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## Short Communication

# Creatinine excretion and relationship with body weight of Nellore cattle[1]

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**ABSTRACT** - The objective of this study was to estimate the urinary creatinine excretion by the shrunk body weight (SBW). In experiment I, 32 Nellore bulls with initial body weight of 259±24.9 kg and 14±1 months-old were used. The group was divided in four animals to maintenance and twenty eight animals feeding *ad libitum* and separated in four groups; each group was slaughtered at different times of feedlot (42, 84, 126 and 168 days). The diet was composed of corn silage and concentrate (55:45). Before the slaughters, the total urinary collection was realized during three days. A database of creatinine excretion was collected from other five studies that had been conducted with Nellore cattle. In all the studies, the total urinary collection was realized during at least three days. At the end of each collection, the animals were weighted. Urinary creatinine excretion (UCE) was related with the shrunk body weight and it can be estimated by the equation: UCE (g/day) = $0.0345 \times SBW^{0.9491}$.

Key Words: crude protein, muscle tissue, total collection, urine

## Introduction

One of the biggest problems found in the experiments conducted with cattle is the total urinary collection to estimate the purine derivatives in urine. There are two main situations that make the use of indirect measures to estimate the urinary creatinine excretion in grazing and lactating animals necessary. In grazing animals, the total urinary collection is virtually impossible. In lactating animals, the problem would be the large volume excreted in 24 hours, and the management at the time of milking would require the displacement of the animals, which would hamper the total collection.

Plasma creatinine is the product of muscle creatine catabolism. Creatine is a metabolite that is used to store energy in the muscle through its conversion into phosphocreatine. The daily degradation of phosphocreatine into creatinine produces approximately 2% of total creatine. The conversion of phosphocreatine into creatinine is a non-enzymatic irreversible reaction that is dependent on stoichiometric factors. Creatinine excretion takes place only via kidney, as it is neither reabsorbed nor reused by the body (González & Scheffer, 2002).

In most of the studies in the literature (Schroeder et al., 1990; De Campeneere et al., 2000), the urinary creatinine excretion is related linearly with the body weight. This suggests that the relationship between creatinine excretion and body weight could follow the same relationship that there is between muscle tissue or crude protein and the body weight; therefore, the best way to estimate the urinary creatinine excretion by the body weight could be using allometric equations.

Therefore, the objective of this study was to evaluate the relationship between the urinary creatinine excretion (UCE) and the shrunk body weight (SBW) of Nellore cattle by meta-analysis.

## Material and Methods

The urinary creatinine excretion (UCE) was obtained by an experiment with Nellore bulls which were slaughtered with different weights. After, these data were analyzed together with the data obtained in five other studies with Nellore cattle using meta-analysis to estimate the UCE by the shrunk body weight.

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In experiment I, 32 Nellore bulls with initial body weight of 259±24.9 kg and14±1 months-old were used. Four bulls were fed maintenance diet (1.1% of body weight) and 28 bulls were fed *ad libtum* and separated into four groups; each group was slaughtered at different times in feedlot (42, 84, 126 and 168 days). The experiment was realized in a completely randomized design. The diet was formulated to contain 12.5% crude protein (CP), as recommendation of Valadares Filho et al. (2010),1.5 kg of gain per day and to consist of 55% corn silage on a dry matter basis and 45% concentrate based on corn, soybean meal, urea/ammonium sulfate, limestone, mineral salt and mineral mix.

Four animals per treatment (sixteen bulls) were fed in Tie Stall system. The other three animals per treatment (twelve bulls) and the maintenance were fed in collective stalls with individual feeding (electronic gates) with total area of 50 $m^2$ with 8 $m^2$ of covered area.

During three consecutive days before the slaughter, total urine collections were realized for each of the four periods of feedlot. Urine was collected using collecting funnels, which were coupled to the animals by hoses leading to gallon-sized urine containers kept in coolers with ice to eliminate the loss of nitrogen via ammonia and to preserve creatinine. At the end of each 24 hours, the total weights and volumes of urine were determined. Later, the contents of the containers were homogenized, and for each, a 50-mL urine sample was then collected without dilution for evaluation of creatinine excretion. After three days of collection, one urine sample per animal, which was proportional to the daily production, was stored at -20 ºC and taken for subsequent laboratory analysis.

The urine creatinine analysis followed the protocol described by George et al. (2005) for high-performance liquid chromatography (HPLC).

The data of UCE were described by Pereira (2009), Barbosa et al. (2006), Barbosa et al. (2011) and Gionbelli (2010) (Table 1).

