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RESEARCH ARTICLE

Effect of purified waste water intake on physiological, growth and health parameters in crossbred (Alpine x Beetal) lactating goats

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Abstract: Present study in goat (*Capra hircus*) was conducted to examine the effect of purified waste water on the physiological responses, health status and growth parameters in comparison to the control group goats maintained on fresh water. The study was carried out in lactating goats maintained at Livestock Research Centre, ICAR-NDRI, Karnal during November to January 2018-19. The dry matter and water intake of the lactating goats non-significantly ($p<0.05$) decreased in the treatment groups as compared to the control group goats provided with fresh water. The different physiological responses (Heart Rate, Respiration Rate and Rectal Temperature) and hematological parameters (TEC, TLC, Hb, PCV, ESR, and DLC) of the goats provided with purified waste water although differed from the control values but the differences were non-significant ($p<0.05$). The growth parameter which included body weight, remained non-significantly ($p<0.05$) different in treatment groups as compared to the control groups. Milk yield in the crossbred lactating goats differed non-significantly ($p<0.05$) in the treatment group as compared to the control group. The parasitological infestation was found to be positive for *Moneizia expansa* and *Giardia sp.* some of the faecal samples of both the groups i.e. control as well as treatment groups. Hence, the purified waste water may be recommended as drinking water to the crossbred lactating goats in the water scarce areas.

Keywords: Goat, Growth, Physiological responses, Water scarcity, Waste water treatment

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Introduction

Livestock are integrated part of agricultural production system of India. Goats are particularly known to be a useful resource for poor people living in the arid and semi-arid regions as they can sustain on scanty and dry forages under extreme climatic conditions meanwhile, other species of livestock often perish in these regions. Majority of the sheep and goat producers in India are from the arid and semi-arid regions, which are characterized by frequent droughts and fluctuating precipitations and the animals reared in these regions are known to face water scarcity and low nutritive feeds (Faroda, 1999). At present, due to climate change water has become a very limiting resource affecting the sustainability of livestock and agriculture (Malley et al. 2009; Tarawali et al. 2011). Therefore, in future days the water availability will become more limited due to the intensified effects of climate change and unpredictable weather resulting in irregular rainfalls (Jaber et al. 2013).

The livestock especially the small ruminants that are adapted to the arid regions have the ability to select high quality forages from the scanty vegetation prevailing in these regions and thus able to maintain a relatively similar basal diet quality during different seasons. These arid adapted animals otherwise reduce their feed intake significantly in extreme dry seasons as the quality and quantity of forage biomass. According to (Alamer, 2006) small ruminants, particularly goats, may stay in a dehydration state for several days when in the summer season they experience water scarcity Adaptability of drought tolerance enables races of sheep and goats to graze far away from watering points even 50 km or further away (Bayer and Feldmann, 2003) for several days and resourcefully exploit irregular desert pastures (Alamer, 2006).Therefore, selection of these drought tolerant animal breeds is very valuable for sustaining the animal production under a progressively challenging environment of water scarcity (Iniguez, 2005).

Limiting water availability to livestock will depress production rapidly and severely, and poor-quality drinking water is often a factor limiting intake. Therefore, the present study was done to investigate if goats may sustain on treated waste water which

fulfills all the drinking standards without being physiologically affected.

Materials and Methods

Geographical location of the study area

The experiments were conducted on the crossbred (Alpine X Beetal) lactating goat present at ICAR-NDRI, Karnal which is situated in Haryana state of India at an altitude of 240 meters above the mean sea level and at 29°42'3" N latitude and 76°59'6" E longitude. The maximum temperature recorded goes beyond 45°C in summers and minimum temperatures drops to 2°C in winters. The average rainfall is about 766 mm.

Experimental animals

Goats used in the study were crossbred (Alpine X Beetal) lactating goats. The average weight of lactating goats was 46.58 kg and those animals which were free from any reproductive, anatomical and physiological disorders were selected. Total twelve lactating female goats (1.5-2 years old), were selected from the Livestock Research Centre, ICAR-NDRI, Karnal. The experimental animals were maintained under proper housing system, provided with wind break curtains and paddy straw concrete flooring, hence the temperature maintained near to their comfort zone. All the studies are carried out under farm conditions of ICAR-NDRI, Livestock Research Centre, from November to January under prevailing management conditions. These lactating goats were further divided equally into two groups, six animals in each group, i.e. control and treatment. The feeding and management practices for both groups were followed as per the feeding standards of Livestock Research Centre, ICAR-NDRI.

