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A Simple Apparatus for Counting the Number of Chewings in Cattle

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Abstract

A simple apparatus for counting the number of chewings in cattle was developed to count the daily total chewing number during the eating and ruminating processes. It was possible to count the number of chewings continuously for more than 2 months without any difficulty. The daily total chewing number or time spent chewing was estimated accurately by only reading the number once a day. When four heifers were fed a constant amount of hay for 3 weeks, the coefficients of variance of the chewing counts for days and animals were 7.3 and 8.8%, respectively. Temporary increase of intake affected the chewing counts for more than 4 days after the feeding.

Discipline: Animal industry
Additional key words: device, ruminant

Introduction

The particle size of the digesta in the rumen of ruminants must be reduced to pass through the lower gut[9]. Chewing activity is reported to play a major role in reducing the particle size of digesta in the rumen[8]. Furthermore, the chewing time can be used as a suitable indicator of the roughage value required to maintain the normal physiological function of the digestive tract[1,10]. However, accurate analysis of the chewing behavior is difficult. Optical observation at regular intervals is likely to disturb the animal behavior due to the illumination or human approach to the animals and to require a great deal of work. Therefore, several types of continuous recording systems to analyze the chewing behavior have been developed, including an apparatus which memorizes data in a logger[6] or which draws the analog type-electronic signals on recording paper from the pressure sensor[2,4,5,11] or the electrode fixed on the cheek of the animals[7]. However, the use of any machine or instrument has some disadvantages such as high cost of machine, difficulty of maintenance in good condition for prolonged recording, or heavy load for the animals. Thus, a simple and cheaper apparatus to analyze the chewing behavior should be developed to evaluate properly any excess or shortage of roughage for livestock performance or the quality of feeds. This study was undertaken to examine the apparatus newly developed by the authors, in order to predict the changes in the chewing number in animals or during days, and analyze the changes in the chewing number after a temporary increase of intake.

Materials and methods

1) Principle of the chewing counter

Tape switch (Tokyo Sensor Co., Type 141-BPH), 10 cm in length, is used as the sensor, which turns on the electricity when the mouth of the animal is opened. The counter used is a five figure digital pedometer reconditioned by connecting on electronic wire to each terminal that comes into contact by vibration. The tape switch and pedometer are connected and fixed to the halter as shown in Plate 1. The portions of halter or tape switch that are frequently in contact with the skin are covered with a soft cloth to prevent abrasion of the skin during prolonged measurement. The battery incorporated into the pedometer can operate approximately for 3 years without requiring a change.

2) Experimental design

Three experiments were carried out to examine the suitability of this apparatus. Experiment 1 was conducted to determine whether chewing activities were accurately detected with this apparatus by connecting it to a recording machine (Nihon Koden Co., EEG-7310) and to record the chewing time spent and number of chewings during the eating and ruminating processes simultaneously. A total of 39 cattle were used for analyzing the chewing activities, namely 18 milking cows fed *ad libitum* and 21 steers kept under a restricted feeding regime in combination with various ratios of concentrate to roughage. After the animals were adapted to the rations for more than 10 days, the chewing behavior was examined for 2 days continuously. The mean chewing time and number of chewings during the 2-day period were used for comparison. The chewing number during the eating and ruminating processes was calculated by multiplying the chewing time and chewing speed directly read from the recorder chart. The counts incidentally detected when the animals licked salt, their own body, or feeder were omitted. The actual daily chewing number was compared with that recorded with the newly developed apparatus.

