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EFFECT OF SALINITY ON BALI CATTLE IN EAST TIMOR

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ABSTRACT

The objective of this study was to determine the salinity level toleration of Bali cattle in East Timor, using the live-weight response method. The *ad libitum* water intakes of cattle eating Leucaena forage, coffee skin and rice straw were also measured. The research was undertaken in Dili, East Timor from 9th September to 3rd November 2019. There were three experimental periods, and each period included a 1-week adjustment period. There were 1-week rest periods between periods 2 and 3. Ten Bali cattle (*Bos javanicus*) bulls were used in this experiment. The bulls were between one and a half and two years of age, and weighed 202 ± 18.52 kg (mean ± sd, range from149 to 235 kg). The ration used in this experiment was a mixture of fermented coffee skins, rice straw and Leucaena leaf – DM basis, Protein ration was 14% and digestible energy was 50% (or 7.5 MJ ME/kg DM). Salt levels were offered: 1000, 3500, 6000 and 8500 mg/L. The feed consumption of Bali cattle offered vary level of salinity was range from 11.58 to 12.57 kg/d DM. All treatments have changed live-weight positively (average 0.56) ranged from 0.23 to 0.76 kg/d, the drinking water was ranged from 19.25 to 25.73 L/d. The average of TDS intake was 6. 038,99 ppm. **Conclusion:** Bali cattle can tolerate salinity to 8500 in East Timor.

KEYWORDS: Bali cattle, salinity, live-weight change.

1. INTRODUCTION

Water is an essential nutrient for animals. It is important for animals to have an adequate supply of good quality water to maintain satisfactory production. The amount and quality of water needed varies between species of animals, between classes in the same species, between different types of feed, and in response to the animals' environment.

Drinking of highly saline water by livestock has been found to lead a range of health problems. Occasionally such water is high in salt which may cause physiological upset or even death in livestock. The main reported effect is depression of appetite, which is usually caused by a water imbalance rather than related to any specific ion. The most common exception is water containing a high level of magnesium which is known to cause scouring and diarrhoea (Faries *et al*. 1914).

Water is an essential nutrient for humans and livestock and drinking water is the primary source of water for most cattle (Irsik 2013). Water is required for the regulation of body temperature, as well as for growth, reproduction, lactation, digestion, metabolism, excretion, hydrolysis of nutrient, transport of nutrients and waste, joint lubrication plus many other functions.

Therefore, it is important that cattle have an adequate supply of good quality water. Amount and quality of water required vary between species of livestock, between classes of stock within species, and in response to the environment in which the stock is inhabiting (Markwick, 2007). Average water requirements of cattle dry stock 25-50 L/d, lactating cows 40-100 L/d and young stock 25-50 L/d. (PIRSA Livestock Industry 2006).

In evaluating the usability of any particular water, local conditions and availability of alternative supplies will play an important role (National Academy of Sciences, 1974), and a number of factors should be considered: (1) Water source: Small shallow wells and streams are more likely to become contaminated or produce poor quality water than are the larger wells and flowing streams. Also groundwater is likely to be more chemically imbalanced than surface water; (2) Seasonal changes: Marginal quality water may become unsuitable in hot dry periods because of: (a) increases in natural salinity due to evaporation during these periods; (b) increased water consumption by the animal due to the heat and increased intake of dry feed; (c) very high evaporation from stock watering ponds or tanks during these periods with the resulting higher salt concentration; and (d) increased water temperature; (3). Age and condition of the animal: Lactating, young and weak animals are normally more susceptible; (4) Feed composition: Dry pastures and high protein supplementary feed in place of previously green pastures may reduce the salinity tolerance of the animal due to the lower moisture content of the feed and higher salt content (intake of some feed supplements are purposely controlled by additions of salt to slow consumption); (5). Species: Variation in tolerance to water salinity is considerable between animal species.

The most important aspect of water as a nutrient is generally the quantity consumed. Depression of water consumption due to contaminants is more common than an imposed mineral imbalance. Some salts and other elements when found in water at higher levels may reduce animal growth and production or may cause illness and death (Marwick, 2007). Curran and Robson (2007) revealed that when considering whether a water source is suitable for livestock, it is essential to test: acidity (pH), salinity and chloride levels. In additional, due to their physiological adaptability many animals are able to ingest a wide variety of different types of water and survive. The measures used to evaluate water quality include pH, hardness, salinity, sulphate, nitrate, and analysis for other specific elements known to be toxic (National Academy of Science 1974).