Waste water purification for drinking

The waste water from institute's Effluent Treatment Plant (ETP) was collected in 1000 liters capacity container and 1000 grams (1 Kg) powdered aluminium sulfate (industrial alum) was mixed thoroughly and kept for 2 hours for complete coagulation and settlement. After this coagulation, 500 grams powdered activated charcoal (PAC)/ dung cake fresh ash was added and mixed thoroughly. This mixed water was allowed to stand 8-10 hours in the same container and clear water was decanted in another container with simple muslin cloth filter and 250 ml 1% sodium hypochlorite solution was thoroughly mixed in water before use to make it free from biological infections. The obtained purified water was analyzed for different quality parameters for use in livestock drinking purpose. All the parameters were within the range of different national and international drinking water standards like IS: 10500, 2012; APHA and EPA standards). The underground tube well water available at Livestock Research Center (LRC), ICAR-NDRI, was used for control group animals. The underground water was also analyzed for its physical, chemical and microbiological parameters .

Analysis of water parameters

Water temperature, turbidity, total dissolved solids, alkalinity, electrical conductivity, oxidative reduction potential, pH and dissolved oxygen were studied by microprocessor soil and water analysis kit.

Water microbial parameters

Total coliform count was done by the Most Probable Number (MPN) method and total bacterial count was done by Total Viable Count method (TVC).

Water intake

Water was offered twice a day at 9 AM and 3 PM. Quantified water was offered ad libitum to the animals and the leftover water was measured to determine the water intake by calculating the difference between the initial amount of water and leftover amount of water.

Physiological responses of lactating cross bred goats

Rectal temperature (°F) was recorded with a digital thermometer by keeping the thermometer in contact with rectal mucosa for 2 min. Respiration rate was measured by observing the inward and outward abdominal movements in one minute. One inward and outward abdominal movement was counted as one respiration and results were expressed as breaths per min. Heart rate per minute was recorded by placing the stethoscope between the left third and fifth intercostal space and the results are expressed were expressed as beats per min.

Blood sample collection and analysis

Blood samples were collected from the jugular vein of the goats in EDTA vacutainer tubes and then immediately placed in the icepacks and brought to the laboratory. Hemoglobin (%) was measured by using Sahli's hemoglobinometer, TEC was done by using Neubauer's (Hemocytometer) method, PCV (%) was measured by micro-hematocrit method, Total leucocyte count ($x10^3$/ml) as well as DLC (%) were analyzed by the Neubauer's counting chamber and ESR (mm/12hrs.) was studied by Westergren method.

Dry matter (DM) of feed

A measured quantity of feed sample in a dry aluminium tray was taken and placed in hot air oven to dry at 100 ± 5°C for 24 hours. The loss in moisture content after drying was estimated and the dry matter was calculated as follows:

$$DM(\%) \frac{(\text{Wt. of Aluminium tray + sample after drying}) - \text{Wt. of Aluminium tray}}{\text{Wt. of fresh sample taken in Aluminium tray}} \times 100$$

Wt. of fresh sample taken in Aluminium tray

Dry matter intake (DMI)

The dry matter intake (kg/day/animal) of experimental animals were recorded on consecutive two days in a fortnight throughout experimental period, by subtracting residual dry matter from the quantity of dry matter offered.

Body weight

Body weight (kg) was measured by using weighing balance during morning hours.

Milk yield and parasitological examination

Milk yield was recorded at morning and evening in kg/animal/day. Faecal sample were collected at fortnight intervals and examined by the direct faecal examination and cross checked by the concentration method.

Statistical analysis

Statistical analysis of the obtained data was performed using software version (22) of the SPSS system. Statistical analysis of the data was carried out to find mean ± S.E. Independent T-test and paired T-test were done to find out the significant difference between treatments and fortnight intervals. The pair wise comparison of means was carried out using post-hoc Duncan multiple comparison tests.

Results and Discussion

The present experiment was conducted on goat (*Capra hircus*) to study the effect of purified waste water intake on their physiological status, hematological, health and body weight parameters. The results related to change in physiological status, health and growth parameters of crossbred lactating animals have been presented below.

Dry matter and water intake of cross lactating goats maintained on fresh and purified waste water

The samples were taken at fortnight intervals and the values of dry matter and water intake have been presented in (Table 1). In case of control group, the dry matter intake was recorded between 1.55 to 1.71 (kg/animal/day) and water intake ranged between 2.83 to 4.07(liter/animal/day), respectively. Whereas, in the treatment group the dry matter intake and water intake were recorded between 1.49 to 1.60 (kg/animal/day), 2.67 to 3.65 (liter/day/animal), respectively. The values recorded were found to be non-significantly ($p<0.05$) different between the groups.

