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Effect of treated waste water intake on physiological responses and growth parameters in crossbred (Alpine x Beetal) kids

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Abstract
Present study was conducted in crossbred (Alpine x Beetal) kids (*Capra hircus*) to study the effect of purified waste water on the physiological responses and growth parameters in comparison to the control group maintained on fresh water. The study was carried out at livestock research centre, ICAR-NDRI, Karnal during January to March 2018-19. There was no significant (p<0.05) change in physiological responses viz. heart rate, respiration rate and rectal temperature of crossbred (Alpine x Beetal) kids provided with purified waste water and control group provided with fresh water. The growth parameters which included body weight, length, height and heart girth also remained non-significantly (p<0.05) different in treatment groups as compared to the control groups. From the observations during the study it can be suggested that the purified waste water provided to the crossbred kids does not have any deleterious effect on their physiological and growth parameters. Further, the purified waste water can be recommended as drinking water to the crossbred kids in the water scarce areas and study also confirm that physio-chemical properties of water are in accordance with the different standards such as Dairy NRC, 2001, EPA 2002 and BIS, 1991.

Keywords: Crossbreed kids, physiological responses, growth, water scarcity, treated water

Introduction
Our earth is known as the "Blue planet" because 70% of its surface is water-covered, but only 2.5% of the world water is fresh and only 1% of it is convenient for use [1]. According to the government survey, only 4% of the global water resources are found in India. It was projected that by 2025 about one third of the population lack enough water for consumption if effective water conservation steps are not taken [2]. A good supply of drinking water is an important element in the production of animals. The absence of an adequate supply of drinking water may be a fundamentally limiting factor in the physiology and productivity of animals [3]. Water sources for goats include drinking water, from food (feeding) and metabolic water by nutrient catabolism and this water is lost continuously in sweat, transpiration, urination and defecation [4]. Reduced availability of water can restrict feed intake and usability, thereby affecting growth, breeding and milk secretion.

In India, animals generally do not have access to good quality water. The main sources of drinking water include ponds, stagnant field water and other contaminated water sources. Under the current scenario, water recycling is the hour-need to meet the growing demand for water in the livestock sector. In order to prevent health issues due to the presence of disease causing organisms and other pollutants, proper treatment of waste water is necessary. Effective treatment of waste water is required to prevent health issues due to microbes and other pollutants causing diseases. Water reuse will save underground water resources, money and reduce the pollution generated by waste water.

Therefore, the present study was done to investigate if goats can sustain on treated waste water which fulfils 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) kids 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.

Management of experimental animals

Twelve crossbred (Alpine x Beetal) kids were selected from the ICAR-NDRI, Livestock Research Centre. The crossbred kids were of 2-3 months old and had an average weight of 11 kg. The kids were free from any reproductive, anatomical and physiological disorders. These kids were further divided equally into two groups, six animals in each group on the basis of their body weight, i.e. control and treatment. Water was offered twice a day at 9 AM and 3 PM i.e., the control group was provided with fresh water for the whole experimental period, whereas treatment group was provided with purified waste water for the whole experimental period. The feeding and management practices for both the group of kids were done as per the feeding standards of Livestock Research Centre, ICAR-NDRI. 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 were carried out from January to March 2018 - 19 under prevailing management conditions.

Ethical approval

The experiment was approved by the Institutional Animal Ethics Committee (IEAC) of Indian Council of Agricultural Research (ICAR)- National Dairy Research Institute (NDRI) constituted as per the article 13 of the CPCSEA rules, laid down by the Government of India (Reg. No. 1705/GO/AC/13/CPCSEA dated. 3/7/2013). Experiment was approved by IAEC (approval no. 43-IAEC-18-24) and all the ethical guidelines were followed during the period of the experiment.

Measurement of physiochemical properties of treated waste water

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.

Recording of physiological parameters and growth parameters

The physiological responses viz., rectal temperature, skin temperature, respiration rate and pulse rate were recorded using standard methods at fortnight interval. Body weight (kg) was measured by using weighing balance during morning hours. The body measurements viz., height at withers, body length and heart girth of kids were recorded by using flexible measuring tape at fortnight intervals.

Physiological responses

Rectal temperature - Rectal temperature (°F) was recorded with a digital thermometer by keeping the thermometer in contact with rectal mucosa for 2 min.

Respiration rate - 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 - 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.

Growth parameters

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

Height at withers (hw) - The height at withers (cm) of the experimental animals was measured as the distance from the flat ground surface to the highest point of the withers.

Body length (bl) - The body length (cm) of the experimental animals was measured as the distance from the point of the shoulders to the pin bone.

Heart girth (hg) - The heart girth (cm) of the experimental animals was measured as the body circumference immediately behind the forelimbs at the fourth rib, posterior to the front leg.

