Water for Domestic Animal Drinking Based on the Categorization of Species in an Urban Brazilian Slum

José Natanael Tavares da Silva, Sabrina Rafael Bezerra, Ulrich Vasconcelos

ABSTRACT

Every animal needs safe water for drinking. The quality of this water is essential for welfare. This study discusses on the quality of water furnished to about 50 domestic animals based on the categorization of species practiced by residents at São Rafael slum, located in the city of João Pessoa, Brazil. The drinking water comes from three sources: municipal supply system, bottled mineral water and directly from the Jaguaribe River. The water perceived as safest was the same as offered to pets. Domestic animal water samples were tested and rated as not recommended in more than 65% of the samples. The density of thermotolerant coliforms ranged between 0 and 11,000 cells/100 mL. One third of the samples considered unsuitable for animal watering were also outside the recommended pH. In addition, a differential behavior was observed in the choice of water source according to the caretaker’s perception of safety. Dogs and cats, considered family members, received the same water as consumed by the family. Even these, 38.5% of the samples, were rated as not recommended and represented a risk to the health of all those who consumed it. As well, a need for good practices of hygiene in water management and cleaning of water dishes, tanks and troughs was seen.

Keywords: Animal Welfare, São Rafael Slum, Speciesism, Water Quality

I. INTRODUCTION

Water is the most important requirement for sustaining life (Falkenmark, 2020). It is the most significant environmental factor for the health and welfare of all living beings (Rosenstock, 2003). Furthermore, water is a critical nutrient in the animal diet as it is involved in numerous physiological functions necessary for the maintenance of all metabolic processes essential to life, homeostasis, growth and reproduction (Wackchaure et al., 2015).

The water used in domestic activities must have its potability guaranteed, especially the microbiological parameters (Adu-Gyamfi et al., 2020). Incorrect habits in water management, however, may affect the users’ health (Silva et al., 2009). This includes the cleaning of storage tanks (Slavik et al., 2020) and hygienic care for household items such as clay filters and other water containers (Meierhofer et al., 2019).

Access to safe water is a basic requirement to ensure animal’s health (Sorenson et al., 2011). Most of the water used by domestic animals originates from the same sources used by their owners (Corson and Doureau, 2013). A smaller portion corresponds to untreated water (Mekonnen and Hoekstra, 2012), such as that collected from natural water bodies (Gerbens-Leenes et al., 2013), dams (Kalwane and Savale, 2012), wells (Amaral, 2004) or rain (Araújo et al., 2010).

Water is a vehicle for many infectious disease agents in animals (Sasakova et al., 2013). The highest risk factor for infections is the ingestion of water contaminated by human feces or from other warm-blooded animals. They are sources of bacteria, viruses, eggs and cysts of pathogenic parasites (Leclerc et al., 2002). Various studies have addressed problem of virus, the origin of waterborne gastroenteritis in domestic animals (Openshaw et al., 2016; Medeiros et al., 2014), however, coliform bacteria are the most important microbiological parameter of water quality in terms of potability and safety against gastroenteritis (Seo et al., 2019).

The main representative of the coliform group (Enterobacteriaceae) is Escherichia coli, a facultative Gram-negative, non-spore-forming, β-glucuronidase producer rod that ferments lactose and forms acid and gas (Cabral, 2010). E. coli occurs naturally in the gut of birds and mammals, in a concentration of 10⁶ cells/gram of feces (Edberg et al., 2000), corresponding to 1% of the total biomass of the large intestine (Mogna et al., 2012). The bacteria can survive from 4 to 12 weeks in water containing certain levels of organic matter (Bumadian et al., 2013), but cannot survive much longer. Hence, the presence of coliform bacteria in water indicates recent fecal contamination (Vasconcelos et al., 2010).
Most waterborne bacteria cause symptoms common to waterborne viruses in domestic animals. These symptoms include abdominal discomfort, fever, vomiting, diarrhea, fatigue, anorexia and weight loss (Praveen et al., 2016). The simplest ways to avoid these zoonoses are good practices of hygiene, proper water treatment, and identification of the parameters that may help different decisions about water management as well as promote health benefits for the animals (Matilla et al., 2018).