The water intake in experimental crossbred lactating goats in both control and treatment group was non-significantly different during the experimental period. The water intake (liters/day) was found to be directly related to the dry matter intake (kg/day) by the lactating goats of control and treatment groups. Dry matter intake in crossbred lactating goats showed a decrease in different fortnight. The maximum dry matter intake was reported in first fortnight and lowest were reported in fifth fortnight. There were significant changes in water intake from first to fifth fortnight. The decrease in the dry matter intake may be attributed to characteristics of lactation as the lactation curve advances the milk yield started declining and dry matter required for lactating goats reduced significantly as reported by (Mleil et al. 2011). The water intake and dry matter intake pattern values are in agreement and in range with the

findings of (Ehrlenbruch, 2010 and Francis 2017). The values of milk yield (kg/day) for lactating goats were in agreement with (Mengistu et al. 2007; Thang et al. 2012)

Physiological responses of cross lactating goats maintained on fresh and purified waste water

The mean±SEM values of fortnightly recorded physiological responses in lactating goats presented in (Table 1). The heart rates (beat/min) for control group goats were ranged between 75.67 to 78.33 (beats/min), whereas, in treated group these values ranged between 76.33 to 78.33 (beats/min.) The heart rate (beats/min.) found to be non-significantly ($p<0.05$) different between the two groups. Similarly respiratory rate (breaths/min.) for control group goats ranged between 23.67 to 26.17 and for treatment

Table 1 Mean (±SEM) values of dry matter, water intake, physiological responses, growth parameters in control and treatment groups of cross bred lactating goats

Parameters	Control			Treatment		
Feed intake	Min.	Max	Mean	Min.	Max	Mean
DMI (kg/animal/day)	1.55	1.71	1.61±0.02	1.49	1.60	1.54±0.01
WI (liter/animal/day)	2.83	4.07	3.42±0.10	2.67	3.65	3.16±0.10
Physiological responses						
HR (beat/min)	75.67	78.33	76.60±0.44	76.33	78.33	77.67±0.66
RR (breaths/min.)	23.67	26.17	25.00±0.42	23.83	28.33	25.70±0.60
RT(^{0}F)	100.98	101.67	101.22±0.16	100.77	100.97	101.29±0.16
BW (Kg)	44.42	49.33	46.58±0.64	43.42	46.08	44.68±1.42

Dry matter intake (DMI), Water intake (WI), Pulse rate (PR); Heart rate (HR), Rectal temperature (RT), Body weight (BW); No significant differences were observed between control and treatment groups ($P<0.05$).

group it varied between 23.83 to 28.33 (breaths/min.). The respiratory rate varied non significantly ($p<0.05$) between both the experimental groups. The data on rectal temperature (^{0}F) also varied non-significantly ($p<0.05$) between control and treatment group goats which ranged between 100.98 (^{0}F) to 101.67 (^{0}F) for control group and 100.77 (^{0}F) to 100.97 (^{0}F) in treatment group (Table 1).

In the present study it was found that there were no significant differences in the physiological responses of lactating goats maintained on control (fresh water) and treated (purified waste water) water. The experimental animals were maintained under proper housing system, provided with wind break curtains and paddy straw concrete flooring, hence the temperature maintained near to their comfort zone. The values of physiological responses were within the ranges as reported by (Darcan et al. 2008; Phulia et al. 2010; Mdletshe et al. (2017; Francis, 2017). The treated water was fulfilling all the required standards as per (Dairy NRC, 2001, EPA, 2002) hence no bacterial or parasitic contamination was caused to the experimental animals. The treatment group also remained healthy as that of controlled group in lactating goats. The animals infected with different bacterial infections and ecto/endo parasites may exhibit higher physiological reactions due to different type of biotic stresses as reported by (Akkari et al. 2011; Khayeche et al. 2014; Silva et al. 2015).

Body weight of cross lactating goats maintained on fresh and purified waste water

Mean±SEM values of body weight in crossbred lactating goats maintained on fresh and purified waste water ranged between 44.42 to 49.33 (kg) in control group and 43.42 to 46.08 (kg) in treated group. The difference in body weights of both the groups found to be varied non- significantly ($P<0.05$).