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 test.

Result and Discussion

Physiochemical and microbial properties of the control and treated purified water

The different physiochemical properties such as temperature, salinity, dissolved oxygen, pH, total alkalinity, total dissolved solids, oxidation reduction potential and turbidity of fresh and treated water were studied as described in Table 1 the values of treated water samples were non significantly (p<0.05) different from the control except salinity pH, total dissolved solids and turbidity which differed significantly (p<0.05) from control samples. However, they were well within the permissible limits of different drinking water standards of Dairy NRC [5] which has shown in Table 1.

Physiological responses

The mean values of physiological responses in crossbred kids are presented in Table 2 and Figure 1. The physiological responses were recorded for fortnightly intervals. The heart rate values were ranged from 79.67 to 84.83 beats per minute for control group of kids whereas these heart rate values ranged between 80 - 83.83 beats per minute in treated groups. The group mean for control and treated groups were 82.03±50 and 82.77±0.73 beats per minute respectively. There was no-significant (p<0.05) difference in heart rate between two groups. The respiratory rate for control group kids was ranged from 30.17 to 34.67 breaths per minute, whereas the values of respiratory rate was between 32.33 to 35.50 breaths per minute in treatment group. The group mean for control group was found to be 32.80±0.46 breaths per minute whereas the corresponding value for treatment group were 33.57±0.50. There were no significant (p<0.05) difference found between control and treatment group between the fortnights. A non-significant (p<0.05) variation was observed in the rectal temperature of kids, which ranged between 101.47 (ºF) to 101.92 (ºF) in control group and between 101.37 (ºF) to 101.98 (º F) in treatment groups. The group mean was found to be 101.77±0.08 (ºF) in case of control where as it was

recorded as 101.81±0.10 (ºF) in treated group.

In the present study it was found that there were no significant differences in the physiological responses of crossbred kids maintained on control (fresh water) and treated (purified waste water) water. It was reported that drinking of the treated sewage effluent has no effect on health problems in the young lambs and kids [6]. The ingestion of waste water derived from effluent did not impact the consumption of sheep, goats and calves, and when the waste was supplied in place of potable water the animals did not refuse to drink the treated water effluent and here was no change in physiological responses of these animals. Some studies have also reported that due to water restriction there was change in physiological responses of sheep [7, 8]. It was reported that the high pulse rate in goats provided with saline water indicates that goats were not tolerant to drinking of saline water that contains 11 g TDS/L [9]. Some studies reported that 40% of water restriction in experimental sheep group showed significantly (p<0.05) higher respiration rate, pulse rate and rectal temperature than the animals of 0% water restriction [10, 11]. In the present study there was no decrease in water intake in treatment group of animals and no significant change in physiological responses of both groups. The values of physiological responses were within the ranges as reported by [12, 13, 9, 14]. The treated water was fulfilling all the required standards as per Dairy NRC [5] EPA [15] hence no bacterial or parasitic contamination was caused to the experimental animals. 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 [16, 17, 18]. The treatment group remained healthy as that of controlled group in both crossbred kids. Hence suggesting that the purified waste water has no ill effect on the health and physiological responses of growing kids.

Growth parameters

Mean values of growth parameters in crossbred kids maintained on fresh and purified waste water at fortnight intervals have been presented in Table 3 and Figure 2. The body weight, length, height and girth of the crossbred kids ranged between 11.25 to 16.75 kg, 45.17 to 54.67 cm, 51.50 to 58.83 and 51.00 to 56.67 cm respectively in the control group whereas in treatment group it ranged from 10.00 to 15.50 kg, 45.33 to 52.67 cm, 47.67 to 57.00 cm, and 46.67 to 56.50 cm, respectively. The mean value in control group was 14.28±0.50 (kg) for body weight, 50.30±0.29 (cm) for length, 54.73±0.03 (kg) for height, and 53.57±1.53 (cm) for girth and in treatment group it was 13.07±0.47 (kg), 49.00±0.28 (cm), 52.70±0.32 (cm) and 51.90±1.61 (cm), for body weight, length, height and girth respectively. The values differed non-significantly (p<0.05) when compared between control and treatment groups for all the growth parameters. Comparison was found to be non-significant (p<0.05) between the control and treatment groups whereas significant between fortnights.