On the other hand, there have been several studies on water potability for animals. These treat the domestic and laboratory animals as mere economic goods and not a sentient being (Taussif et al., 2018; Drastig et al., 2010; Harpreet and Daljit, 2008; Hubbard et al., 2004; Graaf et al. 1999). This speciesist behavior gives the animal the status of “a thing”, which when it becomes ill will generate economic losses for the owners. These attitudes have not changed at least the last three decades (Khbou et al., 2020; Holland, 1990). Speciesism also perpetuates the cycle of negligence of the fact that domestic animal health and welfare should not be associated to any economic interest. Given the consideration of the water rights of animals, the present work aimed to analyze water offered to domestic animals in the São Rafael slum.

II. METHODOLOGY

A. Description of the study site

According to the Brazilian census, IBGE (2010), the São Rafael slum is a subnormal urban agglomeration, located in the city of João Pessoa, Brazil (7°08’08”S-34°51’24”W), comprising 1,326 inhabitants, distributed in 370 households. There are an approximate number of 220 domestic animals (Martins et al., 2020). The urban slum is located at Castelo Branco III district, adjacent to Campus I of the Federal University of Paraíba (Fig 1). The site is delimited by two large roads with intense traffic flow: to the south by Dom Pedro II Avenue and to the east by the road BR 230. The north and west portions are washed by the River Jaguaribe.

![Fig. 1. Location of the São Rafael slum (image from google maps).](image)

The site has three distinct regions (Fig. 2.). In the first, there is the only access road by car, coming off from Dom Pedro II Avenue. This road is paved with stones and most of the houses are made of masonry. Behind these is the Beco da Baiúca. The area is not paved and represents the poorest part of the slum. There is also an exclusive bridge for pedestrians over the Jaguaribe river, connecting the slum to the Torre district.

![Fig. 2. Typical landscape of the São Rafael slum: Beco da Baiúca (left), main entrance (center) and bridge over Jaguaribe River (right).](image)
Most of the Beco da Baúca dwellings are on the river. There is a precarious water supply system. The houses do not have a sewage system nor garbage collection. Many residents are owners of small, medium or large domestic animals, mostly dogs, cats, chickens, pigs, passerines, cows, donkeys, and horses, among others.

B. Sample collection and water analysis

The water is offered to the animals according to the animals’ owners perception of safety. The water available to the São Rafael slum comes from three main sources: i) from the municipal supply system; ii) hydraulic installations built by the residents to pump water directly from the Jaguaribe River; and iii) bottled mineral water.

Water samples available to about 50 domestic animals were evaluated in this study. The concentration of thermotolerant coliforms ranged from 0 to 11,000 cells per 100 mL in these samples.

The protocols for preparing the collection, sampling and sample processing vials were based on the standards of APHA, AWWA and WEF (2012). Over five months (July to November 2017), 15 samples of 100 mL each of water for domestic animals were collected under aseptic conditions from water tanks, house taps and water troughs.

The tests used to characterize the samples were: pH (ISO 10523:2008 method) and detection of total and thermotolerant coliforms (APHA 9221C method). To identify the safety of the water available to the animals, the parameters set out in article 16, I, letter g, of the National Council on the Environment, Directive 357/2005 (CONAMA, 2005), were considered.

III. RESULTS

Table I summarizes the results of the microbiological and pH analyses. The animals’ owners decide which water will be offered to the animals, according to their perception of safety. Generally, they avoid water from the municipal supply system, claiming that it has an earthy color and odor, especially in the rainy season. Some domestic animals receive the same water used as their human owners, especially dogs and cats. However, 38.5% of the water from the samples taken was rated as not recommended.

Water was not recommended for animal drinking in 66.7%; two thirds of this percentage exceeded the density limits for thermotolerant coliforms allowed by the Brazilian directives (Brasil, 2021; CONAMA, 2005). On the other hand, in the remaining third, the samples were also not recommended due to the pH of the water, showing values ten times below the lower limit (pH: 6.0) recommended. These samples with non-recommended pH did not have thermotolerant coliforms.