The growth parameters like body weight (kg) of experimental lactating goats of control as well as treated groups showed no

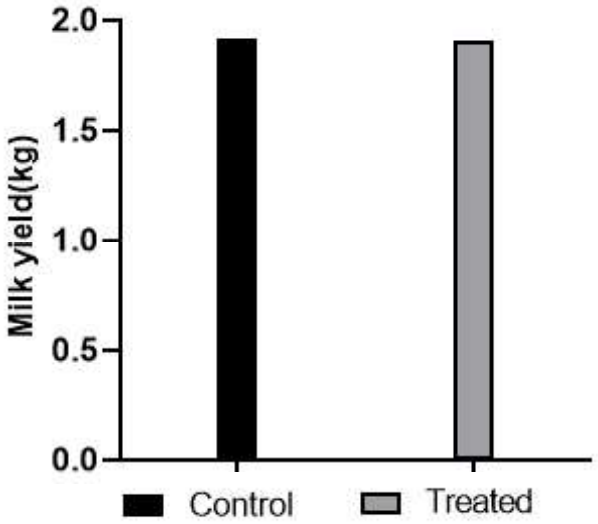

Fig. 1 Milk yield in control and treatment groups of cross bred lactating goats

significant differences. Both the groups were receiving water free from all contaminants and fulfilling all the standards (BIS 1991; Dairy NRC, 2001; EPA, 2002) of drinking water recommended to livestock. The lactating goats receiving purified/ treated water showed a linear pattern in all growth parameters in all five fortnights as that of control group crossbred lactating goats which received fresh water. The growths of crossbred lactating goats of both the experimental groups are in agreement with the findings (Birteeb et al. 2015). The crossbred lactating goats also in both control and treatment group showed normal growth pattern when compared to each other. Similar results were obtained by (Yacout et al. 2015). Hence there was no deleterious effect on the growth parameters of crossbred lactating goats

Heamatological parameters of cross lactating goats maintained on fresh and purified waste water

Table 2 Mean (±SEM) values of hematological parameters in control and treatment groups of cross bred lactating goats

Parameters	Control			Treatment		
	Min.	Max	Mean	Min.	Max	Mean
Hematological parameters						
TEC (million/µl)	16.58	18.81	17.45±0.54	15.63	18.41	17.08±0.48
TLC (thousand/µl)	10.29	13.14	12.08±0.37	11.82	13.45	12.86±0.34
Hemoglobin (%)	7.67	8.00	7.80±0.16	7.41	8.30	7.79±0.13
PCV (%)	28.17	29.97	29.42±0.61	27.95	30.15	29.26±0.48
ESR (mm/12hrs)	0.17	1.00	0.63±0.07	0.33	1.33	0.90±0.08
Differential Leucocyte Count (%)						
Neutrophils,	32.80	36.73	34.96±0.85	33.18	37.25	35.71±0.60
Eosinophils,	1.33	2.33	1.87±0.16	1.83	2.50	2.20±0.13
Lymphocyte	47.72	57.26	52.61±1.33	51.75	55.45	53.89±1.22
Monocyte	1.83	2.33	2.03±0.06	1.67	2.33	1.90±0.06

Total Erythrocyte Count (TEC); Total Leukocyte Count (TLC); Packed cell volume (PCV); Erythrocyte Sedimentation Rate (ESR)

Fig. 2 *Moneizia expansa* egg and *Giardia sp.* cyst found in the faecal sample of crossbred lactating goats

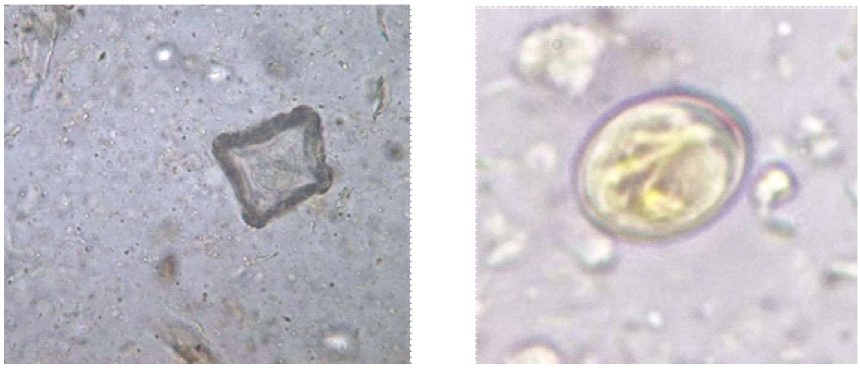

Table 3 Mean (±SEM) values of parasitological status of lactating goats maintained on fresh and purified waste water

Control Sample						Treatment Sample					
1	2	3	4	5		1	2	3	4	5	
Adult/Egg					IR (%)	Adult/Egg					IR (%)
+	-	-	-	-	20	-	-	-	-	-	0
-	+	+	+	+	80	+	+	+	-	+	80
+	-	-	-	-	20	-	-	-	-	-	0
-	-	-	-	-	0	-	-	-	-	-	0
+	-	-	-	-	20	-	+	+	+	-	60
++	+	+	+	+	100	+	-	+	-	+	60

