

Effects of Diets Containing Humic Acid on the Milk Yield, Milk Composition and Blood Metabolites in Saanen Goats

Taskin Degirmencioglu

Department of Animal Health and Husbandry, Uludag University Karacabey Vocational School, Karacabey-Bursa, Republic of Turkey

Abstract: In this research, the effect of diets containing humic acid at different levels on the some blood and milk compositions in Saanen goats were determined. Eighteen Saanen goats (2 old, 52 kg live weight) were fed three diets, containing 0 g kg⁻¹ humic acid (T₁), 1 g kg⁻¹ humic acid (T₂) and 3 g kg⁻¹ humic acid (T₃) in a 3×3 Latin square design experiment. Each period consisted of 21 days of an adaptation phase and 7 days of a sample collection phase. Blood and milk samples were collected at the end of sample collection periods. Total DM intake values were found 1.73, 1.74 and 1.79 kg day⁻¹ for goats fed for T₁-T₃, respectively. It was determined that diet T₃ had much higher (p<0.05) milk yield than did the T₁ (milk yield = 2.45 and 2.11 kg day⁻¹, respectively) and this yield was similar to that of diet T₂ (2.37). However, humic acid did not improve milk fat, non-fat milk solids, milk protein or lactose content. Humic acid application significantly reduced the total cholesterol in blood (p<0.05; 124.1, 100.8 and 102.2 mg dL⁻¹) for T₁-T₃, respectively. LDL cholesterol levels of blood serum were determined as 23.49, 15.14 and 16.19 mg dL⁻¹, respectively, (p<0.05). Further investigation is required to elucidate the effects of humic acid on goat performance.

Key words: Humic acid, goat, milk composition, blood metabolites, cholesterol

INTRODUCTION

Farm animals of modern breed have a considerable genetic potential to produce high amount of milk. For feed quality feed additives play an important role to sustain milk yield and to prevent and control diseases (Islam *et al.*, 2005). Antimicrobial feed additives are world wide used so far in animal husbandry to improve the economy and ecology of animal production by increasing growth rate, decreasing feed expenditure per gain and diminishing the risk of disease (Hays, 1981). But the unavoidable spread of bacterial resistance and cross-resistance to antibiotics used in veterinary and human therapy (Barton, 1998; Khachatourians, 1998) increasingly considered as a hazard, therefore the approval of antimicrobial growth promoters will be phased out by EU legislation by the end of 2005.

Among many alternatives Humic Acids (HA) are described. Humic acids or humus can be defined as the end product of the decomposition of organic matter by aerobic organisms. Humic acid is a long chain molecule which is high in molecular weight, dark brown and is soluble in an alkali solution (Stevenson, 1982). The idea of using humates as feed additives in animal nutrition is new. Humic acids stabilize the intestinal microflora, ensuring an improved nutrient utilization and feed efficiency (Pisarikova *et al.*, 2010). The use of humic acid in ruminants makes sense in that it promotes rumen

microbial growth as it does in the soil. Thus, increasing rumen microbial population which is conducive for nutrient digestion.

The milk yield-increasing effects were mainly investigated in dairy cows. The positive effect of humic acid on milk production, milk fat and protein of dairy cows was reported by Thomassen. Another study had shown that the use of HA as animal feed supplement leads to increased milk production and increased butterfat percentage in dairy cows. Furthermore, the weaning weights increased and faster weight gains were observed in dairy cows while problems with scours greatly decreased (Livestock, 2003). Tunc (2007) showed that diets supplemented with 0.0, 0.1, 0.2 and 0.4% humate (Bovifarm) significantly decreased the serum cholesterol and the LDL levels in the serum of sheep.

The objective of the present study was to investigate the effect of natural humic acid on performance, the milk yield and blood metabolites in Saanen goats fed diets containing humic acid at different levels.

