Research Article

Evaluation of Nitrate Content in Water Samples of Dharmapuri District Meant for Livestock Feeding

C Kathirvelan[1]*, Dharmar Manimaran[1], V Meenalochani[2] and K Arunachalam[3]

[1]Department of Animal Nutrition, Veterinary College and Research Institute, (Tamil Nadu Veterinary and Animal Sciences University, Chennai), Namakkal-637002, Tamil Nadu, India
[2]Veterinary University Training & Research Centre, Salem – 639 006, Tamil Nadu, India
[3]Department of Veterinary Parasitology, Veterinary College and Research Institute, (Tamil Nadu Veterinary and Animal Sciences University, Chennai), Namakkal-637002, Tamil Nadu, India

Abstract

A study has been carried out to estimate nitrate content in drinking water for livestock collected from different sources. Approximately, 760 different sources water samples were collected from Dharmapuri district comprising 8 blocks and in each block 4 villages. The nitrate level analysis is estimated based on the reactions involving acetic acid and Bray's indicator as the coupling agents. The Nitrate level was determined from collected 760 water samples showed that, 67.5% of samples had 10-50 PPM nitrate content, 25.13% had 51-100 PPM nitrate content, 2.89 % had 101-300 PPM nitrate content and 0.39% had above 300 PPM nitrate content. Very small portion of samples (4.07 %) contained traces of nitrate content. The analysis, suggested that water samples below 100 PPM are fit for consumption to livestock and above that level can be used safely after storing of water 1 or 2 days to evaporate part of the nitrate. Hence, analysis of nitrate content in drinking water of livestock recommended so that early warning system can be created for the livestock farmer.

Keywords: Poisoning, Ruminant, Nitrate, Water samples, Dairy cattle.

***Correspondence**
Author: C Kathirvelan
Email: kadhirc@gmail.com

Introduction

Nitrate poisoning is a condition which may affect ruminants consuming certain feed or water that contains an excessive amount of nitrate [1]. The ruminant animal fed on nitrate rich forages or water and it is converted into nitrites and in turn the nitrite is converted into ammonia. The ammonia is then converted into protein by the bacteria present in the rumen. If the ruminant animal fed frequently nitrate rich forages or water over a short period of time, higher level of nitrite accumulated in the rumen. This causes absorption of nitrite by red blood cells and combines with hemoglobin (oxygen-carrying molecule) to form methemoglobin. As a result, methemoglobin incapable of transport oxygen efficiently likes hemoglobin which causes respiratory problems and finally leads to fatality. The conversion of hemoglobin to methemoglobin could leads to animal suffer from oxygen starvation. Animals can die within a few hours of the initial ingestion of a high nitrate feed/water [2].

In ruminant animals, the conversion of nitrate to nitrite and then changed into ammonia. The excess ammonia is absorbed by the blood stream and passed in the urine as urea. This mechanism generally occurs when the nitrate breakdown system is in balance and no surplus of nitrites accumulates [3]. While in monogastric animals such as horses and pigs this type of conversion mechanism occurs, closer to the end of the digestive tract, where there is less opportunity for the nitrites to be absorbed by the blood. The ruminants consumes a high nitrate feed, which led to lack of conversion of nitrate to nitrite and finally to ammonia. This causes excess nitrite to be accumulated in the rumen which intensifies the problem [4]. Thus, ruminant animals were more susceptible than monogastric animals in nitrate poisoning.

Chronic nitrate toxicity is one of the nitrates poisoning where the clinical signs of the diseases are not observed. The common symptoms are reduction in rate of weight gain, lower milk production, depressed appetite, and a greater susceptibility to infections. It also causes abortions within the first 100 days of pregnancy because nitrates interfere with the implantation of the egg in the uterus [3]. Reproductive problems may also occur due to a nitrate or nitrite-induced hormone imbalance, but most are usually not recognized as feed-related. Newborn calves that survive, but are affected by nitrate poisoning, may have convulsions and seizures. Water is one of the significant sources for toxic level of nitrate for livestock. The water from different sources were generally get contaminated by fertilizer, animal

wastes or decaying organic matter. Shallow wells with poor casings are susceptible to contamination. Marginally toxic levels of nitrate in water and feed together may cause nitrate toxicity in animals [5]. Hence, it is mandatory to screen nitrate content in water from different sources. Thus in present study, water samples were collected from different sources in Dharmapuri districts for the estimation analysis of nitrate content to prevent the nitrate toxicity incidence in cattle.