Three basic models were evaluated by data using six studies:

Allometric: $Y = \beta_0 \times X^{\beta 1}$

Linear with intercept: $Y = \beta_0 + \beta_1 \times X$

Linear without intercept: $Y = \beta_1 \times X$

The daily creatinine excretion, in g/day and mmol/day was regressed in body weight using linear and non-linear models in procedures MIXED and NLMIXED of SAS (Statistical Analysis System, version 9.1) respectively. The models included the body weight and study as fixed and random effects, respectively. Several structures of covariance/variance were adjusted; the variance components structure was selected because it has the lowest corrected Akaike information criterion value. The degrees of freedom of the tests were adjusted using the Kenward-Roger method. For all comparisons, the critical level of probability for type I error was $P<0.05$.

## Results and Discussion

The confidence interval (CI) of UCE was CI $(\mu)_{0.90}$ = $(22.28 \leq \mu \leq 29.52)$ (Table 2). Values obtained in the literature

Table 1 - Data grouping to relate urinary creatinine excretion (UCE) and shrunk body weight (SBW)

| Experiment | n | Gender | SBW (kg) | Treatments | Diets | Collection |
|---|---|---|---|---|---|---|
| Pereira (2009) | 4<br>3<br>8 | Heifers | 127±24.2<br>221±22.3<br>434±29.2 | Low voluntay; Medium voluntary; High voluntary and high restricted (1.3% BW) | 60% of corn silage; 30% of concentrate and 10% of cottonseed | Three consecutive days before the slaughters; 200 mL of 20% sulfuric acid in gallons; Mean value of creatinine of three days. |
| Barbosa et al. (2006) | 4<br>4<br>4<br>4 | Steers<br>Bulls<br>Heifers<br>Lactation cows | 242±27.14<br>265.2±28.9<br>242.1±20.4<br>466.8±71.4 | Two concentrate levels (25 or 50%) | Corn silage and concentrate in proportions of 25 (period I) or 50% (period II) (12% CP) | Six consecutive days; 200 mL of 20% sulfuric acid in gallons; Mean value of creatinine of six days. |
| Barbosa et al. (2011) | 8 | Heifers | 258±20 | Levels of 1.2; 1.6; 2.0 and 2.4% BW | 60% of corn silage and 40% of concentrate (12% CP) | Six consecutive days; 200 mL of 20% sulfuric acid in gallons; Mean value of creatinine of six days. |
| Barbosa et al. (2011) | 8 | Heifers | 296±15 | Four abomasal infusion of RNA (Torula yeast, type VI, Sigma®) (1.2 % BW) | 60% of corn silage and 40% of concentrate (12% CP) | Six consecutive days; 200 mL of 20% sulfuric acid in gallons; Mean value of creatinine of six days. |
| Gionbelli (2010) | 3 | Heifers | 160±42.6 | Two concentrate levels (22.5 or 45%); maintenance (1.1% BW) | Corn silage and concentrate (13% CP) | Three consecutive days; 200 mL of 20% sulfuric acid in gallons; Mean value of creatinine of three days. |

BW = body weight; CP = crude protein.

for growing animals are 27.36 mg/kg body weight (BW) (Rennó et al., 2003), 27.99 mg/kg BW (Chizzotti et al., 2008) and 25.47 mg/kg BW (Leal et al., 2007), which are between the confidence interval obtained in this study. In addition to lactation, studies with cows had values that are also between the confidence interval obtained by this study: 23.41 mg/kg BW (Oliveira et al., 2001) and 24.04 and 24.07 mg/kg BW (Chizzotti et al., 2008).

Since the diet of the animal is correctly balanced, the protein percentage decreases and the deposition of fat increases in empty body as the animal approaches the maturity weight. This maturity weight is considered when the weight gain has little protein added (Reid et al., 1955). Considering growing animals, the creatinine excretion, expressed in mg/kg BW, alters due to variation in the percentage of muscle tissue in function of the body weight (Chizzotti et al., 2008).

Some researchers (Van Niekerk et al., 1963; Forbes & Bruining, 1976; Schroeder et al., 1990) found evidence that the urinary creatinine excretion is highly correlated with the body weight of animals or their amount of muscle tissue. The differences between animals are larger than the differences between the excretions from one day to another in the same animal. Furthermore, it is assumed that muscle tissue does not vary from one day to another or that the variation that occurs is minimal. Thus, it can be expected that the daily excretion of creatinine be proportional to the amount of muscle tissue in some animals (Lofgreen & Garrett, 1954).

Because the muscle in animal body is highly related with the body weight (BW), the urinary creatinine excretion (UCE) can be also related with BW. Thus, the database was assembled by five other experiments conducted using Nellore cattle to relate the UCE and the BW (Table 3).