MATERIALS AND METHODS

The study was conducted at a special goat farm where located in Karacabey. The humic acid material used for study was purchased from the Natural feed Company.

Goats were grouped primarily on milk yield prior to the start of treatment (Table 1). Eighteen Saanen goats (2 old, 52 kg live weight) were used in a replicated 3×3 Latin square design. Periods lasted 30 days in which the 1st 3 weeks were used for adaptation with data for statistical analysis being collected in the 4th week. Thus, total experimental period lasted for 90 days.

In each of the three periods, goats were randomly assigned to one of three dietary treatments (DM basis; Table 2). T₁ diet with no Humic Acid (HA); T₂ diet with 1.0 g HA kg⁻¹; T₃ diet with 3.0 g HA kg⁻¹. During the treatment period all goat received *ad libitum* pasture, corn silage (1 kg day⁻¹), alfalfa (500 g) and 0.50 kg experimental diets (per 1.0 kg of milk day) (T₁-T₃) (225, 224 and 220 g CP kg⁻¹ DM and 2617, 2630 and 2613 ME (kcal kg⁻¹)). Goat ration was formulated to 2.90 kg day⁻¹ of milk production with 3.5% fat and 3.5% protein in 2nd lactation according to the NRC recommendations. The quantity of HA added to diet was determined after reviewing multiple references Tunc (2007).

The animals were milked twice daily at 6:30 am and 7:30 pm milk production for each goat was measured

Table 1: Basic information of examination goat $\bar{x} \pm s_x$

Groups	Number of goats	Live weight (kg)	Days in milk	Milk production (kg day ⁻¹)
Control T ₁	6	51.10±3.298	60.33±4.177	2.90±0.209
Treatment T ₂	6	54.15±4.059	65.50±6.339	2.96±0.242
Treatment T ₃	6	49.20±3.769	69.00±1.291	2.98±0.243

Table 2: Composition of feed mixtures and roughages for Saanen goat

Compound	Diet			Roughages	
	0 Humic acid (T ₁)	1 Humic acid (T ₂)	3 Humic acid (T ₃)	Alfalfa hay	Maize silage
Barley	400.0	399.0	397.00	-	-
Wheat	340.0	340.0	340.00	-	-
Soya-bean meal	140.0	140.0	140.00	-	-
Sunflower meal	100.0	100.0	100.00	-	-
Humic acid	-	1.0	3.00	-	-
Marble powder	14.0	14.0	14.00	-	-
Salt	5.0	5.0	5.00	-	-
Vitamin + minerals ¹	1.0	1.0	1.00	-	-
Total	1000.0	1000.0	1000.00	-	-
Nutrient composition (g kg⁻¹)					
Dry matter	903.0	900.9	901.00	890.0	368.2
Organic matters	821.8	814.5	809.20	778.6	350.0
Crude protein	225.3	224.7	220.10	195.7	29.8
Crude fat	35.2	34.6	33.30	28.5	13.7
Cellulose	106.8	101.4	101.80	247.2	76.7
Crude ash	81.2	86.4	91.80	111.4	18.2
Nitrogen free ext.	454.5	453.8	454.00	307.2	229.8
Starch	169.2	168.2	167.00	-	-
NDF	301.5	303.6	300.80	353.6	150.5
ADF	139.1	140.1	138.79	294.3	91.8
ME (kcal kg ⁻¹)	2617.0	2630.0	2613.00	1864.0	912.0
NEL (kcal kg ⁻¹)	1531.0	1544.0	1527.00	1135.0	525.0

