# EFFECTS OF α-ADRENORECEPTOR ANTAGONISTS ON ADRENALINE-INDUCED RUMINATION IN THE GOAT (*Capra jorcis*)

**T.E. A. Osman and K.A. Al-Busadah**
Department of Physiology, Biochemistry and Pharmacology,
College of Veterinary Medicine and Animal Resources,
King Faisal University, P O Box 1757, Al-Ahsa 31982
Saudi Arabia

## ABSTRACT:

Rumination activity, induced by the intravenous (i.v.) injection of adrenaline, was investigated in conscious goats. Rapid i.v. injection of adrenaline evoked rumination, and the duration of rumination activity ranged between 13.4 and 20.9 minutes. When the goats were pretreated with the α1-antagonist prazosin, adrenaline failed to induce rumination. Pretreatment of goats with the α2-antagonist yohimbine had no effect on the adrenaline-induced rumination activity. It is concluded that adrenaline-induced rumination in goats is mediated by α1-adrenoreceptors.

## INTRODUCTION:

Rumination occurs in ruminant animals if the brain receives adequate peripheral excitatory drive from mechano-and chemoreceptors in the wall of reticulorumen. These receptors monitor fibrous ingesta, volatile fatty acid concentration and ionic strength in the reticulorumen (Cunningham, 1997). Experiments on sheep have shown that adrenaline provokes rumination, presumably by modulating the discharge frequency of these receptors. Thus, Kay (1959) has shown that episodes of rumination activity could be induced in sheep by rapid intravenous injection of adrenaline. This observation was confirmed by Ruckebusch and Bardon (1984) and Nicholson et al. (1988).

Adrenergic receptors of both α and β-type have been identified in the reticuloruminal smooth muscle cells. Titchen and Newhook (1968) and Van Miert and Huisman (1968) reported evidence of α -stimulatory and β -inhibitory adrenoreceptors in the ruminal wall of sheep. In line with this,

are the observations of Nicholson et al. (1988) that the induction of rumination by adrenaline in sheep could be prevented by α1 and α2 - adrenoreceptor antagonists, given singly or in combination. Furthermore, Brikas (1989) noted that the α1-agonist phenylephrine stimualted motility of the forestomach and provoked rumination in sheep, whereas the α1-antagonist prazosin prevented these responses. In contrast, Campion and Leek (1995) reported that the injection of α2-adrenoreceptor agonists evoked rumination and increased reticular motility in sheep. The mechanism by which adrenergic agonists evoke rumination is still obscure.

The present study was designed to elucidate the evocation of rumination by adrenaline in the goat, and to determine which of the adrenergic receptor subtypes are involved.

## MATERIALS AND METHODS

### ANIMALS:

Three male Nubian goats, 1.5 years old and weighing 10.0, 13.0 and 15.5 kg, respectively, were used in the present study. Each goat was fitted with a rumen cannula (3 cm in diameter) as described by Jarrett (1948). To facilitate intravenous injections, the animals were fitted with jugular vein catheters (o.d. 1.6 mm, i.d.1.0 mm). These catheters were flushed regularly with sterile saline and filled with heparinized saline.

### TRAINING AND FEEDING SCHEDULE:

A rigorous programme of 3 weeks was adopted for training and feeding of animals. The goats were fed on dried alfalfa and water was available *ad libitum*. The goats were taken every day at 10. A.M. from the pens and put into stands in a loose box in the same shed until they were accustomed to the experimental procedure. A string was passed and tied under the abdomen to prevent the goat from lying down, but not tight enough to suspend it.

### RECORDING:

Reticulum contractions were recorded by placing small (5 $cm^3$) air-filled balloon in the reticulum. Jaw movements were recorded by attaching a

balloon to a head collar. The two balloons were connected to pressure transducers linked to a 4-channel recorder (Rikadenki, WK450, Germany).

**DRUGS:**

In these experiments the following drugs were used: i) adrenaline (Hoechst AG, Germany), ii) Prazosin HCl (Pfizer limited, England) as specific α1-adrenoreceptor antagonist, and iii) yohimbine HCl (Sigma Chem. Co., Germany) as specific α2-adrenoreceptor antagonist.

Shortly before use, the given doses of the drugs were dissolved in no more than 10 ml of sterile normal saline.

