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Intake Behaviour and Digestive Effects of Electronic Identification with Ruminal Bolus in Adult Goats

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Abstract: The effect of the ruminal bolus on the intake behaviour and digestive parameters was studied in a group of 12 castrated adult Majorera goats. For the experiment they were housed in a metabolic box for 2 weeks to allow for adaptation and fed either an ad libitum Fibrous Diet (FD) (n = 6) or a Concentrated Diet (CD) (n = 6) offered at 130% of the previous day's consumption. The animals were subsequently divided into two similar subgroups: bolus (identified with Rumitag Bolus®) and control (simulated application). After one week of feeding with the definitive diet, the measuring period started, which lasted for 12d divided into two sub-periods separated by the application moment (subperiod I: 6d, before bolus application; sub-period II: 6d, after bolus application). Samples of faeces and material refused by the animal were collected daily in order to determine DM, OM, CP, NDF and ADF. For the FD group a significant difference was found due to the period on DMI being higher in sub- period II, but there were no significant statistical differences due to the bolus treatment. For the CD group, DMI increased during sub-period II due to the overall time spent in both sub-groups. Digestibility parameters results were probably conditioned by the stress which was caused by the accumulation of days in the pen. Taking the evolution of daily DM per $kg^{0.75}$ live weight intake into account, both groups presented a similar decrease in intake the day after bolus application, to a great extent due to the stress caused by the identification procedure, nevertheless they recovered their DMI level 48 h after application of the bolus. No statistically significant differences in diet intake and digestibility parameters were found due to the application of the ruminal bolus.

Key words: Digestibility, goats, ruminal bolus, traceability

INTRODUCTION

Due to the policy of food security which has been evolving in the EU as a result of the health alerts in the last decade, the aspect of traceability have been taken into consideration. The EU legal definition for traceability is specified in the EU General Food Law Reg. EC No. 178/2002 and states. The ability to trace and follow a food, feed, food-producing animal or substance intended to be or expected to be incorporated into a food or feed, through all stages of production, processing and distribution.

Rules establishing traceability and keeping production registers for food safety were described in Article 18 of the above mentioned law. The use of electronic methods of animal identification as a trust tool and an indispensable requirement to obtain traceability from the start of the food chain were reported in Council Regulation 21/2004. The transponder, based on an encapsulated microchip with a low radio frequency antenna enclosed in a water-proof protector, is the most important element of this system as described by Caja *et al.*[1]. Three main types of transponders have been recognised by ICAR since[2]: injectables, electronic ear-tags and ceramic boluses. The application of these ruminal boluses as a method for identification for the traceability of livestock including bovine, ovine and caprine meat and the degree to which they are retained by the animal, have been successfully studied in numerous experiments and projects[3-6]. This method has shown greater efficiency than conventional tagging systems for identification[7], revealing values above the ICAR recommendations (> 98%; 2003), being innocuous for the food chain and simple to recover at the slaughtering line[3].

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This framework provides an up to date methodology for tagging and tracing the animal from birth to consumption[1]. With this in mind, tests on the influence of small size boluses on the development parameters of stomachs of fattening lambs have been done[8]. Moreover, research has demonstrated that electronic identification with boluses does not alter feed intake and digestibility in adult sheep[9] or in fattening lambs[10], nor have macroscopic injuries caused by the bolus been observed in the rumen-reticulum of cattle[11] or heavy goat kids . On the contrary, solid bodies can stimulate rumination and ruminal motility and consequently feed intake may improve[12]. As no research has been done on adult goats it was necessary to find out the effect of the electronic ruminal bolus on digestibility parameters and feed intake in these animals.