+: presence of *Moneizia expansa* or *Giardiasp.* - : absence of any parasite IR:Infestation Rate

Mean±SEM of hematological values like Total Erythrocyte Count (TEC million/µl)), Total Leucocyte Count (TLC million/µl), Hemoglobin (Hb %), Packed Cell Volume (PCV %), Erythrocyte Sedimentation Rate (ESR mm/12hrs) in control as well as in treatment groups of crossbred lactating goats have been depicted in (Table 2). TEC, TLC, Hb, PCV and ESR, varied non- significantly ($P<0.05$) between both the groups.

The values for DLC (%) in terms of Neutrophils 32.80 to 36.73, Eosinophils1.33 to 2.33, Basophils0.17 to 0.50, Lymphocyte 47.72 to 57.26 and Monocyte (1.83 to 2.33 %) in control group goats. Similarly, the values of these parameters in treatment groups were found to be ranged between 33.18 to 37.25 for neutrophil, 1.83 to 2.50 in eosinophil, 0.17 to 0.50 in basophil, 51.75 to 55.45 in lymphocyte and in monocyte it ranged between 1.67 to 2.33. The group mean for control was 34.96±0.85 in neutrophils, 1.87±0.16 in eosinophils, 0.37±0.09 in basophils 52.61±1.33 in lymphocytes and 2.03±0.06 in monocytes. In treatment group the mean values were found to be 35.71±0.60 in neutrophils, 2.20±0.13 in eosinophils, 0.33±0.10 in basophils 53.89±1.22 in lymphocytes and 1.90±0.06 in monocytes (Table 2).

All the values of DLC parameters between and within both the groups were found to be non-significantly ($p<0.05$) different whereas only the values of lymphocytes were found to be significantly ($p<0.05$) different within the control group.

The haematological parameters like TEC, TLC, Hb, PCV, ESR and DLC of experimental lactating goats of control as well as treated group showed no significant differences. Both the groups were receiving water free from all contaminants and fulfilling all the standards (Dairy NRC, 2001; EPA, 2002) of drinking water recommended to livestock. The haematological parameters of crossbred lactating goats of both the experimental groups are in normal range of as studied by (Upadhyay and Rao 1985; Phulia et al. 2010; Francis et al. 2017). Hence, there was no deleterious effect on the growth parameters of crossbred lactating goats.

Milk yield of cross bred lactating goats maintained on fresh and purified waste water

Mean±SEM values of milk yield of lactating goats in control and treated groups have been depicted in (Fig.1). The Mean±SEM values of milk yield (Kg/day/animal) of lactating goats ranged between 1.75 to 2.07 (kg/day) in control group and 1.82 to 2.13 (kg/day) in treatment group, which were found to be non-significantly ($p<0.05$) different. The group mean for milk yield in control and treated group was 1.92±0.04 (kg/day) and 1.91±0.03 (kg/day) respectively.

Parasitological status of cross bred lactating goats maintained on fresh and purified waste water

The parasitological status of lactating goats has been depicted in (Table 3 and Fig. 2.) For control group five samples of each crossbred lactating goats were collected at fortnight intervals. During the examination of adult/egg (*Moneizia expansa, Giardia sp.*) infestation rate, only six animals were reported infested with

adult/egg of the above-mentioned parasites. Out of six lactating goats from the control and treatment group which received fresh water and purified waste water respectively, three lactating goats were found to be infested with adult/egg (*Moneizia expansa, Giardia sp)*.

The parasitological status of the crossbred lactating goats under control and treatment groups revealed that there were no significant differences in parasitic infestation of *Girordia sp* and *Monezia expansa.* The findings of this study are in agreement with the results observed by (Salem et al. 2011; Khayeche et al. 2014). In the present study, results showed that the purified waste water offered to the treatment groups of crossbred lactating goats was fulfilling all the recommended biological parameters (BIS 1991; Dairy NRC 2001; EPA, 2002). Water recycling experiences prove to be effective and successful in creating a new source of water supply without comprising the livestock health. Recycling waste water and grey water with organic matter is easier than treating the chemical mixed waste water. Water recycling/ purification along with water conservation techniques may help us to sustainably manage our natural resources.

Conclusion

Since the purified waste water has no detrimental effects on productivity of crossbred lactating goats, it may be concluded that the purified waste water offered to lactating goats was fulfilling all the standards of livestock drinking water. Thus, waste water recycling is effective and efficient tool in creating a new source of water supply without comprising animal's welfare and their health status.

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