Additionally, in half of the samples analyzed that were considered potable for domestic animals, a high concentration of thermotolerant coliforms was detected, but with cell levels below the maximum limit for water destined for this purpose (up to 1,000 cells per 100 mL).

| Table I: Potability Standard of Water Intended for Animals |
|----------------------------------------------------------|
| n | Domestic animals | SW | WC | Parameters | Rating* |
|---|------------------|----|----|------------|---------|
|   |                  |    |    | TC         | TTC     | pH     |         |
| 1 | Pig; chicken     | MS | No | 2300      | > 2300   | 7.0    | NR      |
| 2 | Dog              | BW | Yes| 2300      | > 2300   | 7.0    | NR      |
| 3 | Dog; passerine   | JR | Yes| 2300      | > 2300   | 6.5    | NR      |
| 4 | Chicken; pig; donkey | MS | No | 0         | 0       | 6.0    | Satisfactory |
| 5 | Dog              | JR | Yes| < 110     | 110     | 6.0    | Satisfactory |
| 6 | Dog              | JR | Yes| 120       | **      | 6.0    | NR      |
| 7 | Cat; passerine   | JR | Yes| 110       | 0       | 6.0    | Satisfactory |
| 8 | Cat              | BW | Yes| 110       | 0       | 6.5    | Satisfactory |
| 9 | Dog              | BW | Yes| 23000     | 11000   | 6.0    | NR      |
| 10| Dog              | BW | Yes| 690       | 9200    | 7.0    | NR      |
| 11| Dog              | BW | Yes| 110       | 0       | 7.0    | Satisfactory |
| 12| Dog; cat         | BW | Yes| 2300      | 1100    | 6.0    | NR      |
| 13| Dog              | BW | Yes| 110       | 0       | 5.0    | NR      |
| 14| Dog              | BW | Yes| 110       | 0       | 5.0    | NR      |
| 15| Cat              | BW | Yes| 110       | 0       | 5.0    | NR      |

SW – source of water (MS – municipal supply; BW – bottled water; JR – Jaguaribe River); WC – consumption of the same water by animal owners; TC – total coliforms; TTC - Thermotolerant Coliforms per 100 mL; NR - not recommended; *Maximum values: CTT to 1,000/100 mL and/or pH between 6.0 and 9.0; ** non-conclusive analysis

DOI: http://dx.doi.org/10.24018/ejdevelop.2022.2.1.70
A. Potability assessment of water samples

Although water is an indispensable resource for life, under certain circumstances it can also be an efficient vehicle for diseases transmission, evoking concern for water safety and quality as important matters (Wen et al., 2020; Forstinus et al., 2016). Access to safe water is a basic right for any animal and every animal needs clean water to drink (Peveler et al., 2015). Our study revealed the existence of microbiological indicators of recent fecal contamination in samples of water for domestic animals in the São Rafael slum.

Based on observations and dialogues with the residents during the collections, it was found that the habit of cleaning water tanks and other water reservoirs is not common. In addition, a previous study revealed that animal caretakers assumed that there was no need for regular cleaning frequency of water containers and tanks used for domestic animals watering (Martins et al., 2020). This lack of a cleaning habit significantly compromises water quality and permits high levels of thermotolerant coliforms to be formed (Bortoli et al., 2017), as detected, for example, in samples 9, 10 and 12. On the other hand, in waters considered potable, particularly in samples 4, 7, 8 and 11, recent fecal indicators were not detected, coinciding with the residences where the animal owners carried out daily change of water as well as frequent cleaning of the water containers.

Water is the main source of exposure of domestic animals to enterobacteria; the degree of infection seems to be associated with potentially controllable factors (LeJeune et al., 2001), such as a simple cleaning of water containers. The surfaces of these are suitable environments for colonization of biofilms (Obiofu et al., 2018), including those formed by enterobacteria (Abberton et al., 2016). Although coliform bacteria are less resistant under conditions outside their natural habitat (Davino et al., 2015), the risk of developing biofilms of pathogenic microorganisms, including enterobacteria, is greater when the receptacles store raw water, rich in organic matter (Kim and Han, 2014).

In addition, biofilms may be distributed inside along the pipes; the water collected in the taps may present a microbial concentration many times higher than that detected in storage tanks (Gora et al., 2020). This results from a greater accumulation of nutrients at the output terminal (Volk and LeChevallier, 1999).