**PROTOCOL:**

The three goats (No.1, 2 and 3) were taken into the stands at around 08.00 hours. They were allowed to eat dried alfalfa for a period of one hour before the injection of any drug. Reticular balloons, fitted with stiff wire to keep them in place, were introduced into the reticulum, and head collars, adapted with inflated rubber teats for recording jaw movements, were properly adjusted in place. The treatments were as follows:

a) Adrenaline alone (3-5 $\mu g.kg^{-1}$) was injected as a bolus during resting or eating. Adrenaline injections were repeated 10 times into goat No.1; 8 times into goat No. 3 and 5 times into goat No. 2 during different periods and on different days.

b) During this experiment, the goats received i.v. adrenaline (3-5 $\mu g\ kg^{-1}$) as a bolus, preceded by an i.v. infusion of prazosin (20 $\mu g\ kg^{-1}\ min^{-1}$ for 30 min).

c) During this experiment, the goats received i.v. adrenaline (3-5 $\mu g.kg^{-1}$) as a bolus, preceded by an i.v. infusion of yohimbine (20 $\mu g.\ kg^{-1}.\ min^{-1}$ for 30 min).

The antagonists were never injected during rumination periods and each infusion of individual antagonists was repeated twice on different days.

## RESULTS:

As shown in table 1, the response of the three goats to bolus of adrenaline (3-5 μg $kg^{-1}$) given intravenously was characterized by a latency period that varied between 2.4±0.3 and 4.7±0.5 minutes. The number of cycles after the onset of rumination ranged between 16.3±2.1 and 22.5±4.6, whereas the duration of activity ranged between 13.4±1.9 and 20.9±4.8 minutes.

**Table (1) : Mean (± SEM) rumination activity of three goats to a bolus of adrenaline (3-5 μg. $Kg^{-1}$) given intravenously. n = the number of successful repetitions**

| Goat | Body weight (kg) | n | Latency period (min) | Rumination activity | |
|---|---|---|---|---|---|
| | | | | Number of cycles | Duration (min) |
| 1 | 15.5 | 10 | 4.7±0.5 | 16.3±2.1 | 13.4±1.9 |
| 2 | 13.0 | 8 | 2.4±0.3 | 22.5±4.6 | 20.9±4.8 |
| 3 | 10.0 | 5 | 3.5±0.8 | 18.4±7.5 | 16.7±8.0 |

Fig. 1a shows jaw movements and reticular contractions of a goat injected i.v. with adrenaline. There was a brief inhibition of reticulum activity before the onset of rumination. All the three goats responded on each occasion when adrenaline was injected except for two occasions with goat number 2.

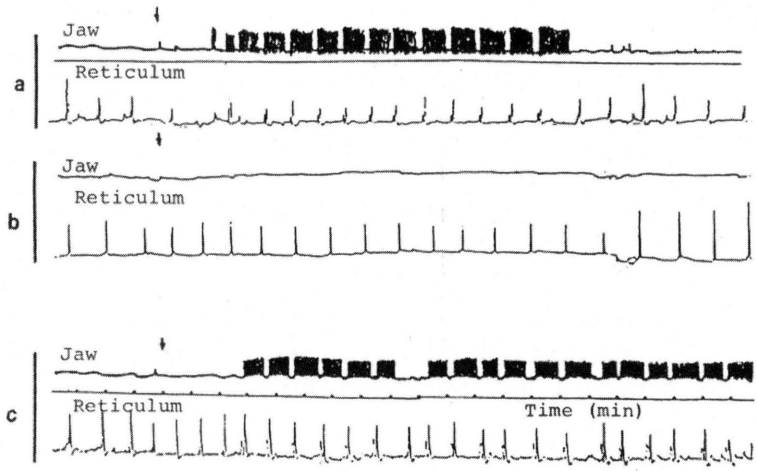


**Fig. (1) : The effect of intravenous injection of adrenaline on rumination and reticular motility in the goat.**

(a) Injection of adrenaline (3-5 μg. $kg^{-1}$) induced rumination after a short latency period, as made evident by jaw movements of cudding and normal triphasic reticular contractions.
(b) Pretreatment of goat with prazosin inhibited adrenaline induced rumination activity.
(c) Administration of yohimbine failed to prevent adrenaline from inducing rumination.

