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# Effect of water salinity on water intake and ruminal volatile fatty acids concentration in Murrah buffalo calves

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## Abstract
Eight growing male Murrah calves, average 220±5 kg body weight, were randomly assigned to three treatments consisting of water containing different levels of total dissolved solids (TDS; mg/l): Control=500; Treatment =2,000 and were fed as per ICAR 2013 at National Dairy Research Institute (NDRI), Karnal India (29° 42" N latitude) during winter. Animals were arranged in a randomized complete block design for 120 days, with 1 week for water adaptation. Water intake was recorded daily and rumen fermentation parameters were evaluated at monthly interval. Water intake was higher for animals receiving 2,000 mg/l TDS (17.43 l/day) in the drinking water. No treatment effects were observed in any of the variable of rumen fluid study, with the exception of ammonia nitrogen which was decreased significantly ($P<0.05$). It was concluded that the rumen presents a surprising buffer capacity which resists changes in rumen fermentation parameters at 2000 ppm TDS, so it was concluded that TDS alone is insufficient to characterize drinking water quality for animals.

**Keywords:** Water salinity, water intake, rumen volatile fatty acids, Murrah male buffalo calves

## Introduction
In a world that faces increasing challenges of water scarcity, the optimum use of all available resources becomes critical. This is particularly true for the hyper-arid, arid and semi-arid regions where per capita water availability is already less than the "critically low" level of 1000 $m^3$ per annum. Water is a major constituent of the body and is important for proper functioning of various physiological processes including the ionic balance, digestion, absorption, metabolism, heat balance, and elimination of waste products from the body (Yoshihara, 2016) [21]. Water is the most abundant compound on earth's surface, covering 70 percent of the planet. An adequate supply of clean, fresh drinking water is widely considered essential for optimal cow health and maximum milk production (Church 1991; Valtorta *et al.*, 2008) [4, 20]. The water requirements of the animals can be satisfied in three ways: 1. Feed water 2. Drinking water and 3. Metabolic water (from tissue and organic substrates oxidation). The amount and quality of water needed varies between species of animals and classes in the same species (NRC, 2005) [15] and is affected by the animals' environment which includes factors such as seasonal changes in pasture types and availability, food water content and ambient temperature (Ismail *et al*., 1995; Lopez *et al.*, 2016) [8, 14]. It is most important nutrient for the maintenance and productivity of dairy cattle. Water is consumed in considerably larger quantities compared to other nutrients so an adequate supply of clean, fresh drinking water is widely considered essential for optimal cow health and maximum milk production. The provision of adequate supplies of good quality drinking water for livestock is of major concern. In general, water salinity is the major factor determining the suitability of particular resource for livestock (Ray, 1989) [10] The presence of high concentrations of some inorganic ions such as $Ca^{2+}$, $Mg^{2+}$, $Na^{+}$, $Cl^{-}$, $SO_4^{2-}$ and $HCO^{3-}$ in animals' drinking water may cause harmful effects resulting in poor performance, illness or even death (Kellems and Church, 2002) [9]. All sulfate salts ($Ca^{2+}$, $Na^{+}$, $Mg^{2+}$), when exceeding 1500 mg/L, can decrease productivity because of their laxative effect, the most potent being sodium sulfate (Socha *et al.*, 2003) [18]. Considering the importance of water intake and its quality and subsequently affecting the production performance of the animals, the present studies was planned to study the effect of water salinity on water intake and rumen fermentation in growing Murrah buffalo calves.

## Materials and methods

### Experimental animals and diets

To validate the results of *in vivo* studies**,** Twenty Murrah male growing calves (12 to 18 months of age) were randomly assigned to two treatments. The treatments consisted of water containing different levels of TDS (mg/l): Control 500 ppm and Treatment 2,000 ppm. The animals were fed on ration containing green fodder, wheat straw and concentrate mixture to meet their nutritional requirements (ICAR, 2013) [7]. Water was offered twice a day at 11:00 am and 4:00 pm. and feed refusals were removed at 9:30 am. The duration of the experiment was of 120 days.