Many sources of contamination and growth conditions of pathogenic microorganisms in the water for domestic animals can be enumerated (LeJeune et al., 2001). Some of these sources were observed in this study, namely: proximity of the water source to the animal feeder, protection of the water through from direct sunlight, presence of other animals sharing the same environment, presence of stagnant water with slime formation, bad habits of hygiene of owners in relation to water management and presence of debris in tanks and water troughs.

The highest deposit of sedimented debris in water vessels occurs during the animal’s act of drinking the water (Langenegger and Döbereiner, 1988). Accumulated at the bottom of the receptacle, debris serves as a nutrient for microorganisms, which, without proper cleaning of the tanks, increases the level of infection transmission (Dutra et al., 2001). The accumulation of nutrients may also favor an increase in the growth rate of pathogenic organisms, sometimes exceeding by 1,000 times the levels detected in the sediment and in the water column above (Ashbolt et al., 1993).

Both coliform bacteria and E. coli are universally used to assess the microbiological safety of water (Ahmed et al., 2015). These bacteria, however, are not necessarily pathogenic, but serve as indicators of contamination by fecal material and the risks of major infections that this contamination offers (Leclerc et al., 2001). One of the pioneering studies on the safety of water for domestic animals, related to animal welfare, was carried out with Psittaciformes (parrots, macaws and cockatoos, among others). Enterobacteria and other potentially pathogenic bacteria were detected, including Pseudomonas aeruginosa and Klebsiella spp. In addition, E. coli was present in 84% of samples from open containers and in 37% of bottles (Evans et al., 2009).

Due to the lack of knowledge of what microorganisms other than coliforms can threaten animal health, some authors have suggested the inclusion of new microbiological parameters, for example enteric viruses (Atoyan et al., 2011). In Brazil, the directive for animal water safety in microbiological terms only provides for the detection of up to 1,000 colonies per 100 mL of thermotolerant coliforms, (CONAMA, 2005). These levels are considerably different from the limit of water safety for humans, i.e., zero coliforms (Ministério da Saúde, 2021).

Recently, thermotolerant coliforms have been identified as key to the animal production industry (Erkan-Can, 2019). For decades, this sector has provoked many ethical discussions regarding the relationship between animal suffering and animal market value (Hsiao, 2017). Safe water provides, for example, a guarantee of higher quality milk production (Lardner et al., 2005; Murphy, 1992). Thus, the physical-chemical parameters of water safety have gained attention (Yonnana et al., 2015). However, the minimum and maximum allowances of organic and inorganic substances vary greatly among countries (Valente-Campos et al., 2014). In some cases, upper limits for different compounds are not even required, indicating
the need for standardization. It is also noteworthy that, for a more consistent analysis of water safety, other parameters than just microbiological ones should be included (Oliveira et al., 2018). However, there is a consensus that coliform analysis is the main parameter.

B. Speciesism on the part of animal owners as a basis of how they care for water supplied to animals

The present work observed an interesting fact: the perception of what makes water safe by the animal owners was not the same as their choice of which water source would be used for animals to drink from. In 86.5% of cases, dogs and cats were offered water from the same source as consumed by the owners, because these animals are thought of as family members (Fig 3). The chosen source of water is usually mineral bottled water or water from the Jaguaribe River, which is wrongly considered safe, because according to the animal owners’ perceptions, it did not present color, odor or foam formation.

On the other hand, the use of bottled water or water from the river was in contrast to the use of water from the municipal supply for other beings used for breeding/food (pig, poultry), transport (donkey) or mere adornment (passerines in cages). The habit of favoring members of a species over another is defined by speciesism (Singer, 2004). Based on the concept of speciesism, humans do not apply the principle of equal consideration to non-human animals. Speciesism also does not promote the abolition of domestic animals, and if there is no deconstruction of the property status or “thing status” with them, speciesism remains active (Francione, 2013). Additionally, speciesism attributes several distinct values according to the species: the animal has some value; not every animal has the same value; and human life is worth more than animal life (Frey, 1988).