The confidence interval (CI) of the intercept indicated that it differs from zero [$CI(\mu)_{0.90} = (0.10 \leq \mu \leq 0.86)$] and the CI of exponent of the allometric model differed from one [$CI(\mu)_{0.90} = (0.90 \leq \mu \leq 0.99)$]. It shows that the models estimate differently UCE by the BW. However, the allometric model showed lower corrected Akaike information criterion and this model is considered the best to explain the data behavior. Since the relation between the muscle and the BW is allometric and the creatinine excretion is linearly related with muscle, the relation between creatinine excretion and BW should also be allometric. Therefore, it suggests that the best model to evaluate the relation between creatinine excretion and BW is the allometric one. Thus, the equation to estimate the UCE by the BW is UCE (g/day) = $0.0345 \times SBW^{0.9491}$.

Schroeder et al. (1990) obtained the proportion of 20.7 mg of UCE to each increase of 1 kg of BW [UCE (g/day) = 2.45 + 0.021 × SBW]. As for the equation developed by Schroeder et al. (1990) and meta-analysis, it overestimates the creatinine excretion especially for lighter animals (Figure 1), while the equation developed by this study suggests that the urinary creatinine excretion increases with the increase in SBW, but in smaller proportion.

The amplitude and the data quantity used for the development of this equation are greater than those used by Schroeder et al. (1990). Therefore, it is considered that in situations where the urinary collection is an obstacle, the use of this equation is an alternative when the knowledge of UCE is relevant in the study. On the other hand, if the equation intercept of Schroeder et al. (1990) were considered, it would overestimate the urinary creatinine excretion and the equation would still consider that cattle excretes creatinine with zero body weight.

Table 2 - Description of grouping data of the six studies

| Items | n | Mean | SD | Maximum | Minimum |
|---|---|---|---|---|---|
| SBW (kg) | 174 | 313.17 | 94.23 | 565.40 | 96.50 |
| UCE (g/day) | 174 | 8.03 | 2.39 | 15.16 | 1.07 |
| UCE (mmol/day) | 174 | 71.03 | 21.13 | 134.00 | 9.48 |
| UCE/SBW (mg/kg) | 174 | 25.90 | 2.20 | 32.39 | 17.73 |

n = observations; SD = standard deviation; SBW = shrunk body weight; UCE = urinary creatinine excretion.

Table 3 - Equations to estimate the urinary creatinine excretion (UCE) by shrunk body weight (SBW, kg)

| Model | n | $s_{x.y}$ | AICc |
|---|---|---|---|
| | g/day | | |
| $UCE = 0.4816_{\pm 0.2162} + 0.0242_{\pm 0.0007} \times SBW$ | 174 | 0.546 | 294.5 |
| $UCE = 0.0256_{\pm 0.0003} \times SBW$ | 174 | 0.554 | 297.9 |
| $UCE = 0.0345_{\pm 0.0054} \times SBW^{0.9491 \pm 0.0257}$ | 174 | 0.546 | 281.4 |
| | mmol/day | | |
| $UCE = 4.2572_{\pm 1.9110} + 0.2139_{\pm 0.0063} \times SBW$ | 174 | 4.824 | 974.4 |
| $UCE = 0.2265_{\pm 0.0031} \times SBW$ | 174 | 4.902 | 982.2 |
| $UCE = 0.3048_{\pm 0.0475} \times SBW^{0.9491 \pm 0.0257}$ | 174 | 4.824 | 970.1 |

n = observations; AICc = corrected Akaike information criterion.

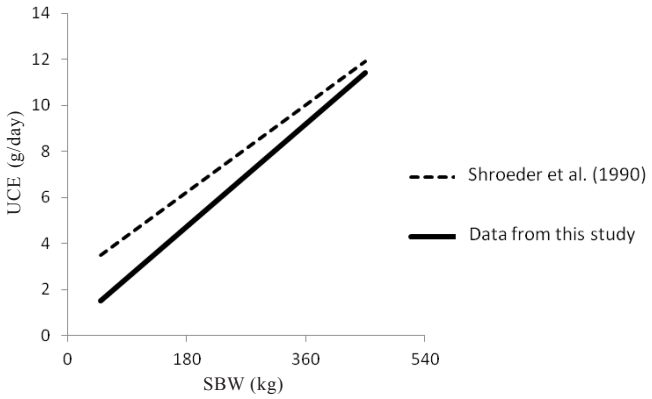


Figure 1 - Comparison of equations to estimate the urinary creatinine excretion (UCE) (g/day) by the shrunk body weight (SBW, kg).

## Conclusions

The urinary creatinine excretion in Zebu cattle can be estimated by body weight, through the equation: UCE (g/day) = $0.0345 \times SBW^{0.9491}$.