### Water formulation

In order to formulate the water for the different treatments, Saline water was procured from a local farm located at village indri in Karnal District (Haryana). The water was brought in water tank and stored in water tanks at experimental site. The TDS of collected water was 4000 ppm. It was further diluted with fresh farm water to prepare treatment water of 2000ppm. Water samples were taken every week in order to analyze TDS.

### Experimental measures and sample analysis

### Water intake

Individual water intake was recorded twice a day. The volumes of water offered to and refused by every calve were estimated with the help of measuring bucket. The difference between both estimates (offered and refused) represented the total water intake.

### Sample collection and analysis

### Rumen parameters

Fifty ml sample of rumen liquor was obtained with the help of a stomach tube introduced in to the ventral sac, at 4 hour after feeding at monthly interval. Ruminal concentration of ammonia was measured according to the method described by Conway (1962) [5]. TVFA concentration was determined as described by Barnett and Reid (1957) [3]. Sub- samples utilized for individual volatile fatty acid (VFA) analysis were filtered through two layers of gauze, acidified with m-phosphoric acid (25%) in 5 N $H_2SO_4$ and kept at -20°C before analysis. Individual VFA in the samples were determined using gas chromatograph (Nucon 5700, Nucon Engineers, New Delhi) equipped with flame ionization detector and stainless steel column packed with chromosorb 101 mesh 80 – 100 (length 1.5 m; o.d 3.175 mm; i.d. 2 mm). Sample (2 ml) was injected through the injection port using Hamilton syringe (10 ml). Different VFA's were identified on the basis of their retention time area covered on monitor and their concentration (mM/L) was calculated by comparing the retention time as well as the peak area of standards after deducting the corresponding blank values. Standard VFAs solution prepared as 60, 20 and 8 mM/100 ml acetic, propionic and butyric acids respectively.

### Statistical analysis

The results obtained during this study were analyzed using software package SPSS version 16.0, 2010.

## Results and discussion

Mean intake of water was 14.07 litres in control group while it was increased to 17.43 in T1. There was increase of 23.8% water intake at 2000 ppm TDS (Table 1, Figure.1). This increase in water intake might be due to animal's more need for water to excrete the excess salt from the body to maintain ionic balance. Water intake by cattle has been described as a function of DMI and ambient temperature (Soloman *et al*., 1995) [19]. Increased water consumption may suggest a response to increased salt intake; increased water consumption, in turn, appeared to stimulate feed consumption. Increased water consumption is a physiological response to increased salt load. Mader and Davis (2004) [12] indicated additional water is required to maintain systematic osmotic balance, with the excess salt flushed from the body via the urine. Kii *et al*. (2005) [11] reported that water consumption increased with increasing salt content, and the deer offered 8500 mg TDS per kg drank significantly ($P$<0.05) more water than those that received the control water (570 mg TDS per kg). The average value of $NH_3$ –N was decreased from 24.15±0.57 mg/dl at start of experiment to 19.30±0.38 mg/dl at 120 days in treatment group (Table 2). This showed the decreasing trend with increase in the TDS level. This might be due to more utilization of $NH_3$ –N by rumen microbes or salinity of water might enhance buffering capacity of rumen liquor thus promote microbial growth thereby reduces the level of ammonia in rumen. However, interaction between water salinity and microbial growth is not clear. Valtorta *et al.,* (2008) [20] reported ruminal ammonia concentration for treatments containing different amounts of TDS: 1,000 and 5,000 in the drinking water as 7.6 and 8.4 mg/dl respectively in lactating Holstein cows. This might be due to the rumen surprising capability to resist change in rumen fermentation parameters. They also reported that rumen parameters and microbiology were not affected by water salinity. The buffering system in the rumen includes not only the saliva, but also the feed (Bahman *et al*., 1993) [2]. In the present study, there was no significant change observed in the TVFA concentration and molar proportion of VFA's (Table 2). Patterson *et al*., (2003) [16] found no effect on VFA concentration when fed chaffed rations to sheep receiving either freshwater or a 1.3% sodium chloride solution. Ruminal VFA production is closely microbial yield and absorbed amino acids. However, sheep are known to tolerate high amounts of salt in their drinking water (Loneragan *et al*., 2001) [13]. The result obtained in present study was in accordance with the findings of Arjomandfar *et al*. (2010) [1] where concentrations of VFA in the ruminal fluid were not affected by the water salinity. Valtorta *et al*. (2008) [20] recently reported that water TDS up to10000 ppm did not influence the VFA production of grazing Holstein cows. Ingestion of a large volume of saline water has the potential to alter the pH and thus the microbial function and activity; however, the secretion of a large volume of saliva of high buffering capacity seems to have compensated for any effect of ingested minerals on ruminal pH.