The intravenous infusion of prazosin or yohimbine did not cause any change on the reticulum contractions (Fig. 1a and b). There was a failure to ruminate in response to adrenaline given as a bolus after the i.v. administration of prazosin (Fig. 1b). Yohimbine given i.v. prior to administration of adrenaline, did not prevent the latter from inducing rumination in all occasions (Fig. 1c).

## DISCUSSION:

In the present work adrenaline given as a bolus induced rumination in goats. This finding accords with previous observations in sheep (Kay, 1959; Ruckebusch and Bardon, 1984; and Nicholson et al., 1988) that a period of rumination activity can be quite consistently induced by a rapid intravenous injection of adrenaline. The rumination activity was often preceded by a brief inhibition of reticulum contractions. This response is probably the result of direct inhibition of the muscles by β-receptor stimulation, which

exist in the wall of the reticulorumen (Titchen and Newhook, 1968; Van Miert and Huisman, 1968).

Adrenaline-induced rumination may be caused by increased mechanoreceptors discharge from the wall of the reticulorumen conveyed through vagal afferent fibres to the gastric centres (Kay, 1959; Ruckebusch and Bardon, 1984). According to Ruckebusch and Bardon (1984) adrenaline briefly increases intrinsic activity of the reticulum wall in which normal, extrinsic contractions had been abolished by bilateral vagotomy. Kay (1959) has indicated that the presence or absence of the contents of the rumen made no difference to the responsiveness of the reticulorumen to adrenaline. Nevertheless, Nicholson et al. (1988) found that the latent period of the response was 1-2 minutes in sheep fed long hay throughout the experiment. The present study has shown longer latent periods (2.4 and 4.7 minutes) in goats fed dried alfalfa for a period of one hour before the injection of any drug. This tends to suggest a synergism between the mechanical stimulus, greatest after ingestion of fibrous food, and the effect of adrenaline. However, non of these observations explains why the specialized triphasic motility pattern of the reticulum, and all the associated reflex actions of rumination, should be evoked rather than the simple general increase in motility which occurs when a resting goat begins to eat.

In the present study prazosin inhibited adrenaline-induced rumination in the goat. This is in agreement with the findings of Nicholson et al. (1988) and Brikas (1989). The results of the present work indicate that α1-adrenoreceptors are involved in adrenaline-induced rumination in the goat. This is discordant with the observations of Bueno et al. (1983) and Campion and Leek (1995) that the injection of α2-adrenoreceptor agonists evoked rumination in sheep. Bueno et al. (1983) found that tolazoline, a mixed α-1, α-2-antagonist, inhibited dopamine-induced rumination in sheep. These authors (taking tolazoline as a selective α2-antagonsit) concluded that this effect of dopamine on rumination involved α2-adrenoreceptors. If they had attributed the inhibitory effect of tolazoline to its α1-antagonistic properties (Hoffman, 1984), their suggestion would have been in agreement with the suggestion of the present work.

The present findings confirm earlier reports that α-adrenergic blockade does not significantly affect the extrinsically regulated resting contractions of the reticulorumen (Leek and Van Miert, 1971; Toutain et al 1982; Ruckebusch 1983; Ruckebush and Toutain 1984; Brikas 1989).

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# تأثير حاصرات ألفا علي تحريض الاجترار بواسطة الأدرينالين في الماعز

تاج الأصفياء أحمد عثمان و خالد بن أحمد البوسعدة

قسم وظائف الأعضاء و الكيمياء الحيوية و الأقربازين ، كلية الطب البيطري والثروة الحيوانية، جامعة الملك فيصل، ص.ب. ١٧٥٧، الأحساء ٣١٩٨٢، المملكة العربية السعودية

**الملخص :**

اشتمل البحث علي دراسة تأثير الحقن الوريدى لمادة الأدرينالين علي تحريض الاجترار فى الماعز. الحقن الوريدى السريع لمادة الأدرينالين حرض الاجترار، وراوحت مدة الاجترار ما بين ١٣,٤ و ٢٠,٩ دقيقة. و قد فشل الأدرينالين في تحريض الاجترار عندما تم حقن الماعز بمادة البريزوسين، و هى إحدي حاصرات ألفا ١. بينما لم يؤثر حقن مادة اليوهمبين، و هي من حاصرات ألفا-٢، علي تحريض الاجترار بواسطة الأدرينالين. هذا و قد استنتج من هذه الدراسه أن تحريض الآجترار بواسطة الأدرينالين فى الماعز يتم عبر مستقبلات ألفا -١.