Trace minerals and vitamins (per kg): 150 mg of ZnSO₄·7H₂O, 80 mg of MnSO₄·H₂O, 200 mg of MgO. About 5 mg of CuSO₄·7H₂O, 1 mg of KIO₃, 5000 IU Vitamin A, 1000 IU Vitamin D and 20 IU Vitamin E

daily. But It was not determined the individual consumption of roughage as a reason of applying of group feeding in study. The content of dry matter, organic matters, crude protein, crude fat and ash in the diets were analyzed by methods Helrich (1990). Neutral Detergent Fiber (NDF) and Acid Detergent Fibers (ADF) values were determined using methods outlined by Robertson and van Soest (1981). The SNF, fat, protein and lactose contents of milk were analyzed using a Milcosan FT-120 device. The blood samples taken 2 h post feeding at the end of each period were allowed to coagulate in the tubes and 2800 rpm. The total protein, glucose, triacylglycerol, total cholesterol, LDL cholesterol and HDL cholesterol were analyzed in blood serum using a Siemens dimension biochemistry device.

Data were analyzed as a 3×3 Latin square design trial using SPSS (1998). The linear model included the effect of goat, period and diet.

RESULTS AND DISCUSSION

Chemical composition of the diets and alfalfa hay and maize silage was shown in Table 2. Dry Matter (DM), Crude Protein (CP) and ME values were similar for diets T₁-T₃, however, crude ash content in diet T₁ was lower than those of diets T₂ and T₃. There was little difference in chemical composition of All diets. The effects of the treatments on food intake, milk yield and composition and blood metabolites were shown in Table 3. The yields in milk (kg day⁻¹) were higher (p<0.05) for goats fed the T₃ diet than for goats fed the T₁ and T₂ diets.

Table 3: The effects of humic acid containing diets on live weight, DM intake, milk yield and composition and blood metabolites of goats

Diet	Control			SEM	p-value
	Humic acid (g kg ⁻¹ feed)	1 (T ₂)	3 (T ₃)		
Live weight (kg)	52.530	52.180	52.260	0.520	-
Silage DM intake (kg day ⁻¹) ¹	0.387	0.394	0.405	-	-
Alfalfa DM intake (kg day ⁻¹) ¹	0.449	0.448	0.490	-	-
Concentrate DM intake	0.903	0.900	0.901	-	-
Total DM intake (kg day ⁻¹) ¹	1.739	1.742	1.796	-	-
Milk parameters					
Milk yield (kg day ⁻¹)	2.110 ⁰	2.370 ^{0b}	2.450 ⁰	0.020	*
Fat (%)	3.550	3.670	3.580	0.070	NS
SNF (%)	8.410	8.300	8.580	0.030	NS
Protein (%)	3.730	3.600	3.920	0.040	NS
Lactose (%)	3.820	3.830	3.770	0.030	NS
Blood parameters					
Total protein (g dL ⁻¹)	7.860	7.820	7.590	0.020	NS
Glucose (mg dL ⁻¹)	40.500	40.220	35.940	0.491	NS
Triacylglycerol (mg dL ⁻¹)	33.610	33.400	36.520	0.560	NS
Total cholesterol (mg dL ⁻¹)	124.100 ⁰	100.800 ⁰	102.200 ⁰	1.454	*
LDL cholesterol (mg dL ⁻¹)	23.490 ⁰	15.140 ⁰	16.190 ⁰	0.529	*
HDL cholesterol (mg dL ⁻¹)	79.830	77.560	86.440	0.876	NS

¹SEM not applicable to this treatment and also these DM intake values for goat were not added to pasture consumed; SEM = Standard Error Mean, ^{a,b}Significant differences, *p<0.05, NS: Not Significant

Silage, alfalfa and total DM intake were similar for all goats. Percentages of fat, SNF, protein and lactose in milk were not affected by dietary treatment. Humic acid application significantly reduced the total cholesterol in blood ($p < 0.05$; 124.1, 100.8 and 102.2 mg dL⁻¹) for T₁-T₃, respectively. LDL cholesterol levels of blood serum were determined as 23.49, 15.14 and 16.19 mg dL⁻¹, respectively ($p < 0.05$). There was no significant difference in serum total protein (g dL⁻¹), glucose (mg dL⁻¹), triacylglycerol (mg dL⁻¹) and HDL cholesterol levels.