Experiment 2 was conducted to investigate the changes in the chewing number in days and in the animals determined with the apparatus. Four mature steers were fed 6 kg of hay mainly composed of second cut orchardgrass hay

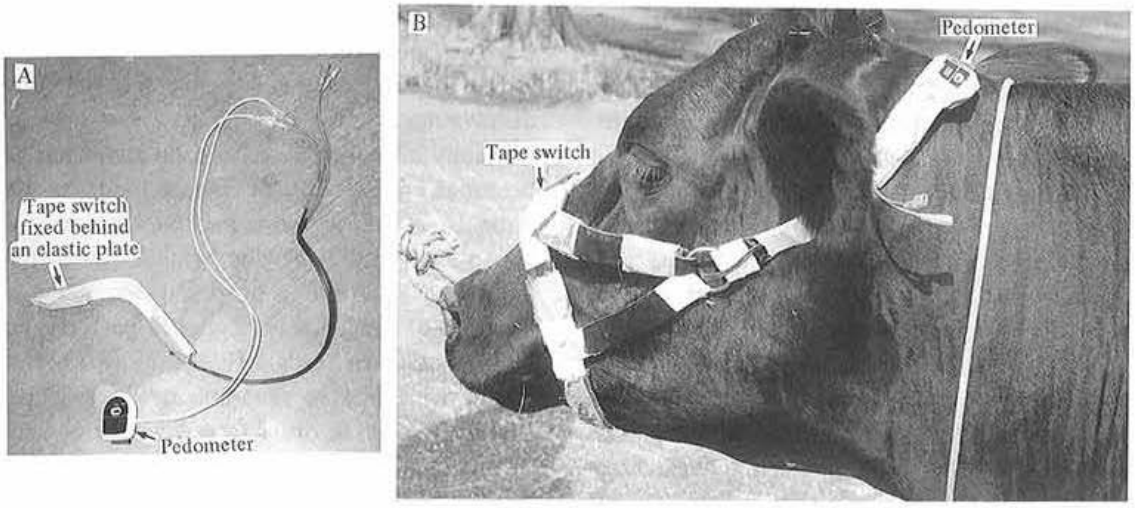

Plate 1. A: Main parts of simple counting apparatus
B: Halter equipped with the counting apparatus

only at 9 a.m. once a day and kept under the same feeding conditions for more than 1 month. After the animals were adapted to hay for more than 1 week, the halter equipped with the apparatus was attached to each animal and the chewing number was read just before feeding once a day for 3 weeks.

Experiment 3 was conducted to analyze the effect of a temporary increase of intake on the subsequent chewing number. Five animals fed the same hay under the same feeding regime for 1 month as described in Experiment 2 were given 4 kg of extra hay only once together with 6 kg of the same hay. After the temporary increase in the amount of hay, the chewing number was recorded with the apparatus for 5 days.

Results and discussion

The chewing patterns drawn on the recorder chart are shown in Fig. 1. The signals could be readily distinguished due to the on-off type of impulses. During rumination the animals produce boli with short pauses. The chewing speed for producing a bolus is fairly constant. On the other hand, chewing during eating is continuous with irregular pauses and the chewing speed is not constant. Incidental jaw movements caused by licking or head motion are also counted as chewings. When the chewing number is read once a day, incidental counts become the main factor for the overestimation of the number of chewings during the eating and ruminating processes. Thus, the actual chewing number (Y, nos./day) directly read from recorder charts was compared with that (X, nos./day) counted with the newly developed apparatus. The relationship is shown in Fig. 2. The regression equation with a high correlation was derived as follows:

$$Y = 1.103X - 9395 \quad (r = 0.987,\ n = 39).$$

Incidental counts in the dairy herd fed *ad libitum* were much lower than those in the steer group fed restricted intake. The mean percentage of the incidental counts, which was 5.2% (2,820 chewings/day), was in agreement with the 5% value reported by Dado and Allen[3] using dairy cattle. However, the incidental