![Registration of a residence during collection: “family member” dogs drink the same water consumed by the owners and have access to the house; pigs are confined and are offered municipal supply water, considered not potable for humans but suitable for “nonfamily” animals.](image)

In a recent study that evaluated water management by the residents of São Rafael slum over a three-year period, a speciesist profile was detected in this population. The same study estimated around 220 domestic animals in a census of animal population in the domiciles. Among them, dog was the most numerous. The dogs also were the greatest holders of affective memory among residents. In addition to dogs, cats were the second animal recognized as family members by 90% of the owners (Martins et al., 2020). This constitutes the main reason for differentiated care, including water selection for drinking and regular cleaning of water vessels. Even though this behavior is based on empirical decisions about water safety, it does not exempt either caretakers or animals from the consumption of unsafe water.

It is important to emphasize that speciesism is legitimized by society regardless of class or level of education (Durante et al., 2017). The determining factors are deeper and have cultural and religious roots (Wolf, 2000). Additionally, the construction of a hierarchy of animals by the animal owners or caretakers...
occurs unconsciously because they are close to or coexist in the internal environment of the residence. Living within or outside the household is based on the decision by the owners, who decide which are the supposedly "inferior" animals and which would be "superior", and treating them accordingly (Ryder, 2002).

This attitude is well evidenced by the fact that dogs and cats are the only beings designated by their owners as "animals". There is no recognition of a common term to define or differentiate the dog and cat from pig, fish, chicken, donkey or birds, except for words like "pig", "animal breeding", "thing for eating", "vehicle" and "object to adorn the house" (Martins et al., 2020). The fact that there is no recognition of what is or is not animal, interspecies relationships are quite complex, reaching levels that involve moral and ethical perceptions (Albersmeier, 2021; Caviola et al., 2019). In addition, a community that already lives under precarious sanitary conditions, and speciesism within speciesism is observed, all species are exposed to the same degree of risk.

Assuming that every animal must be treated equally and not as an inferior organism to human beings, the related concern with the safety of the water offered is still a neglected topic and little information is available in the literature (Edstron and Curra, 2003). For example: some of the published research is primarily concerned with safe water for experimental animals, especially with murinic models. Access to safe water may guarantee their welfare and reliable results. The safer the water, the less risk of stress or infections (Serre et al., 2004).

In addition, concern with drinking water safety for domestic animal reflects an interest in the cost and economic losses associated with the problems in the health and welfare of the domestic animal (Giri et al., 2020; Rahman et al., 2020; Sinclair et al., 2019; Hooda et al., 2000). In summary, the literature views the animal as a pathogen reservoir and a risk for disease transmission to humans (Belongia et al., 2003), as well as to what extent animal health is represented in losses in scientific experimentation (Evans et al., 2017) or in agrobusiness (Rehman et al., 2011).

Thus, the present work is focused on the relationship between the safety of water for domestic animals and the possible health risks involved in the consumption of unsafe water and how this is related to an assumption about which animals merit human treatment, a type of speciesism. There is agreement on the fact that other indicators should be proposed in the analysis of water given to animals to drink; future studies are needed to elucidate the degree of risk, including identification of new microbiological parameters, as well as development of methods to reduce contamination and/or detect it. It is also noteworthy that actions of environmental education may promote positive results in terms of ensuring harmonious coexistence between species.

V. CONCLUSION

A high percentage of water samples offered to domestic animals residing in the São Rafael slum was considered below safe water limits. In addition to demonstration of speciesist behavior towards animals, as well as a lack of good practices of hygiene and habits in water management, there was a false perception of what constitutes water safety, thus exposing both humans and animals to waterborne diseases. This work reports for the first time, data on the microbiological safety conditions of water for domestic animal drinking in São Rafael slum and assumes that this scenario is very similar in other subnormal urban agglomerations.

ACKNOWLEDGMENT

The authors express their respect and recognition to the residents who opened their doors to our researchers, as well as wish all the best to each animal that inhabits that site.

The English text of this paper has been revised by Sidney Pratt, Canadian, MAT (The Johns Hopkins University), RSA dip - TESL (Cambridge University)

FUNDING

Universidade Federal da Paraíba (Project PJ333-2017) – Practicing environmental health with animal owners in the São Rafael slum (PROBEX 2017 Call).

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.
REFERENCES

Abbeetan, C.L., Bereschenko, L., van der Wielen, P.W.J.J., & Smith, C.J. (2016) Survival, biofilm formation, and growth potential of environmental and enteric Escherichia coli strains in drinking water microcosms. Applied and Environmental Microbiology, 82, 5320-5331.