## References


BARBOSA, A.M.; VALADARES, R.F.D.; VALADARES FILHO, S.C. et al. Efeito do período de coleta de urina, dos níveis de concentrado e de fontes protéicas sobre a excreção de creatinina, de uréia e de derivados de purina e a produção microbiana em bovinos Nelore. **Revista Brasileira de Zootecnia,** v.35, n.3, p.870-877, 2006.

BARBOSA, A.M.; VALADARES, R.F.D.; VALADARES FILHO, S.C. et al. Endogenous fraction and urinary recovery of purine derivatives obtained by different methods in Nellore cattle. **Journal Animal Science**, v.89, p.510-519, 2011.

CHIZZOTTI, M.L. VALADARES, S.C.; VALADARES FILHO, R.F.D. et al. Determination of creatinine excretion and evaluation of spot urine sampling in Holstein cattle. **Livestock Science**, v.113, n.2-3, p.218-225, 2008.

DE CAMPENEERE, S., FIEMS, L.O., BOUCQUÉ, C.H.V. *In vivo* estimation of body composition in cattle. **Nutrition Abstracts and Reviews, Series B, Livestock Feeds and Feeding**, v.70, n.7, p.495-508, 2000.

FORBES, G.B., BRUINING, G.J. Urinary creatinine excretion and lean body mass. **American Journal of Clinical Nutrition**, v.29, p.1359-1366, 1976.

GEORGE, S.K.; DIPU, M.T.; MEHA, U.R et al. Improved HPLC method for the simultaneous determination of allantoin, uric acid and creatinine in cattle urine. **Journal of Cromatography B**, v.832, p.134-137, 2005.

GIONBELLI, M.P. **Desempenho produtivo e exigências nutricionais de fêmeas Nelore em crescimento**. 2010. 101f. Dissertação (Mestrado em Zootecnia) – Universidade Federal de Viçosa, Viçosa, MG.

GONZÁLEZ, F.H.D.; SCHEFFER, J.F.S. Perfil sanguíneo: ferramenta de análise clínica metabólica e nutricional. In: CONGRESSO NACIONAL DE MEDICINA VETERINÁRIA, Gramado. **Anais...** Porto Alegre, 2002.v.29, p.5-17.

LEAL, T.L.; VALADARES, R.F.D.; VALADARES FILHO, S.C. et. al. Variações diárias de excreções de creatinina e derivados de purinas em novilhas. **Revista Brasileira de Zootecnia**, v.36, n.4, p.905-911, 2007.

LOFGREEN, G.P.; GARRETT, W.N. Creatinine excretion and specific gravity as related to the composition of the 9, 10, 11th rib cut of Hereford steers. **Journal of Animal Science**, v.13, p.496-500, 1954.

PEREIRA, V.S.A. **Influência do peso corporal e das características de carcaça sobre a excreção de creatinina e utilização de coleta spot de urina para estimar a excreção de derivados de purinas e de compostos nitrogenados em novilhas Nelore**. 2009. 45f. Dissertação (Mestrado em Zootecnia) – Universidade Federal de Viçosa, Viçosa, MG.

OLIVEIRA, A.S.; VALADARES, R.F.D.; VALADARES FILHO, S.C. et. al. Produção de proteína microbiana e estimativas de excreções de derivados de purinas e de uréia em vacas lactantes alimentadas com rações isoprotéicas contendo diferentes níveis de compostos nitrogenados não-protéicos. **Revista Brasileira de Zootecnia**, v.30, n.5, p.1621-1629, 2001.

REID, J.T.; WELLINGTON, G.H.; DUNN, H.O. Some relationships among the major chemical components of the bovine body and their application of nutritional investigations. **Journal of Dairy Science**, v.38, n.12, p.1344-1359, 1955.

RENNÓ, L.N.; VALADARES, R.F.D.; VALADARES FILHO, S.C. et. al. Níveis de proteína na ração de novilhos de quatro grupos diferentes: estimativa da produção de proteína microbiana por intermédio dos derivados de purinas na urina. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 40., 2003, Santa Maria. **Anais...** Santa Maria, 2003. (CD-ROM).

SCHROEDER, A.L.; BERGEN, W.G.; MERKEL, R.A. Estimation of lean body mass, empty body protein and skeletal muscle protein from urinary creatinine excretion in beef steers. **Journal of Animal Science**, v.68, suppl.1, p.311, 1990.

VALADARES FILHO, S.C.; MARCONDES, M.I.; CHIZZOTTI, M.L. et al. **Exigências nutricionais de zebuínos puros e cruzados – BR CORTE**. Viçosa, MG, Brazil, 2010. 193p.

VAN NIEKERK, B.D.H.; REID, J.T.; BENSADOUN, A. et al. Urinary creatinine as an index of body composition. **Journal of Nutrition**, v.79, p.463-473, 1963.