Hardness is a measure of the concentration of divalent metallic cations (++ charged) dissolved in water and is generally expressed as the sum of calcium and magnesium concentrations expressed as equivalents of calcium carbonate. Other divalent metallic cations such as iron and Manganese can contribute to hardness, but concentrations are usually much lower than calcium and magnesium. Trace element nutrition research indicates that waters with high iron concentrations (greater than 0.3 mg/L) can affect cattle health and performance by impacting copper and zinc absorption. Limited research also suggests that high levels of dietary calcium consumption (greater than 12.5 g calcium/kg diet) can reduce selenium absorption. Hard waters can also be problematic to low pressure and low flow watering systems due to the accumulation of insoluble calcium and magnesium carbonate deposits. Producers located in karst regions should give additional consideration to hardness because elevated levels of calcium and magnesium are associated with limestone (karst) geology. Hardness guidelines are: 0-60 mg/L is soft; 61-120 mg/L is moderately hard; 121 – 18- mg/L is very harda and >35 mg/L is brackish (Irsik 2007).

The presence in animals’ drinking water of high concentrations of some inorganic salts such as chlorides, sulphates and bicarbonates of calcium, magnesium and sodium, may cause harmful effects resulting in poor performance, illness or even death (Irsik. 2007)

Water for domestic and livestock used should be in the pH range of 6.5 to 8.5 (Curran and Robson, 2007). Less than 5.5 indicated the pH is highly acidic: acidosis and reduced feed intake may occur. Moreover, highly alkaline water (over 9) may cause digestive upsets and diarrhoea, lower feed conversion efficiency and reduce intake of water.

Another principal factor affecting water quality is the amount of total dissolved salts (TDS) in the water, also referred to as the water "salinity". Salinity is the presence of high levels of soluble salts in soils or waters. Curran and Robson (2007) revealed that salinity is the sum of all, mineral salt present in the water, including sodium, calcium, magnesium, chloride, sulphate and carbonate. Dissolved salts in water are expressed in milligrams per litre (equivalent to part per million – ppm (or in terms of the electrical conductivity of the water, measured in deciSiemens per metre (dS/m) or microSiemens per centimetre (µS/cm); its conversion is 1 dS/m = 1000 µS/m = approx. 640 mg/L or 640 ppm (Markwick, 2007). The relationship is varies considerably between waters

The effects of salinity on stock depend on: (1) the species, breed, age of the animal's drinking water. (2) The water and mineral content of the feed the animals are consuming; (3) temperature (climate temperature, and water temperature); and (4) which minerals are present in the water (Curran and Robson, 2007). These factors must be considered when determining the suitable of water source.

Runyan *et al.* (2009) suggested salinity level limits for different classes of livestock as follows: (1) Less than 1,000 milligrams per litre (mg/l). Considered low. Excellent for all classes of livestock and poultry. (2) 1,000-2,999 mg/l. Very satisfactory for all classes of livestock and poultry. Temporary, mild diarrhoea in livestock or watery droppings in poultry may be noticed in animals not accustomed to this level of salinity. (3) 5,000-6,999 mg/l. Marginal quality for beef cattle, sheep, swine, and horses. Water this saline should not be used for pregnant or lactating animals and it is not suitable for poultry. (4) 7,000-10,000 mg/l. Considerable risk for pregnant or lactating cows, horses, sheep, or immature animals of any class. Avoid use for all animals if possible; however, older animals may subsist on water of this quality under certain conditions. (5) Over 10,000 mg/l. Because of high risks associated with such saline water, regard it as unusable under any condition.

Curran and Robson (2007) found that within a population of animals, the individual animal's tolerance will vary. When saline water is used, livestock should be monitored for symptoms of salt poisoning such as: excessive thirst, abdominal pain, increased urination, nasal discharge, lack of appetite, vomiting diarrhoea, nervous signs (such as star-gazing, tremors, blindness, circling, walking backwards, head pressing, wobbly in the legs, knuckling at the fetlocks), lying down, convulsions and death.

Underground water throughout Timor Leste may contain dissolved salts in excess of animals' capacities to tolerate them, but this is not known as no surveys of Timor Leste stock waters have been conducted. In Australia, underground waters may contain as much as 3,500 mg TDS/L (Holmes and Waterhouse 1983; Saul and Flinn 1985). In fact, groundwater near Deniliquin in NSW may have as much as 40,000 mg/L (Watkins and Bauld 1999), and groundwater from the Queensland/NSW border region contain between 270 and 26,500 mg/L (Please, *et al* 2000).