Materials and Methods

All chemicals used were of analytical reagent grade, and doubly distilled water was used in the preparation of all solutions in the experiments. Hydrochloric acid solution (0.1N HCl) was prepared by 10 ml HCl in 1L Distilled water. Acetic acid (20%) was prepared by 20 mL Acetic acid in 80 ml distilled water. Bray's indicator prepared by 100g barium sulphate ($BaSo_4$),10g manganese sulphate ($MnSO_4.H_2O$), 2g Zinc (metallic Zn), 75g citric acid, 4g sulphanilic acid,2g 1-naphthylamine are mixed. The bray's indicator is stored in blackened bottle away from light.

Sample Collection

The numbers of water samples were collected based on the propionate random sampling from the Dharmapuri districts area. The Dharmapuri district area was around 4497.77 Km^2 [6]. In Dharmapuri district, 760 water samples were collected from different villages of different blocks namely Morrappur, Pappireddy patty, Palakkodu, Pennagaram, Nallampalli, Dharumapuri, Karimangalam, and Harur by using stratified random sampling/Multi stage random sampling. The source of water samples commonly from Bore Water, Well Water, River Water and Sewage Water were collected for the estimation of Nitrate.

Nitrate determination

Nitrate content was estimated using Wiseman and Jacobson (1965) method. The Nitrate content was estimated by colorimetric method and measured at a wave length of 520 nm [7]. Cattle fed water Samples were taken in 1ml test tube and add 1ml of (20%) acetic acid and 0.5g of Brays indicator for the determination of nitrate. The pink color was observed and compared with score card value. The pink colour formation was due to the reduction of nitrate to nitrite by zinc and manganese sulphate. The reaction then followed by diazotization of sulfonic acid with nitrate ion and subsequently coupled with 1-napthylamine to from pink colour.

Results and Discussion

Different sources of water samples collection

Totally 760 water samples were collected from different sources. Among them, 184 from Well water samples, 182 from Bore Well samples, 106 Bore/Well samples, 133 from River water samples and 1575from Sewage water samples. The different sources of water samples collected were listed in **Figure 1**.

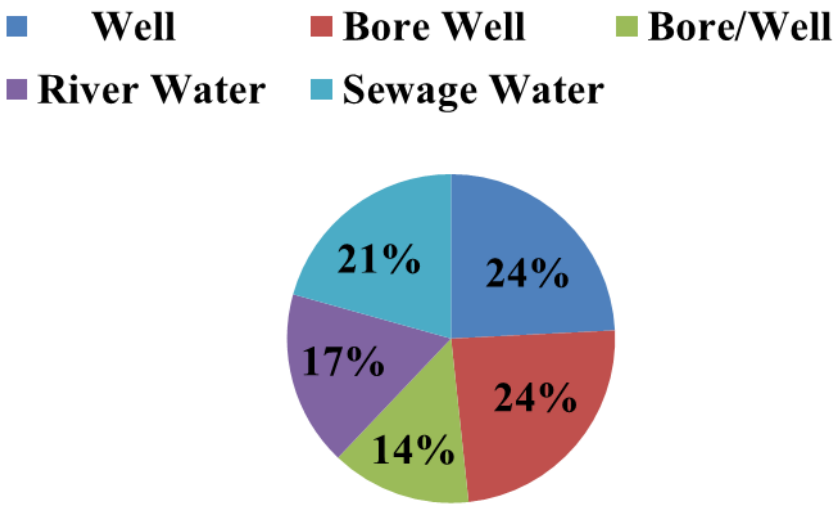

Figure 1 Collection of water samples Dharmapuri Districts

Nitrate estimation of water samples

The nitrate content was estimated from different water samples **Table 1**. The result showed that nitrate concentration found to be varying between samples. Among 760 water samples in Dharmapuri district, 67.5% samples had 10-50 PPM nitrate content, 25.13% had 51-100 PPM nitrate content, 2.89% had 101-300 PPM nitrate content, 0.39% had above 300 PPM nitrate content and 4% had traces of nitrate content. The results are summarized **Table 2**.