Ahmed, W., Sidhu, J.P.S., Smith, K., Beale, D., Gyawali, P., & Toze S. (2015) Distributions of fecal markers in wastewater from different climatic zones for human fecal pollution tracking in Australian surface waters. Applied Environmental Microbiology, 82(4), 1316-1323.

Alfors, M. (2021) Specieism and speciescentrism. Ethical Theory and Moral Practice, 24, 511-527.

Amare, L.A. (2004) Drinking water as a risk factor to poultry health. Brazilian Journal of Poultry Science, 6(4), 191-199.

APHA, AWWA, WEF. (2012) Standard Methods for the Examination of Water and Wastewater. Washington, DC.

Araújo, G.G.L., Volotolini, T.V., Chizzotti, M.L., Turco, S.H.N., & Carvalho, F.F.R. (2010) Water and small mammal reproduction. Revista da Sociedade Brasileira de Zootecnia, 39, 326-336.

Ashbolt, N., Grohmann, G., & Kiech C. (1993) Significance of specific bacterial pathogens in the assessment of polluted receiving water of Sydney. Water Science and Technology, 27, 449-452.

Atoyan, J.A., Herron, E.W., & Amador, J.A. (2011) Evaluation of microbiological water quality in the Pettaquamscutt River (Rhode Island, USA) using chemical, molecular and culture-dependent methods. Marine Pollution Bulletin, 62(7), 1577–1583.

Belongia, E.A., Chyou, P-H., Greenlee, R.T., Perez-Perez, G., Bibb, W.F., & DeVries, E.O. (2003) Diarrhea incidence and farm-related risk factors for Escherichia coli O157:H7 and Campylobacter jejuni antibodies among rural children. Journal of Infectious Diseases, 187(9), 1460-1468.

Bortoli, J., Rempel, C., Maciel, M.J., & Tavares V.E. (2017) A qualidade da água de desossedentação animal e a preservação das áreas de preservação permanente. Bemisamerican Journal of Environmental Sciences, 83(3), 170-179. Portuguese.

Bumadían, M.M., Almansury, H.H., Bozakouk, I.H., Lawga, C.L., & Almansory, H.H. (2020) Coronaviruses in farm animals: Epidemiology and public health implications. Veterinary Medicine and Science, 7, 322–347.

Cabrera, B.J.P.S. (2010) Water microbiology. Bacterial pathogens and water. International Journal of Environmental Research and Public Health, 7(10), 3657-3703.

Caviola, L., Everett, J.V.C., & Faber, N.S. (2019) The moral standing of animals: Towards a psychology of specieism. Journal of Personality and Social Psychology, 116(6), 1011-1029.

CONAMA. (2005). Resolução nº 357, de 17 de março de 2005. Dispõe sobre a classificação dos corpos de água e diretrizes ambientais para o seu enquadramento, bem como estabelece as condições e padrões de lançamento de efluentes, e dá outras providências. Brasília, DF. Portuguese.

Corson, M., & Doreau M. (2013) Assessment of water use by livestock. Products Animations, 26, 239-248.

Draugelis, K., Hopchow, A., Krautz, S., Klauss, H., & Plöchl, M. (2010) Water footprint analysis for the assessment of milk production in Brandenburg (Germany). Advances in Geosciences, 27, 65–70.

Durante, F., Tablante, C.B., & Fiske, S.T. (2017) Poor but warm, rich but cold (and competent): Social classes in the stereotype content model. Social Issues, 73(1), 138-157.

Dutra, I.S., Döbereiner, J., Rosa, I.V., Souza, L.A.A., & Nonato, M. (2001) Surto de botulismo em bovinos no Brasil associados à ingestão de água contaminada. Pesquisa Veterinária Brasileira, 21(2), 43-48. Portuguese.

Edberg, S.C., Rice, E.W., Kainr, R.J., & Allen, M.J. (2000) Escherichia coli: the best biological drinking water indicator for public health protection. Journal of Applied Microbiology, 88, 1065–1165.

Edström, E.K., & Curran, R. (2003) Quality assurance of animal watering systems. Lab Animal, 32(5), 32-35.

