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A Simple Urine Collecting Apparatus and Method for Steers

Zhi-Jun Cao, Fang Mo, Chun-Quan Wang, Yu-Long Xian, Mei Ma,
Sheng-Li Li, Chun-Cheng Xu and Xiao-Ming Zhang
State Key Laboratory of Animal Nutrition, College of Animal Science and Technology,
China Agricultural University, 100193, Beijing, China

Abstract: An apparatus and method that can allow continuous and precise total collection of urine under normal conditions was developed. This apparatus and method satisfies the urine sampling requirement of balance studies and metabolic experiments of steers. The apparatus is comprised of a urine cup and collection barrel. The total and precise collection of urine can be achieved without leakage, fecal contamination and urethra infection. The apparatus has minimal negative effects on the steers and does not influence the steers normal physiological activities.

Key words: Apparatus, method, urine collecting, urine cup, collection barrel, steers

INTRODUCTION

The importance of total urine collection from steers for nitrogen balance and energy metabolism experiments is highly recognized. The apparatus and method are also crucial factors, which can influence the accuracy of collection. Because of the complicated urinary tract anatomy, there is no perfect apparatus and method to continuously and precisely collect urine from steers without having negative effects on their health and activities until now.

In the past, one method for total collection of urine was to catheterize the urethra (Allen, 1974) however, the possibility of losing the catheter and the risk of urethra infection made this method undesirable. It also prevented steers from being fed under normal conditions and possibly affected the collection urine volume. The most common technique for total collection of urine was to use a metabolism crate (Smith, 1979), but the complete separation of urine and feces was still a problem. Also, lots of manpower and procedures were needed for the construction of the metabolism crate. Veenhuizen *et al.* (1984) described an apparatus in which an external collection apparatus was placed over the penis and sheath using an attachment pad to conduct the urine to a container. This technique could effectively alleviate the stress on steers and avoid leakage under normal conditions. However, there was the potential risk of obstruction of the drainage hose, when the steers stepped on it, while standing up or lying down. This may lead to the inability to collect some, or even all of the urine. Thus, the scientific results might not be desirable because of the risk of infection and stress resulting from aspects of complicated apparatus, difficult-handling procedures and negative effects on steers. The objective of the study was to describe an easy handling method and an inexpensive, portable and reusable apparatus to continuously and precisely collect urine from steers with minimal negative effects on them.

MATERIALS AND METHODS

Animal care and usage were approved and conducted under established standards of the college of Animal Science and Technology, China Agricultural University, Beijing, China.

Urine cups: The urine cup was made from an infundibular rubber cup, canvas, straps and drainage hose (Fig. 1). Inner tubing of bicycles or cars of 0.2 cm thickness, attached to the distal end with rubber cement, could be used as the primary material for the infundibular urine cup (Fig. 1a). According to the shape of the penis and sheath, the canvas (Fig. 1b) of 0.2 cm thickness was cut to dimensions enough to cover the steers penis areas and was sewn up onto the infundibular rubber cup with plastic wires. At the same time, 10 circular holes were made in the canvas in order to fix the straps onto the steers. The straps (Fig. 1c) were made of flexible rubber hose of 1.0 cm inner diameter and 0.2 cm thickness to ensure suitable

Corresponding Author: Xiao-Ming Zhang, State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, 100193, Beijing, China

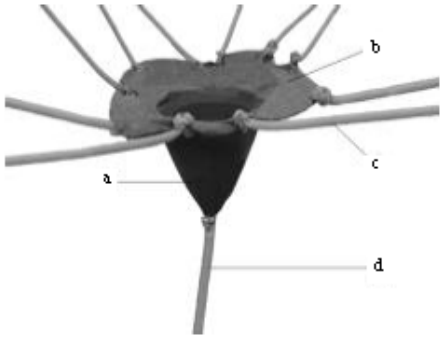

Fig. 1: Appearance of urine cup

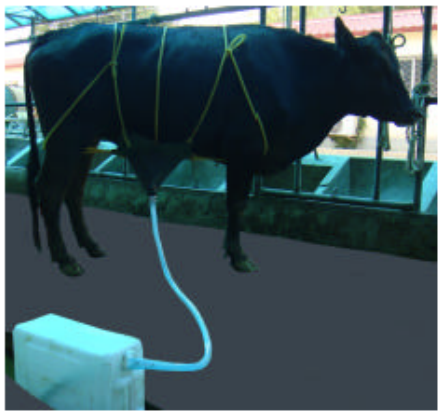

Fig. 2: Appearance of the apparatus

pressure distribution and no injuries to the body. From the side-view, the urine cup was taper-shaped with a large end and a small end. The diameter of the large end of the urine cup was approximately 30 cm, which is the suitable size to entirely cover the edge of the penis area. The diameter of the small end of the urine cup was about 3.0 cm to ensure close contact with the drainage hose. Then a 3.0 cm diameter drainage hose (Fig. 1d), made of transparent PVC flexible pipe, was fixed onto the small lower end of the infundibular rubber cup by means of steel wires to conduct urine from the urine cup to the collection barrel. The complete detachable urine cup is shown in Fig. 1. Suitable cleaning with detergent and rinsing in hot water after each collection period can ensure that the urine cup is reusable for several times.