**Table 1:** Effect of different levels of saline water on fortnightly water intake (litres/d)

| Fortnights | Control | Treatment |
|---|---|---|
| 1 | 15.46±1.55 | 15.04±1.67 |
| 2 | 15.39±1.69 | 15.31±1.76 |
| 3 | 12.75$^{a}$±1.04 | 17.41$^{b}$±1.75 |
| 4 | 13.20$^{a}$ ±0.48 | 15.76$^{b}$±1.66 |
| 5 | 12.48$^{a}$ ±1.20 | 15.30$^{b}$±3.31 |
| 6 | 13.13$^{a}$±0.80 | 17.60$^{b}$±2.56 |
| 7 | 14.72$^{a}$±0.79 | 18.84$^{b}$±2.47 |
| 8 | 16.88$^{a}$±0.86 | 21.81$^{b}$±2.05 |
| Mean | 14.07$^{a}$± 1.16 | 17.43$^{b}$±2.97 |

**Table 2:** Effect of different levels of saline water on rumen parameters

| Treatment | Period | | | | | | P value | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 30 | 60 | 90 | 120 | Mean | T | P | T*P |
| **Ammonia Nitrogen** | | | | | | | | | |
| Control | 23.65±0.43 | 24.04±0.15 | 24.04±0.45 | 24.12±0.60 | 23.47±0.37 | 23.83±0.18 | 0.000 | 0.000 | 0.000 |
| Treatment | 24.15±0.57 | 22.18±0.33 | 22.18±0.17 | 21.82±0.31 | 19.30±0.38 | 22.20±0.41 | | | |
| Mean | 23.85±0.19 | 23.11±0.19 | 23.76±0.32 | 22.97±0.62 | 21.38±0.78 | 23.04±0.30 | | | |
| **TVFA** | | | | | | | | | |
| Control | 9.19±0.24 | 8.64±0.10 | 8.63±0.15 | 8.41±0.17 | 8.88±0.23 | 8.75±0.21 | 0.644 | 0.072 | 0.715 |
| Treatment | 8.95±0.16 | 8.64±0.04 | 8.53±0.07 | 8.50±0.12 | 8.43±0.22 | 8.61±0.15 | | | |
| Mean | 8.82±0.12 | 8.74±0.09 | 8.57±0.10 | 8.45±0.09 | 8.54±0.08 | 8.62±0.10 | | | |
| **Acetic Acid** | | | | | | | | | |
| Control | 59.94±0.64 | 60.64±0.29 | 60.29±0.62 | 59.60±0.29 | 60.25±0.56 | 60.14±0.48 | 0.393 | 0.809 | 0.852 |
| Treatment | 60.47±0.29 | 60.32±0.99 | 60.04±0.55 | 61.17±0.49 | 61.09±0.15 | 60.62±0.56 | | | |
| Mean | 60.32±0.21 | 60.42±0.26 | 60.29±0.21 | 60.44±0.20 | 60.64±0.17 | 60.42±0.21 | | | |
| **Propionic Acid** | | | | | | | | | |
| Control | 24.74±0.28 | 25.23±0.53 | 24.82±0.43 | 24.77±0.50 | 24.64±0.45 | 24.84±0.18 | 0.875 | 0.588 | 0.901 |
| Treatment | 24.77±0.31 | 25.51±1.17 | 25.35±0.19 | 24.17±0.21 | 24.16±0.26 | 24.79±0.58 | | | |
| Mean | 24.66±0.23 | 24.96±0.28 | 24.78±0.19 | 24.51±0.14 | 24.55±0.32 | 24.69±0.20 | | | |
| **Butyric Acid** | | | | | | | | | |
| Control | 15.32±0.38 | 14.13±0.27 | 14.90±0.19 | 15.63±0.26 | 15.12±0.21 | 15.02±0.35 | 0.218 | 0.446 | 0.901 |
| Treatment | 14.76±0.39 | 14.17±0.40 | 14.61±0.45 | 14.66±0.36 | 14.75±0.26 | 14.59±0.35 | | | |
| Mean | 15.02±0.22 | 14.63±0.21 | 14.93±0.14 | 15.05±0.14 | 14.81±0.14 | 14.89±0.18 | | | |