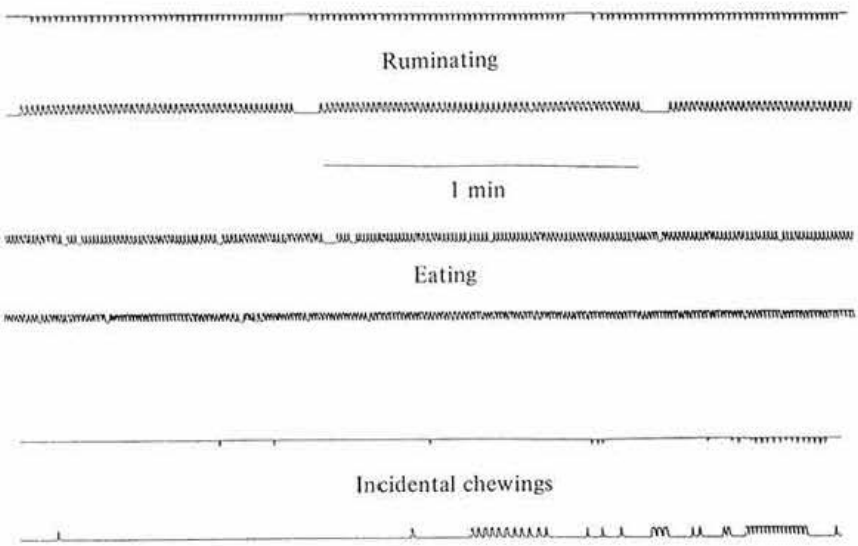

Fig. 1. Chewing patterns recorded with a simple counting apparatus using a tape switch as a sensor

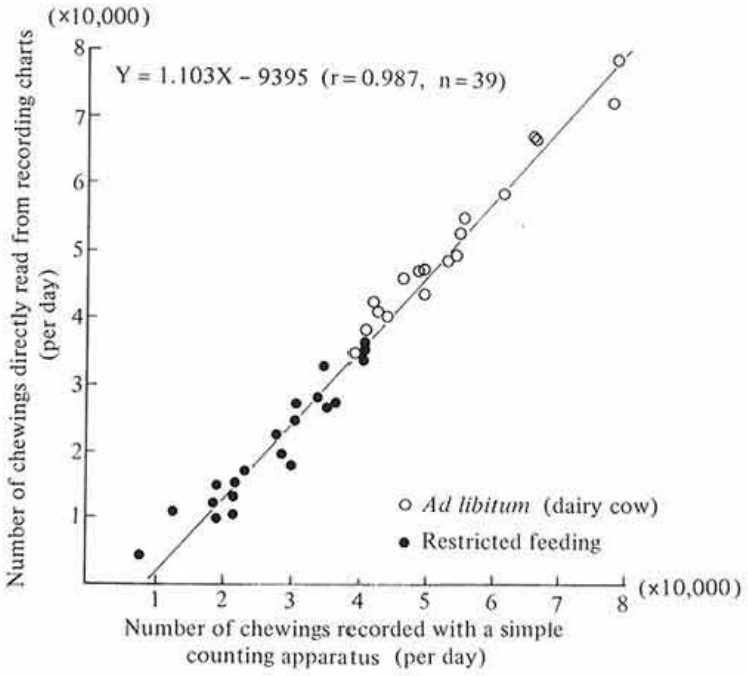

Fig. 2. Relationship between the number of chewings recorded with a simple counting apparatus and that directly read from recording charts

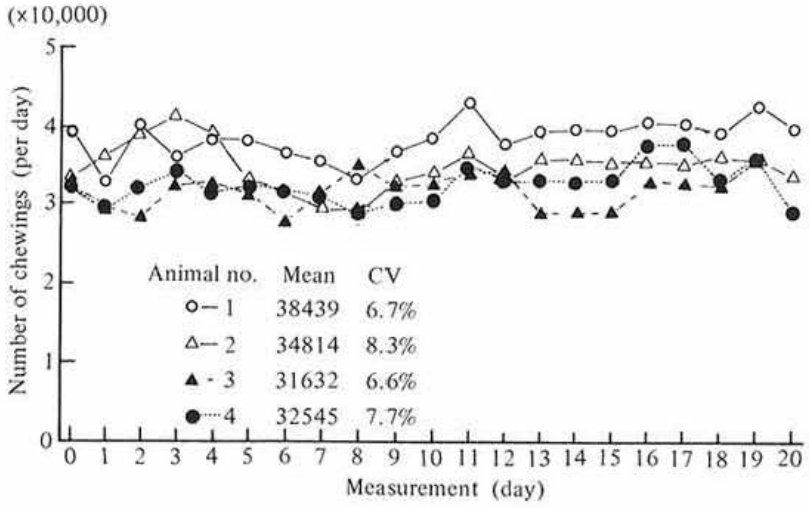

Fig. 3. Daily variation in the number of chewings recorded with a simple counting apparatus