The effects of the diets with 0, 1.0 and 3.0 g HA kg⁻¹ on live weight for goats were tested. No significant changes were noted for live weight and feed intake of goats. These result was in agreement with (Livestock, 2003) who found that HA did not effect the feed intake of dairy cows at the end of the trial and also in agreement with the findings of Vucskits *et al.* (2010) who reported that low or high doses of HA did not effect the feed intake and bady weight in rats. However, McMurphy *et al.* (2011) reported that DMI in holstein steers was decreased for 5.0 and 10.0 g kg⁻¹ HA and increased for 15.0 g kg⁻¹ HA compared to control. Similarly, Chirase *et al.* (2000) demonstrated a similar decrease in intake during the 1st 28 days for cattle fed a lower HA concentration (7.8 g kg⁻¹) vs. a control and increased concentrations (15.6 and 31.2 g HA kg⁻¹).

However, no increase in efficiency was observed for the 56 days period. In the present experiment. The milk yield of groups appeared to be reduced as a result of the late weaning period 60. The milk production of goats increased as the HA dosage of diet increased (Table 3). The daily milk yield of goats fed on diets T₂ and T₃ at the end of the trial was 2.37 and 2.45 kg days, respectively compared with 2.11 kg day⁻¹ for T₁. The differences between the means of diet T₁ and diets T₂ and T₃ were significant ($p < 0.05$). These results were in agreement with Thomassen who found that dietary supplementation of HA at 2.0 g kg⁻¹ significantly increased the milk production of dairy cattle and also in agreement with the findings of a company publication (Livestock, 2003) who reported that the use of HA as animal feed increased milk production in dairy cows. The observed increase in milk yield correlates with the improved utilization of nutrients in animal feed due to the stabilization of the rumen and intestinal flora by HA application. This leads to an increase in milk yield of the animal without increasing the amount of feed given to the animal (HuminTech, 2004).

However, HA had no significant effect on percentages of fat, SNF, protein and lactose in milk. Contrary to these observations, some reports exist to show that HA treatment improved the milk composition (Livestock, 2003). The observed response variance may

be related to several factors, such as forage type, forage to concentrate ratio, feeding strategy, animal differences, the lactation length tested and the source of the HA product.

In the current study, total cholesterol parameters in goats were significantly reduced due to HA supplementation ($p < 0.05$). In the present study, such reductions were determined as 23.11 and 21.42% in treatment groups (T₂ and T₃). This result was similar to that of Banaszkiwicz and Drobnik (1994) found that diets with HA decreased the total cholesterol levels in rats. Similarly, Tunc (2007) reported that total cholesterol values were 60.48, 33.06 and 34.81% in treatment groups. These reported values were higher than the findings. The differences observed in studies can be related to several factors such as nutrition and animal differences. Similar trend was also recorded for LDL cholesterol level. It was found that the diets with HA decreased the LDL cholesterol level in treatment groups (T₂; 15.14 and T₃; 16.19 mg dL⁻¹) than the control (23.49 mg dL⁻¹). Tunc (2007) reported that diets with HA decreased the LDL cholesterol level about 74.75, 24.37 and 42.22% with treatment of three different HA (1.0, 2.0 and 4.0 g HA kg⁻¹). The disorder of the liver can be increase the cholesterol level in blood serum. Long-term application of HA resulted in the stimulation of omithine decarboxylase in overall liver mass (Maslinski *et al.*, 1993). It is also clear that the Ha plays a role in the liver function and protects somewhat from disease (Lotosh, 1991). But the precise modes of action involved are not yet clear and need further investigation. There were no significant differences for means of glucose, total protein and triacylglycerol of blood serum in present sudy ($p > 0.05$; Table 3).