Table 1 Collection of water samples at Dharmapuri Districts Water Samples

Water Sources	Well	Bore Well	Bore/Well	River Water	Sewage Water
Total=760	184	182	106	133	155

Table 2 Nitrate estimation of water samples at Dharmapuri District

Water Sources	Nitrate content (ppm)				
	Trace	10-50	51-100	101-300	>300
Well	--	154	28	02	--
Bore Well	01	125	51	06	--
Bore/Well		50	54	01	--
River Water	30	93	08	--	--
Sewage Water	02	77	64	11	03
Total	31	513	191	22	03
	(4.07)	(67.5%)	(25.13%)	(2.89%)	(0.39%)

Water samples which had >100 PPM nitrate content has related with incidences of nitrate toxicity and death of dairy animal [5]. The water gets high risk source of nitrates through water from deep wells fed by soil water from highly fertile soils, condensed water from ventilating shafts in piggeries due to higher ammonia levels in the air, fluids draining from silos containing materials which is rich in nitrates and water contaminated by fertilizer, animal wastes or decaying organic matter may also be a source of toxic levels of nitrate. Marginally toxic level of nitrate present in water and feed when combined to give cattle can also lead to poisoning. Livestock breeding could also affect consuming water samples above 100 ppm nitrate content [2]. Hence in present study, very few samples were recorded above 100 PPM nitrate content. This might be due to that source of water from ponds, shallow wells or streams that collect drainage from manure, highly fertilized fields or industrial waste. Deep wells are usually safe sources of water [8]. In this study bore well/well collected from different sites were found to be predominantly below 100 PPM which illustrates that bore well waters are usually safe sources of water. These waters should be safe for livestock and prevent nitrate poisoning.

Conclusion

Hence, it can be concluded that nitrate estimation is necessary in different water samples where the farmer following indiscriminate use of fertilizers or excess application of urea/poultry manure to the field, so that to prevent the nitrate toxicity incidence in cattle.

Acknowledgement

The authors would like to acknowledge the Tamil Nadu State Council for Science and Technology (TNSCST), Chennai, Government of Tamil Nadu for their financial support.

References

[1] Charlie Stoltenow and Greg Lardy. 2015. Nitrate poisoning of Livestock NDSU Extension Service, V839.
[2] Crowby, J.W. 1985. Vet. Bull.56:Abst.7257.Guide B-807; PP 1-4.
[3] Barry Yaremcio.1991.Nitrate Poisoning and Feeding Nitrate Feeds to Livestock AGRI-FACTS, Agdex 400/60-1.
[4] Christopher D.2010.Nitrate Poisoning of Livestock. NM state university.
[5] Richard S. Adams, Thomas R. McCarty, Lawrence J.2012.Hutchinson.Prevention and control of Nitrate Toxicity in Cattle. Extension. pp-1-20.
[6] Thirunavukkarasu M, Sankaran V.M, Kathiravan.G and Karunakaran. R. 2012. Green Fodder Availability in Tamil Nadu – A District Wise Analysis. Indian Vet. J., Vol. 89 (10): 18- 20.

[7] Chamandoost S et al. 2016, J. Hum. Environ. Health Promot. 1:80-86.
[8] Provinand Pitt. 2012. Nitrates and Prussic Acid in Forages. The Texas A&M University System, E-543; PP 1-12.

Publication History
Received 13.06.2019
Revised 14.12.2019
Accepted 14.12.2019
Online 14.12.2019