counts in the restricted feeding group were 7,359 chewings/day on the average, which accounted for 26% of the total chewing counts. Thus, this measurement system may not be suitable for very restricted feeding regimes due to the increase of the occurrence of unrelated behavior such as licking or nibbling of feeder. However, this method is considered to be suitable for estimating the approximate daily chewing number under a wide range of feeding conditions. Furthermore, a highly positive correlation was obtained between the total chewing time (Y, min/day) and the counts (X, nos./day) measured with this apparatus. The equation was as follows:

$$Y = 0.01377X - 34.2 \quad (r = 0.977, \ n = 39).$$

Therefore, the chewing time can also be estimated with this counting method.

The daily changes in the chewing number of four steers fed constant daily amounts of hay are shown separately in Fig. 3. The coefficients of variation in the chewing number in days ranged from 6.6 to 8.3%. The mean coefficient was 7.3%, which suggested that detectable significant differences ($P<0.05$) between two treatments in the chewing number accounted for 32, 16.5, 12.6, 10.6, and 9.6% of the total counts after 2, 3, 4, 5, and 6 days of observation in each treatment, respectively. Moreover, since the coefficient of variation of the chewing number in the animals was 8.8%, the variation in the number of chewings was larger for animals than for days. Harumoto and Kato[4] also reported the same tendency. Thus, the difference in the chewing number or time in animals is more important than the period, for statistical treatment.

The results obtained in Experiment 3 are shown in Fig. 4. The effect of temporary addition of feed was observed up to 4 days after the increase. The percentages of increase in the chewing number were 57, 26, 11, 5, and 1% on the 1st, 2nd, 3rd, 4th, and 5th day after the temporary increase in the supply of feed,

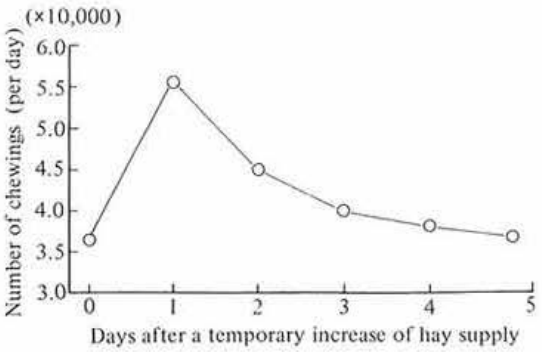

Fig. 4. Changes in the number of chewings after a temporary increase of hay supply

respectively. This variation in the chewing numbers suggested that at least 4–5 days were needed to obtain a stabilized chewing number even after a temporary change of intake. The changes in the chewing number after a temporary increase of intake may be related to the turnover time required for converting particles that can not pass in the rumen to those that can pass, because it was reported that the particle size in the rumen is mainly reduced by rumination, and the turnover time from impassable to passable particles in the rumen was 22.6 hr[8]. The rate of decrease in the chewing number after the temporary increase in the supply of feed was calculated to be 3.9%/hr during the 3-day period. This reciprocal value (25.6 hr) is close to the fractional turnover rate of large particles in the rumen.

It is concluded that the newly developed apparatus enables to detect the daily number of chewings accurately over a long period of time without requiring any special maintenance, and can be used in studies related to the chewing behavior of housed as well as grazing animals. However this apparatus should be covered with water-proof materials to protect it from rain, if it is used outdoors.

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