CONCLUSION

Humic acid based diets affected the milk yield but the treatment did not affect milk composition however, it reduced the level of cholesterol in blood serum. Therefore, diet T₃ with 3.0 g HA kg⁻¹ can be offered as alternative method for organic milk production as its feeding did not affect the health of Saanen goats.

REFERENCES

- Banaszkiwicz, W. and M. Drobnik, 1994. The Influence of natural peat and isolated humic acid solution on certain indices of metabolism and of acid-base equilibrium in experimental animals (In Polish). *Roczniki Panst Woweego Zakadu Higieny*, 45: 353-360.
- Barton, M.D., 1998. Does the use of antibiotics in animals affect human health?. *J. Aust. Vet.*, 76: 177-180.

- Chirase, N.K., L.W. Greene, F.T. McCollum, B.W. Auvermann and N.A. Cole, 2000. Effect of bovipro on performance and serum metabolites concentrations of beef steers. Western section. Am. Soc. Anim. Sci. Proc., 51: 415-418.
- Hays, V.W., 1981. The Hays Report: Effectiveness of feed additive usage of antibacterial agents in swine and poultry production. Long Beach, Rachele. Laboratories, Inc. Report, 12476-01,5/81-91.
- Helrich, K., 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Virginia, USA.
- Humintech, 2004. Huminfeed-tierfutterzusätze and veterinar medizien and huminsaure basierende produkte. Humintech®Humintech GmbH, Heerdter Landstr.
- Islam, K.M.S, A. Schumacher and J.M. Gropp, 2005. Humic acid substances in animal agriculture. Pak. J. Nutr., 4: 126-134.
- Khachatourians, G.G., 1998. Agricultural use of antibiotics and the evolution and transfer of antibiotic-resistant bacteria. Can. Med. Assoc. J., 159: 1129-1136.
- Livestock, R. Us., 2003. Field trials on dairy cattle. Enviromate Inc., Boat Club Road, Fort Worth, Texas. <http://www.livestockrus.com/consignments/enviromate/enviromate.htm>.
- Lotosh, T.D., 1991. Experimental bases and prospects for the use of humic acid preparations from peat in medicine and agricultural production. Nauchnye Doki Vyss Shkoly Biol. Nauki., 10: 99-103.
- Maslinski, C., W.A. Fogel and W. Andrzejewski, 1993. An examination of humate stimulated liver functions. Acta Pol. Pharm., 50: 413-416.
- McMurphy, C.P., G.C. Duff, S.R. Sanders, S.P. Cuneo and N.K. Chirase, 2011. Effects of supplementing humates on rumen fermentation in Holstein steers. South African Soc. Anim. Sci., 41: 134-140.
- Pisarikova, B., Z. Zraly and I. Herzig, 2010. The effect of dietary sodium humate supplementation on nutrient digestibility in growing pigs. Acta Vet. Brno, 79: 349-353.
- Robertson, J.B. and P.J. van Soest, 1981. The Detergent System of Analysis and its Application to Human Foods. In: The Analysis of Dietary Fiber, James, W.P.T. and O. Theander (Eds.). Marcel Dekker, New York.
- SPSS, 1998. SPSS/PC+V.2.0. Base manual for the IBM PC/XT/AT and PS/2. Marjia and Morusis, SPSS Inc. 444 N. Michigan Avenue, Chicago, IL, 60611.
- Stevenson, F.J., 1982. Humus Chemistry: Genesis, Composition, Reactions. 1st Edn., John Wiley, New York, USA.
- Tunc, M.A., 2007. The effect of humate on rumen parameters and blood values in sheep. Master's Thesis, Animal Feeding and Nutrition Department of Medicine: Health Sciences, Ataturk University, Turkey.
- Vucsits, A.V., I. Hullar, A. Bersenyi, E. Andrasofszky, M. Kulcsar and J. Szabo, 2010. Effect of fulvic and humic acids on performance, immune response and thyroid function in rats. J. Anim. Phys. Anim. Nutr., 94: 721-728.