The effects of saline water on *Bos taurus* cattle, and sheep, are well known. Tolerances (mg TDS/L) suggested by Inglis (1985) are: sheep, 13,000; beef cattle, 10,000; dairy cattle, 6,000. Ruminant animal feeding standards (CSIRO 2007; Dryden 2008) suggest maximum TDS levels (mg/L) of 3,500 to 4,000 for lambs and calves, 4,500 to 6,000 for adult, dry stock, 6,000 to 10,000 for dry adult sheep and cattle, and 15,000 for dry, adult sheep. Dissolved magnesium salts may represent a particular hazard to stock. CSIRO (2007) recommends an upper limit of 600 mg Mg/L for ruminants.

There are no data on the ability of Bali cattle to tolerate salts in water. Further, there is no information on the TDS contents of waters in Timor Leste. It is clear from this that work on responses by Bali cattle to water salinity is urgently needed. It is expected that tolerances will be similar to those for *Bos taurus* and *Bos indicus* cattle, as the water: dry matter intake ratios measured by Yuliaty (2013) are similar to those reported for *B. indicus* and *B. taurus* cattle eating similar feeds. Therefore, in this research 8500 mg/L was planned as the highest TDS level. The purpose on this research was to measure how highly saline water may impact on Bali cattle. In this research, the approach used to find out how water salinity might impact on livestock in East Timor, Therefore the study focus on to measure the effect on Bali cattle of consuming water with different salinity levels. Obtain further information on the nutritive composition of cattle feeds commonly used by farmers in East Timor.

Research Methods

This experiment was conducted in Loes, Atabae, East Timor over 55 days, from 9th September to 3rd November 2019. There were three experimental periods, and each period included a 1-week adjustment period. There were 1-week rest periods between periods 2 and 3. Ten Bali cattle (*Bos javanicus*) bulls were used in this experiment. The bulls were between one and a half and two years of age, and weighed 202 ± 18.52 kg (mean ± sd, range from149 to 235 kg).

A randomised incomplete blocks design (Cochrane and Cox 1992) was used, in which each bull (block) received three of the five treatments. Each period of the experiment was 21 days (7 days rest given the control water, 7 days gradual adaptation to the allocated salinity treatment level, 7 days water and food intake measurements).

The ration used in this experiment was a mixture of fermented coffee skins, rice straw and leucaena leaf – DM basis (Table 1). The proportion ration were rice straw 39%, coffee skins 15% and Leucaena 55%. Amount of water was used 4 L/kg DM (Yuliaty, 2013) and salt levels were offered: 1000, 3500. 6000 and 8500 mg/L. Animals had *ad lib* access to water.

Table 1: Feed Composition.

Nutrient	Fermented coffee skin	Rice straw	Leucaena
DM (%)	85.78	79.94	42.5
Crude Protein (%)	3.65	21.05	3.64
NDF (%)	92.84	87.87	46.99
Na (%)	0.04	0.1	0.24
Ca (%)	0.44	0.17	1.82
GE (MJ/kg DM)	4722.4822	3550.9162	4593.5737

RESULTS AND DISCUSSION

Effects of salinity on Bali cattle

The responses of Bali cattle to drinking saline water: effects on feed consumption. Live weight change, drinking water, Total dissolved solids intake, are described in Table 2.

Table 2: Responses of Bali cattle to drinking saline water: effects on feed consumption, live weight change, drinking water, total dissolved solids intake.

Response of	Treatment					Mean
	Control	1000 mg/L	3500 mg/L	6000 mg/L	8.500 mg/L	
Feed Intake (Kg/d) DM (P = 2.99)	12.21 ± 1.79	12.41 ± 1.14	12.57 ± 2.07	11.79 ± 1.90	11.58 ± 2.56	12.11 ± 1.89
Live-weight change (Kg/d) DM (P = 0.73)	0.76 ± 0.66	0. 63 ± 1.09	0.54 ± 0.86	0.23 ± 0.46	0.63 ± 1.15	0.56 ± 0.88
Drinking water L/d (P = 0.21)	19.25 ± 8.51	15.65 ± 2.31	23 ± 12.09	20.01 ± 8.60	25.73 ± 11.53	20.28 ± 3.88
TDS water (ppm) intake	2135.97 ± 431.85	3005.49 ± 656.67	5808.91 ± 1176.58	8505.80 ±1455.97	10738.70 ± 2454.77	6038.99 ±3628.41

The feed consumption of Bali cattle offered vary level of salinity was range from 11.58 to 12.57 kg/d DM. All treatments have changed live-weight positively (average 0.56) ranged from 0.23 to 0.76 kg/d. Drinking water was ranged from 19.25 to 25.73 L/d while crude protein was around 2.05 (range from 1.94 to 2.11). The average of TDS intake was 6. 038,99 ppm.