MATERIALS AND METHODS

To facilitate the collection of faeces and urine during the study of digestive effects of the bolus, 12 castrated adult Majorera breed bucks were stabled in a metabolic box provided with a feeder and drinker. Animals were separated into two groups and kept in the boxes for 2 weeks to allow for adaptation to them and also to an ad libitum Fibrous Diet (FD) (n = 6; Live Weight (LW) 43.1±5.4 kg, long fibre content 80%) or concentrated diet (CD) (n = 6, LW 54.4±4.9 kg, long fibre content 25%), offered at 130% of the previous day's consumption (Table 1). FD was mainly based on forage (wheat straw and alfalfa) accompanied by a small amount of grain (maize and barley in equal quantities). CD consisted in a mixture of maize, barley and soyabean meal at 18.0% of crude protein content (with the proportion 2:2:1, respectively) and a small amount of wheat straw, which was to enable the ruminant function to work. Both diets were isoproteic. FD offered had 80% of DM composed of: 90.1% OM, 50.5% NDF, 36.9% ADF and 13.8% CP and CD showed 91.3% of DM based on: 91.3 OM, 27.7% NDF, 16.3 ADF and 13.0% CP. At the end of the adaptation period, animals in each group were randomly assigned into two similar subgroups (Control vs. Bolus). The bolus transponders worked at a frequency of 134.2 kHz according to ISO 11785 and each one was encased and fixed in a bolus (Rumitag Bolus; 75 g; 21×68 mm, 3.6 g/cm^3) by epoxy resin (MP Super, Ceys S.A., Barcelona, Spain). Gesreader II (Gesimpex Comercial S.L., Barcelona, Spain). Portable transceivers were used for the reading controls during the experiment. After one week of feeding with the definitive diet, the measurement period started, which lasted for 12d, divided into two sub-periods separated by the moment of application t (sub-period 0: 6 d, before bolus application; sub-period 1: 6 d, after bolus application). The control subgroup did not receive a bolus, although the application was simulated, causing a similar stress to those animals which did. The animals were weighed weekly to check the average daily weight gain. The food was always given at the same time in the morning when the samples were collected. Samples of faeces and material refused by the animal were collected daily in order to determine DM by drying in a forced air heat cabinet (48 h, 60°C). Afterwards these samples were crushed to 1 mm to discover its OM after calculating the amount of ash in muffle (3 h, 510°C). Furthermore a mixture of the faeces and material rejected by the animal in each sub-period was made separately. An aliquot of 2% was hermetically kept at room temperature until analysis. CP was determined by the Kjeldahl method and NDF and ADF according to the procedure used by Van Soest *et al.*[13] on a Fibertec System. Apparent digestibility of each nutrient was calculated according to the expression: Dig. (%) = [1-(excreted/ingested)] x 100. The effect of the treatment on feed intake and digestibility was statistically processed by analysis of variance-covariance (SPSS 11.0 for Windows; SPSS Inc., IL., USA) taking the values of the variables in the first subperiod as covariable. Treatment means were compared by Tukey's test and statistical significance was declared at $p<0.05$.

Table 1: Diet composition. DM (g) offered at the end of the adaptation period

Ingredient	Fibrous diet (FD)	Concentrated diet (CD)
Alfalfa hay	450	-
Wheat straw	270	270
Barley	92	276
Maize	91	273
Soyabean meal	-	135

RESULTS AND DISCUSSION

At the end of the experiment, all the animals retained the applied bolus. Animals in both subgroups increased live weight in accordance with the chemical composition of the diet and positive energy balance in accordance with previous reports[14]. The effects of the bolus on feed intake and apparent digestibility of each nutrient for FD are shown in Table 2. Intake values were lower than reported for some goat breeds on high forage diets (Murciano-Granadina, Sanz *et al.*[15] crossbred Boer[16] and greater than others[17,18]. A significant difference ($p<0.01$) was found due to the time on DMI being higher during sub-period II, but there were no significant statistical differences due to the bolus treatment. Moreover, DM per kg$^{0.75}$ LW intake was slightly lower in control group. These results coincided with observations made by Caja *et al.*[1], who found effects on feed intake in ovines

Table 2: Effects of the treatment on feed intake and digestibility parameters for fibrous diet

	Control		Bolus			Effect (p<)	
Item	Subperiod I	Subperiod II	Subperiod I	Subperiod II	S.E.M.	Period	Bolus
LW	45.1	46.0	41.0	41.9			
g DM d^{-1}	671	676	632	647	18.0	0.008	0.825
g DM kg^{-1} $LW^{0.75}$	38.6	38.2	39.0	39.4	1.0	0.012	0.755
Digestibility							
DM[1] (%)	51.1	48.8	52.9	49.6	1.2	0.896	0.732
OM[2] (%)	50.4	48.5	52.6	48.5	1.7	0.802	0.882
NDF[3] (%)	34.3	38.6	35.0	33.0	1.2	0.189	0.090
ADF[4] (%)	32.4	31.9	34.8	30.1	1.7	0.952	0.762
CP[5] (%)	64.3	68.5	65.2	69.8	0.7	0.151	0.706

Control: without bolus; Bolus: Rumitag Bolus (75 g; 21 x 68 mm, 3.6 g/cm^3); Subperiod I: Before bolus application/simulation; Subperiod II: After bolus application/simulation, *: $p<0.05$, [1]DM = Dry matter, [2]OM = Organic matter, [3]NDF = Neutral detergent fibre, [4]ADF = Acid detergent fibre, [5]CP = Crude protein

Table 3: Effects of the treatment on feed intake and digestibility parameters for concentrated diet