The growth parameters like body weight (kg), length (cm), height (cm) and girth (cm) of experimental kids of control as well as treated groups showed no significant differences. The kids receiving purified/treated water showed a linear pattern in all growth parameters in all five fortnights as that of control group kids which received fresh water. The growth of crossbred kids of both the experimental groups are in agreement with the findings of [16]. Similar results were obtained by [19]. Some of water restriction studies in small ruminants showed that significant reduction in body weight and growth parameters in animals kept on 20% and 40% of water restriction compared to control [3, 10]. It was reported that decreased water intake will affect body weight and growth parameters. Further in present study shows that by supplementing of purified waste water does not affect water intake and no significant change in body weight and growth parameters in fresh water and purified waste water fed groups [11]. Hence study shows there was no deleterious effect on the growth parameters of crossbred kids when supplied with purified waste water [20].

Table 1: Physiochemical properties of fresh water and purified waste water used in experiment

Physiochemical properties of water			
Properties	**Control**	**Treatment**	**Reference Values**
			Dairy NRC, 2001
Temperature (°C)	20.67^{A}±1.96	22.03^{A} ±2.02	20 C
Dissolve Oxygen (ppm)	15.23^{A} ±1.78	10.60^{A} ±1.18	>5
Conductivity (µS)	452^{A}.00±31.50	484.83^{A} ±21.67	500-800us/cm
Total Dissolve Solid (ppm)	390^{A}.83^{A}±17.15	452.83^{B}±17.67	<1000 safe,1000-2999 can be used
Salinity (ppm)	304.83^{A}±6.29	330.83^{B}±7.30	0-400
pH	7.20^{A} ±0.06	7.56^{B}±0.067	6.5-8.5
Oxidation Reduction potential (mV)	-44.17^{A} +0.16	-33.83^{A} ±1.72	----
Turbidity (NTU)	1.68^{A} ±0.16	2.60^{B}±0.23	<10

*****The values with different superscripts A, B between rows differ significantly (p≤0.05***).***

*No significant difference was observed between control and treated samples at 5% level of significance (p<0.05).

Table 2: Mean±SEM values of physiological responses in crossbred kids maintained on fresh and purified waste water

Fortnight	Heart Rate (Beats/Minute		Respiration Rate (Breaths/ Minute)		Rectal Temperature (°F)	
	Control	**Treatment**	**Control**	**Treatment**	**Control**	**Treatment**
1	84.83±0.75	83.83^{b}±1.11	33.67 ±0.92	33.00^{b} ±0.97	101.47±0.22	101.37±0.24
2	81.17±1.56	83.33^{ab}±2.35	32.67±0.71	32.33^{ab}±1.17	101.88±0.19	101.85±0.22
3	82.83±1.30	83.83^{ab} ±1.66	34.67±0.67	35.50^{b}±1.80	101.80±0.19	101.93±0.23
4	79.67±1.02	80.00^{a}±0.73	30.17±0.75	33.83^{a} ±0.60	101.92±0.14	101.98±0.20
5	81.67±1.02	82.83^{ab}±1.89	32.83±1.28	33.17^{ab}±0.54	101.80±0.11	101.90±0.20
Group Mean	82.03±0.58	82.77±0.73	32.80±0.46	33.57±0.50	101.77±0.08	101.81±0.10

* No significant difference was observed between control and treated samples at 5% level of significance (P<0.05).

* The values with different superscripts a, b between the rows differ significantly (p≤0.05).

Table 3: Mean±SEM values of growth parameters in crossbred kids maintained on fresh and purified waste water.

Fortnight	Body Weight (Kg)		Length (Cm)		Height (Cm)		Girth (Cm)	
	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment
1	11.25 ^{a}±0.64	10.00 ^{a}±0.52	45.17^{a}±0.60	45.33^{a}±1.05	51.50^{a}±0.99	47.67^{a}±0.88	49.67 ^{a}±1.41	46.67^{a}±0.88
2	12.25 ^{a}±0.64	11.42^{ab}±0.45	47.67^{a}±0.61	45.50^{a}±0.81	52.17^{ab}±1.30	49.00^{a}±0.73	51^{ab} ±1.34	48.5^{ab} ±0.87
3	15.08 ^{b}±0.83	13.67^{bc}±0.56	50.67^{b}±0.71	51.33^{b}±1.02	55.50^{bc}±0.92	53.33^{b}±0.84	54.33^{bc}±1.12	52.50^{bc}±0.62
4	16.08 ^{b}±0.76	14.75^{c}±0.86	53.33^{c}±0.99	50.17^{b}±0.65	55.67^{bc}±0.84	56.50^{c}±0.99	56.17^{c}±0.79	54.00^{c}±1.03
5	16.75 ^{b}±0.64	15.50^{c}±0.86	54.67^{c}±0.67	52.67^{b}±0.92	58.83^{c}±0.87	57.00^{c}±0.86	56.67^{c}±0.42	56.50^{c}±0.76
Group Mean	14.28±0.50	13.07±0.47	50.30±0.29	49.00±0.28	54.73±0.03	52.70±0.32	53.57±1.53	51.90±1.61

*No significant difference was observed between control and treated samples at 5% level of significance (P<0.05).
* The values with different superscripts a,b,c between the rows differ significantly (p≤0.05).