Eskan, M., & Doreau M. (2019) Evaluation of animal drinking water quality for cattle enterprises. Fresenius Environmental Bulletin, 28, 3527-3535.

Evans, E.E., Nettifee-Osborne, J., Webb, D., Jay, P., & Flammer, K. (2009) Assessment of microbial quality of water offered to captive psittacine birds. Journal of Avian Medicine and Surgery, 23(1), 10-17.

Evans, M. (2017) Water flow monitoring for automated systems: Edstrom FloSense. Lab Animal, 46(11), 436-437.

Falkenmark, M. (2020) Water resilience and human life support - global outlook for the next half century. International Journal of Water Resources Development, 36(2-3), 377-396.

Arens, A.A. (2002), Auditing in Australia: an integrated approach. 5th ed. Frenchs Forest: Pearson Education Australia.

Francione, G.L. (2013) Introdução aos direitos dos animais: seu filho ou seu cachorro? Campinas: Editora da Unicamp.

Frey, R.G. (1988) Moral standing, the value of lives, and speciesism. Between Species 4(3), 191-201.

Forstius, N.O., Ikkoszukwa, N.E., Enomike, M.P., & Christiansa, A.O. (2016) Water and waterborne diseases: A review. International Journal of Tropical Diseases, 12(4), 1-14.

Gerbens-Leenes, P.W., Mekonnen, M.M., & Hoekstra, A.Y. (2013) The water footprint of poultry, pork and beef: A comparative study in different countries and production systems. Water Resources and Industry, 1-2, 25-36.

Giri, A., Bharti, V.K., Kalia, S., Arora, A., Balajee, S.S., & Chaurasia, O.P. (2020) A review on water quality and dairy cattle health: a special emphasis on high-altitude region. Applied Water Science, 10(79). https://doi.org/10.1007/s13230-020-1160-0

Gora, S.L., Soucie, T.A., McCormick, N.E., Ontiveros, C.C., L’Herault, V., Gavin, M., et al. (2020) Microbiological water quality in a decentralized Arctic drinking water system. Environmental Science and Water Research Technology, 6, 1855. https://doi.org/10.1039/d0w00019a.

Graaf, D.C., Vanopdenbosch, E., Ortega-Mora, L.M., Abassi, H., & Peeters, J.E. (1999) A review of the importance of cryptosporidiosis in farm animals. International Journal of Parasitology, 29, 1269-1287.

Harpreet, K., & Daljit, K. (2008) Prevalence of gastrointestinal parasites in domestic animals of Patiala and its adjoining areas. Journal of Veterinary Parasitology, 22,13–17.

Holland, R.E. (1990) Some infectious causes of diarrhea in young farm animals. Clinical Microbiology Reviews, 3(4), 345-375.

Hooda, P.S., Edwards, A.C., Anderson, H.A., & Millera, A. (2000) A review of water quality concerns in livestock farming areas. Science of the Total Environment, 250(1-3), 143-167.

Hsiao, T. (2017) Industrial farming is not cruel to animals. Journal of Agricultural and Environmental Ethics, 30, 37-54.

Hubbard, R.K., Newton, G.L., & Hill, G.M. (2004) Water quality and the grazing animal. Journal of Animal Sciences, 82, E255–E263.

IBGE. (2021, May 16). Censo demográfico 2010: aglomerados subnormais - primeiros resultados. https://biblioteca.ibge.gov.br/visualizacao/periodicos/92/cd_2010_aglomerados_subnormais.pdf.

ISO (2008). Water quality – Determination of pH (ISO 10525:2008).

Kawale, A.M., & Salve, P.A. (2012) Determination of physical-chemical parameters of Deoli Bhrorus dam water. Advances in Applied Sciences Research, 3(1), 273-279.

Kboua, M.K., Jedidi, M.D., Zaalouri, F.B., & Benzarti, M. (2020) Coronaviruses in farm animals: Epidemiology and public health implications. Veterinary Medicine and Science, 7, 322–347.

Kim, M., & Han, M. (2014) Characteristics of biofilm development in an operating rainwater storage tank. Environmental Earth Sciences, 72, 1633-1642.

DOI: http://dx.doi.org/10.24018/ejdevelop.2022.2.1.70 Vol 2 Issue 1 February 2022 19