The main aim of this study was to measure the effect of different level salinity offered to Bali cattle on “production” (i.e. live weight gain, FCR) and to investigate salinity condition of water in East Timor. Another aim was to evaluate feed local chemically and tolerate range of Bali to the feed.

There were not significant all the variables except on TDS consumptions ($P<0.01$). Feed local where used indicated not bad effect on Bali bulls.

Feed used in this study were local feed which commonly use such as Leucaena and non-conventional feed such rice straw and coffee skin. The nutritive value of the feed is similar to that intended, but the protein content of leucaena and coffee skin were lower than the reference data used to formulate the ration (21 % compared to 25% by assumed and 3.65 % compared to 10% by Yonathan 2010). In future work, as it appears that published nutritive value data may not apply to East Timorese feeds, it would be advised to test the ingredients before formulating experiment diets.

Live weight change

In this study found that the highest live weight gain were positive at all levels of salinity offered included the control or no added salt. The average of live weight gain was 0.56 (± 0.88) and ranged from 0.23 to 0.76 kg per day. The growth rates are likely to be higher than highest value in previous research by Yuliaty (2013) found Bali cattle fed solo leucaena gain weight was 0.26 kg/d. The research result also within ranged of study by Mastika et al. (1996) was 0.76 and Bamualim and Widahayati worked on Bali cattle e fed 60% grass and 40% legume leaf revealed weight gain ranged from 0.2 to 0.8 kg/d. Even though the results of live weight gain were moderate but statistical analysis revealed that salinity level offered had not significant effect on live weight change. This could be explained that the measurements period was very short time so there was not enough time to see The effect of salinity on livestock weight change. Another possibility is different salinity levels are not expected to change live-weight because unless they have a major effect on feed intake (this could happen if water intake was very low and may be due to Bali cattle can tolerate well salinity on 8500 mg/L.

Drinking water

Drinking water requirement of cattle is influenced by the animal's genotype, its age, physiological status, activity or productivity, food intake and food quality and climatc conditions (Dryden 2008), water intake in this study ranged from 15.65 to 25.73 L.d. The previous research (Yuliaty 2013) found that water intake of Bali cattle in East Timor feed different level of energy was 8 to 17 L per day with mean was 11. 00 ± 1.37 L/d. The result was in range by NRC (2001) and Dryden (2008) which found that water intake of growing beef cattle is about 15 to 67 L/d.

Water quality is important in maintaining water consumption; in the semi-arid zone many of the sources contain salts that will result in a high salt intake (CSIRO 2007). Water salinity has been shown to affect both water and food consumption (Dryden 2008). The water used in this experiment was from an underground source, and although its composition was probably similar to river water, this study found that water salinity offered was not affected on water drinking of Bali bulls.

In this experiment the feed diet were contain fibre- and protein-rich, and all of these increase the water requirement (for excreting undigested fibre and for excreting urea formed from excess protein). Ruminants tend to drink more water when they are offered feed of higher protein content (NRC 1981). The increased water intakes were associated with higher dietary protein content when the animal has to excrete urea produced from the deamination of excess amino acids (Agricultural Research Council 1980). Yape Kii and Dryden (2005) found that water consumption by rusa deer (*Cervus timorensis*) stags was influenced by different types of feed. The study found that deer consumed more water when fed oaten hay and that this was related to the higher NDF of this feed. It may be that the water intakes measured in this experiment are higher than would be expected when grass or straw was a main diet component.

Total dissolved solid intake

One of indicator of water quality is salinity content. In this experiment the salinity level offered was within safe range for livestock. The average salinity water was 6036.99 (±3628.41) ranged from 2.135 to 10.738,70 ppm. Recommendation was revealed that water salinity level 7.000 to 10. 000 is considerable risk in using for pregnant or lactating cows, cattle in confinement (Thiex and German 2004).

The maximum salinity water consumption on this research was highest that recommended by Westrup (2013) for sheep could be tolerated water salinity about 1000 mg/L ppm however interestingly in this study unhealthy salinity effect on 8500 was not found. That could be explained that Bali bulls have higher level tolerate to saline water than other breeds.

CONCLUSION

Bali bulls can tolerate salinity to 8500 ppm due to there was not indicated symptoms unsuitable on healthy matter and increased live-weight change. Saline water in East Timor is suitable for Bali cattle shown by shown not bad effect on productivities such live weight change, ration efficiency. Water from water sources' in East Timor is suitable for livestock. Non-conventional feed such coffee skin and rice straw can utilize as feed alternatively for Bali cattle in East Timor especially during dry season.

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