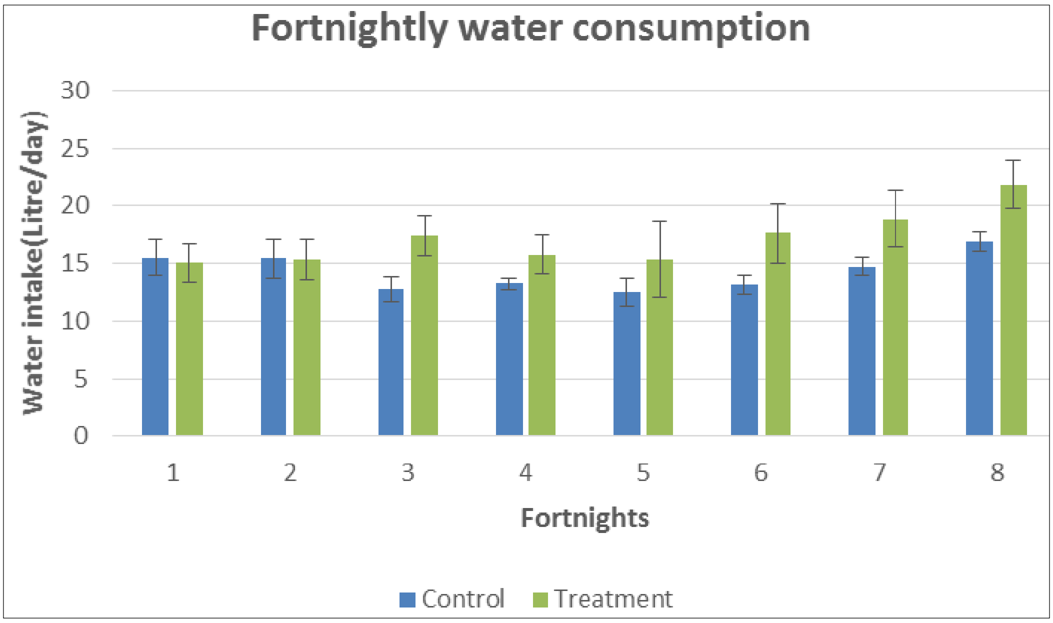


**Fig 1:** Effect of different levels of saline water on fortnightly water intake (litres/d)

## Conclusion

Results obtained in this study showed that the water salinity of approximately 2000ppm has no adverse effect on rumen volatile fatty acids concentration moreover there was increase in the intake of water was reported at 2000 ppm TDS water. So water upto 2000ppm TDS does not interfere in rumen fermentation of growing Murrah buffalo calves.

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