	Control		Bolus			Effect (p<)	
Item	Suberiod I	Subperiod II	Subperiod I	Subperiod II	S.E.M.	Period	Bolus
LW	54.0	55.0	54.9	56.0			
g DM d^{-1}	833	885	915	931	12.0	0.001	0.278
g DM kg^{-1} $LW^{0.75}$	41.8	43.8	45.3	45.6	0.5	0.005	0.290
Digestibility							
DM (%)	77.4	73.8	74.3	71.8	0.5	0.048	0.765
OM (%)	79.4	76.1	76.0	73.6	0.5	0.050	0.700
NDF (%)	38.6	35.2	29.4	29.0	0.6	0.723	0.128
ADF (%)	32.3	29.1	25.9	24.0	1.3	0.952	0.341
CP (%)	76.3	71.5	71.5	69.7	0.6	0.033	0.253

Control: without bolus; Bolus: Rumitag Bolus (75 g; 21 x 68 mm, 3.6 g/cm^3); Subperiod I: before bolus application/simulation; Subperiod II: after bolus application/simulation, *: $p<0.05$, [1]DM = Dry matter, [2]OM = Organic matter, [3]NDF = Neutral detergent fibre, [4]ADF = Acid detergent fibre, [5]CP = Crude protein

due to the time period, even though they reported that DMI was lower after bolus application. No significant differences were observed in any of the digestibility coefficients for this diet. Nevertheless, fibre digestibility parameters decreased during sub-period II (except for NDF in control subgroup), these results being similar to those reported by Caja *et al.*[1]. Results altogether indicate that this could be due to the faster movement of food in sub-period II, conditioned by the stress which was caused by the accumulation of days in the pen[19], so ruminanting time was lower and consequently the particles that escape through the reticulo-omasal orifice were rougher[20]. Moreover, Moore *et al.*[16] reported DMI enlarged during experimental time for six weeks. As it was a fibrous diet, minor digestibility of the fibres will have influenced the lowering of DM and OM coefficients.

In the same way, for CD animals, in both subgroups increased live weight during the experiment, as is illustrated in Table 3. Taking previous reports into account[21], diets based on quality degradable proteins obtain a higher feed intake, which could explain why parameters in this group were higher than in the FD group. DMI increased during sub-period II ($p<0.01$) during the time spent in both subgroups, probably for same reason as for the FD group. On the other hand, DM and OM digestibility were slightly lower during that sub-period ($p<0.05$). These results could be possible in response of intake behaviour, especially on this type of concentrated ration[22,16]. As observed by Caja *et al.*[3], NDF and ADF coefficients decreased during the experiment but no statistical differences due to the period and bolus were found. CP digestibility was also lower in sub-period II due to the time effects ($p<0.05$) because endogenous nitrogen loss is proportional to the DM soyabean meal ingested[23]. Moreover, other authors[24] assume that bolus location is in accordance with the sequence of reticulorumen motility described by Dziuk[12] for high density bodies. In this way, as the bolus should remain in the reticulum, it appears that the rumination process and the rate of passage of digesta were not altered by this size of bolus, as was found by Caja *et al.*[3] in adult ovine with the same prototype.

In accordance with previous reports[3,24], any effect on natural performance was observed after application/simulation. Taking account the evolution of daily DM per $kg^{0.75}$ LW intake, both groups presented the same patterns during the study period as is shown in Fig. 1. According to Caja *et al.*[3] a drop in the intake was observed the day after bolus application. When DM per $kg^{0.75}$ LW intake was considered, the decrease was similar in both groups (4.7 vs 3.2 g for FD; 5.9 vs 6.2 g for CD). As reported by Aoyama *et al.*[25], goats submitted to stress fail to eat, so this decrease in intake during the first day of application was due to a great extent to the stress caused by identification, as the DMI level was recovered on the second day after application[25]. As observed by

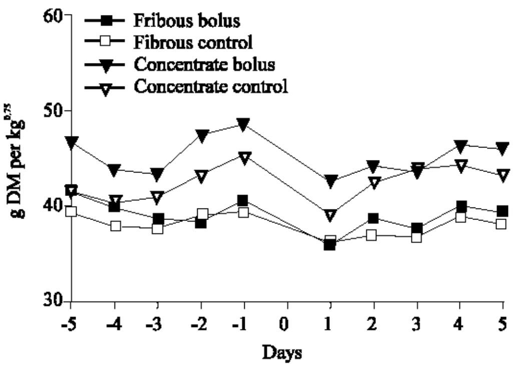

Fig. 1: Evolution of DM kg^{-1} LW$^{0.75}$ before and after bolus application/simulation

Caja *et al.*[9], who reported that the early application of small boluses in lambs did not damage intake, no statistically significant differences in feed intake were found to be due to the application when measurement took place.

CONCLUSION

In summary, taking into consideration that no significant differences were observed in any of the digestibility coefficients related to the application of the bolus and that the small decrease in the intake observed the day after treatment must be produced by the effect of stress and not to the bolus itself, the electronic identification with ruminal bolus should be considered as a safe method of tracing goats.

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