Collection barrel: The barrel made of transparent hard plastic is suitable for use as the collection barrel. The diameter of the opening of the collection barrel should be approximately 3.5 cm to ensure that the drainage hose could be inserted into the barrel. The urine was removed and collected from the barrel twice per day in most of the experiments, therefore the volume of the collection barrel should be about 15 L because the steers could produce 3.9-18.6 L day^{-1} urine.

Installation of urine apparatus: The external penis area should be cleaned with soap and rinsed. After hair was removed by clipping, the urine cup was then harnessed in position to the penis area by 10 flexible rubber hose straps, which were brought across the side and over the back of the steers. Three straps were evenly distributed to the chest, mid and hind belly of the steer from the side view. The middle rubber straps were firstly fixed in place, followed by rubber straps across the chest and thigh, respectively. The fore straps were fixed onto the body by going around the inner fore legs. The hind straps were pulled into position across the steers' hind legs and then tied onto the canvas strap (Fig. 2). Following the above procedures, appropriate adjustments were carried out according to the elasticity of the straps and the position of the urine cup.

About 10 cm of the distal end of the drainage hose was inserted into the opening of a 15 L urine collection barrel and fastened with a steel wire. Total 200 mL of 10% H_2SO_4 was added to the container to avoid nitrogen loss during the studies. The collection barrel was placed inside a channel made in the ground next to the steer (Fig. 2). Under extremely cold conditions, the drainage hose could be wrapped with thick padding to avoid freezing of urine.

RESULTS AND DISCUSSION

The method creates a fully-enclosed tube. Urine flows from the prepuce of the steer through the urine cup and into the collection barrel. The apparatus may be kept in place for a long time. Under regular conditions, urine collections from steers are performed for a consecutive 72 h (3 day) and even up to 120 h (5 day) in one experimental period. Urine can be totally collected without leakage and fecal contamination to ensure accurate results, when the apparatus and method are correctly used.

The urine cup is made of soft materials and has a large contact area, which will not cause any injury to the body. Also, the apparatus does not affect the steers normal physiological activities, such as eating, ruminating, urinating, standing up or lying down. About 40 apparatus constructed to date, using the above mentioned materials and methods, have been used for urine collection in balance studies and metabolic experiments at 4 universities. In the studies, steers with body weight of 399 kg (SD = 28) at the start of the experiment using this apparatus produced 7.3 L day^{-1} (SD = 3.4) of urine on average. Urine volumes ranged from 3.9-18.6 L day^{-1} for different steers, respectively during the experimental period. The total amount of urine produced by any one steer varied <1.0 L every other day. The usage of a urine cup avoids the procedure of

inserting catheters into the bladder and therefore, eliminates the potential infection. The previous studies showed better animal welfare with the urine collection method as compared to the catheters method (Hobbs *et al*., 1950; Veenhuizen *et al*., 1984).

Compared with the methods provided by Hobbs *et al*. (1950) and Veenhuizen *et al*. (1984), the apparatus in the study avoided the adhering of the attachment pad to the penis area. Thus, steers are not required to continue standing for at least 30 min to ensure the cement sets sufficiently. Also, lots of manpower and procedures are saved because of the simple materials and easy installation. The apparatus is more economical, costing only $10.0 (material and labor) and can be used for 15-20 collections (Kong, 2006; Huang, 2005; Xian, 2009). The uniformity of the experimental results has discribed its effectiveness and durability. There are several types of apparatus for collecting urine from steers. Most of the methods are indispensable in certain situations. The greatest advantages of the apparatus in the study are the creation of the urine cup, which effectively prevents urine collection from leakage and contamination the position of the collection barrel, which secures the drainage hose in place and ensures no obstruction during different physiological activities.

The critical points in constructing the apparatus are that the diameter of the large end of the urine cup should be of suitable size to cover the entire edge of penis area and that the width of the straps should be wide enough to ensure that the pressure will be properly distributed without causing any injury to the steers body. Both factors must be determined by the anatomy of each steer. Also, the drainage hose and collection barrel are positioned on side, instead of behind of the steer. This tiny improvement has been proved to effectively avoid leakage caused by the steers trample.

CONCLUSION

An apparatus that can allow easy collection of urine under normal conditions for metabolism experiments of steers has been described. It is simple, inexpensive, portable and reusable.

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