	

*OM+B: Organic minerals mixture plus bran. **OM+S: Organic minerals mixture plus starch. NS: Non significant. The values marked with different letters (a–b) in the same row and letters (A-B) in the same column are significantly different.

4. Discussion

In general, supplementation of minerals mixture to goats in late pregnancy and extend for 15 days after parturition enhanced immunity of goats and improved kid's birth weight, rectal temperature and weaning weight. In the same time, there are no significant differences between all groups in initial or final goats' body weights or body weight changes.

These results were agreed with Hatfield et al., [16] and Garg

et al., [3] who reported that late gestation and early lactation supplementation of Zn methionine improved growth rates and body weights in lambs as well as lamb weaning weight. Similarly, supplementation of Zn during late gestation and early lactation to cows and their calves improved calf weaning weight but did not affect cow weight change [17]. Therefore, the high performance of the kids in this study may be attributed to Zn supplementation in the mineral mixture or the collective role of Zn, Mn, Cu and Co [18].

However, the present findings were disagreed with [19] who found that no significant difference in body weight gain and feed/gain among lambs treated with different levels of zinc. In addition, supplementation of steers with cobalt had no effect on their performance [20].

In the present study, supplementation of minerals mixture plus wheat bran had significant effects on birth and weaning weights of kids in comparison with minerals mixture plus starch. Wheat bran is quite palatable, and is well known for its ability to prevent constipation because of its swelling and water-holding capacities. Bran has a high capacity to absorb water and swell, because of its fiber and non-starch carbohydrates [21]. Also, wheat bran has a bulk effect in the colon, giving it laxative properties [22]. Consequently, enhanced performance of kids that born from goats fed minerals mixture plus bran in late pregnancy and lactation may be attributed to digestible characters of wheat bran. This may explain why wheat bran is better than starch when adding with minerals mixture.

The current study reported that supplementation of goats with organic mineral mixture with bran or starch at late gestation till 15 days after kidding increased serum globulin levels significantly in goats and numerically in their kids. Increasing of the goats' serum globulin level may be attributed to the role of the trace mineral content (zinc 26.5%, Manganese 17.5%, Copper 9.2% and Cobalt 2.5%) because Zinc finger proteins play an important role in immune function [23, 24, 25] and Copper may regulate immune function [26]. Regardless the species, E. van Heugten, et al. [27] indicated that the requirement of Zn to optimize certain aspects of the immune system in swine may be greater than that necessary for growth performance, as suggested by improved macrophage function with the addition of Zn. Therefore, administration of zinc (26.5%) might improve the birth weight, rectal temperature and weaning weight faster than immune response which, need more time or high dose. Additionally, manganese may be added to the list of trace minerals enhancing immunity [28]. However, Grace [29] found that feeding sheep pellets with Mn concentrations 400 mg/kg dry matter decreases daily weight gains by about 40%. This difference may be attributed to high dose of Mn in compared to low dose of Mn in mineral mixture in present study.

Another best finding in this study was the improvement effect of minerals mixture supplementation on birth rank of kids. It was obvious that first kids born by goats in control group had higher serum globulin concentrations in compared with second and third born kids. But supplementation of minerals mixture for dams enhanced immune status of second and third born kids in comparison with first one. This may be attributed to improvement of immunity of dams as a result of increasing of globulin levels in minerals mixture supplemented groups. Furthermore, first kids born by goats supplemented with organic minerals mixture plus starch had higher significantly glucose level compared to kids born by goats supplemented with organic mineral mixture plus bran and control groups. This may be attributed to dietary administration of starch increases energy by enhancing glucose blood level [30].

5. Conclusion

In conclusion, dietary supplementations of goats with organic minerals mixtures in late pregnancy improved the maternal immunity and neonatal rectal temperature, birth and weaning weights. Additionally, supplementation of minerals mixture for dams had superior effect on immune status of second and third born kids in comparison with first ones.

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