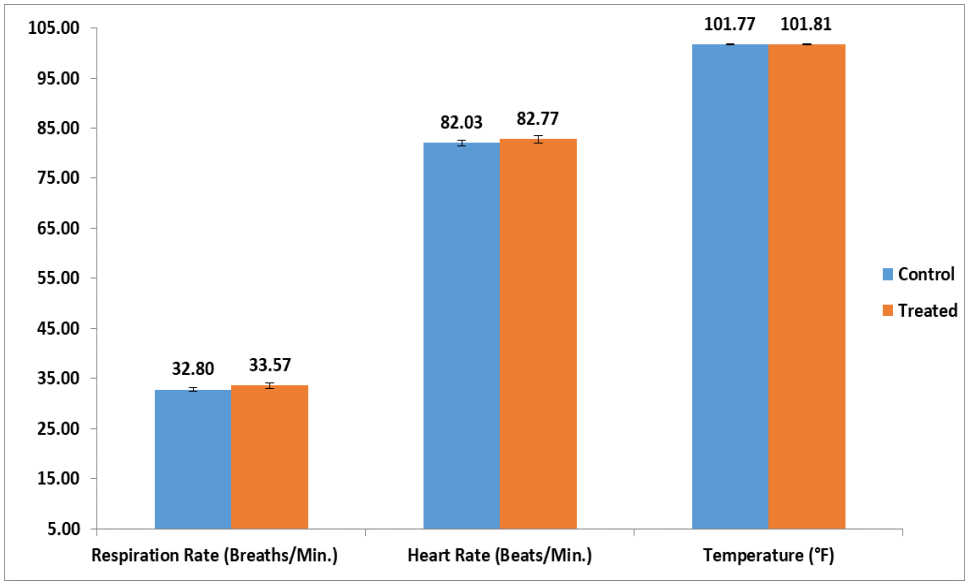

Fig 1: Physiological responses in crossbred kids maintained on fresh and purified waste water

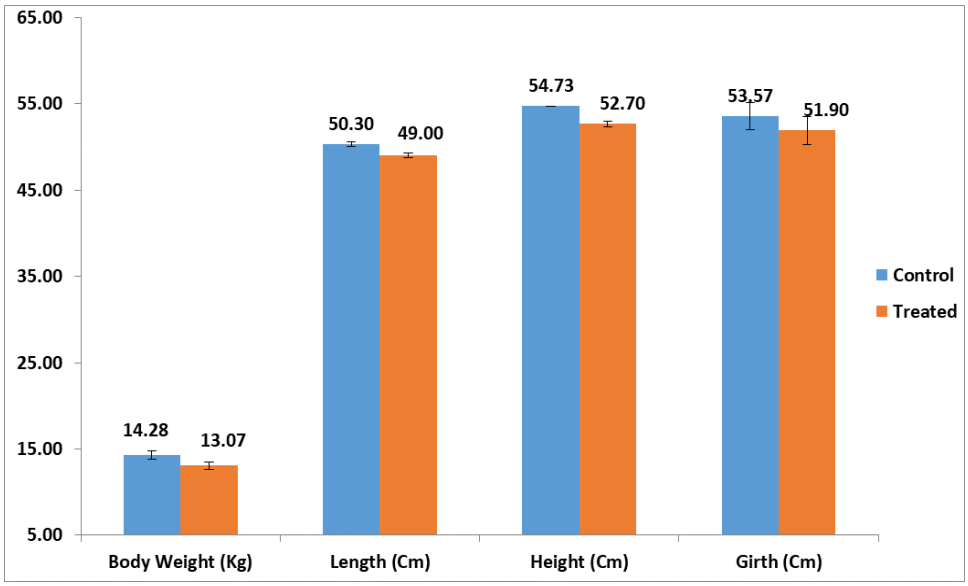

Fig 2: Growth parameters in crossbred goat kids maintained on fresh and purified waste water

Conclusions

Water recycling experiences are useful and efficient in generating a new water supply without compromising animal welfare and health. Water recycling / purification and water conservation strategies will enable us to handle our natural resources in a sustainable manner. It is concluded that the purified waste water offered to the treatment groups of crossbred kids was able to fulfil all the recommended biological parameters (BIS 1991, Dairy NRC, 2001, EPA, 2002) and has no detrimental effects on physiological responses and growth parameters of crossbred kids. Goats can sustain on treated waste water which fulfils all the drinking standards without being physiologically affected and to meet required amount and quality water by purification of waste water in scarcity areas.

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