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Influence of behavioural and physiological variables on natural pasture utilization by grazing goats

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SUMMARY - Sward utilization by goats decreased as the grazing time on the same pasture increased. The purpose of the research is to acquire more information on the grazing behaviour of goats and on the role of the olfactory system on grazing selectivity. A comparison will be made between anosmic and non-anosmic goats to study whether pasture utilization is influenced by olfactory stimuli. The research is split into four branches: (i) reversible peripheral anosmia to study the role of olfaction in grazing goats; (ii) grazing behaviour of anosmic and non-anosmic goats; (iii) isolation and characterization of natural bioactive substances in herbage; (iv) adenylate-cyclase activity in olfactory epithelium from goats and sheep. The various approaches are discussed. We also report preliminary trials to develop an appropriate method of behavioural observation in addition to a new design of tracheotomy tube and oesophageal fistula.

Key words: Goats, grazing behaviour, anosmia, olfaction.

RESUME - "Influence des variables comportementales et physiologiques sur l'utilisation des pâturages naturels par les chèvres". L'activité sélective que les chèvres exercent par rapport à la flore conditionne considérablement le rendement d'utilisation du pâturage. Il faut acquérir des connaissances plus précises sur le comportement au pâturage des chèvres, en particulier, à l'égard du rôle joué par la sensibilité de l'odorat et du goût, puisqu'il n'y a pas, jusqu'à présent, d'informations objectives à ce sujet. Dans le cas qui nous occupe, on sait que la chèvre utilise les disponibilités du pâturage d'une façon décroissante par rapport au nombre de jours de pâturage sur la même surface. Cela ne dépend pas de l'éclaircissage des espèces végétales appétissantes; par contre, il est probable que la réduction graduelle observée dans l'utilisation du pâturage par les chèvres, soit causée par une "pollution olfactive" croissante qui se manifeste parmi les animaux appartenant à la même espèce; dans ce cas, il est très important de savoir jusqu'à quel point un pâturage peut être correctement exploité. Nous abordons la question par l'induction de l'anosmie réversible.

Mots clés : *Chèvre, comportement, pâturage, odorat, anosmie.*

Introduction

It has been recognized that goats show a different grazing style than sheep and cattle (Gordon and Iason, 1989). Goats have been indicated as browsing species since they take shallower bites from the sward surface (Milne, 1991). They have a high degree of selectivity due to a narrower, pointed dental arcade (Gordon and Illius, 1988). Diet selection by ruminants is also strongly influenced by anti-herbivore compounds in plant tissues (Freeland and Janzen, 1974; Cooper and Owen-Smith, 1985). It has been found that the sward utilization by goats decreased as the grazing time on the same pasture increased (Fedele *et al.*, 1988; Rubino *et al.*, 1988; Morand-Fehr, 1990). However, relatively few studies have addressed the question of what behavioural and physiological mechanisms ruminants use while feeding.

The research aims to acquire more information on the grazing behaviour of goats and on the role of the olfactory system on grazing selectivity. In particular, a comparison will be made between anosmic and non-anosmic goats to study whether pasture utilization is influenced by olfactory stimuli. Since little information is available on this topic, a multidisciplinary approach was adopted. Therefore, the research was divided as follows: (i) reversible peripheral anosmia to study the role of olfaction in grazing goats; (ii) grazing behaviour of anosmic and non-anosmic goats; (iii) isolation and characterization of natural bioactive substances in herbage; (iv) adenylate-cyclase activity in olfactory epithelium from goats and sheep (see Biondi and Fabbri's communication).

Reversible peripheral anosmia to study the role of olfaction in grazing goats

Olfaction has a three stage system: reception, elaboration and perception. Procedures that would interfere with elaboration o perception sites (C.N.S. transections; ablation of olfactory bulbs) were excluded.

The destruction of the olfactory mucosa by irrigation with $ZnSO_4$ to induce anosmia at receptorial level has been reported in sheep (Poindron, 1974) and dogs (Houpt *et al.*, 1982). This technique has the advantage of being reversible in time, because after a variable period the nerve fibres and receptors will regenerate. However, the method was discarded because it seemed unreliable.

An appropriate method would be to apply a local anaesthetic that would impair the activity of the receptors for a short time. Trials were carried out on sheep and goats applying topically 4% tetracaine HCl, 2% lidocaine HCl and 10% cocaine HCl respectively. These anaesthetics were sprayed, nebulized or atomized through a nasal catheter directly on the olfactory mucosa. Sheep showed higher degree of olfactory depression after cocaine HCl than goats.

Tracheotomy could be a possible alternative to local anaesthetic. It has several advantages over olfactory mucosa destruction: (i) it provides a reliable consistent

anosmia because it diverts the air column from the olfactory mucosa; (ii) there is no permanent damage since after the trials the animals can recover olfaction at any time.

Preliminary trials were carried out on 3 goats which had been tracheotomized for periods of up to two months. Results showed that the subjects could not discriminate high concentrations of a challenging odour (concentrate-based pellet mixed with 0.1% of pork faeces). Human tracheotomy tubes were implanted. These posed some problems related to the cleaning and obstruction of the tubes.

A joint project has been set up with the Department of Biomaterial of University of Naples to devise a new prosthesis similar to the Montgomery T tube (Ellis *et al.*, 1984), which will allow instant reversibility of the anosmic effect and a reduction of continuous cleaning.

In addition to the grazing behaviour of the anosmic subjects, the ingesta through an oesophageal fistula will also be analyzed. Currently, animals surgically prepared with oesophageal fistula are used to gather data on intake and diet selection. The fistulas currently in use have given rise to several problems: (i) ulcerations and progressive enlargement of the oesophagostomia; (ii) dislodgement of the prothesis and loss of saliva.

These problems are due to the shape, material and implantation technique of the prosthesis and may affect the welfare and behaviour of the animal, particularly at high temperature (Ellis *et al.*, 1984; Provenza and Malechek, 1986; Pfister *et al.*, 1990). A new one-piece medical grade polyurethane prosthesis has been developed. It offers several advantages over traditional ones:

i. The one-piece design reduces the accumulation of food particles in contact with oesophageal mucosa and skin, reducing inflammation and infection.

ii. The elasticity of the prosthesis allows it to conform to the shape of the fistula, reducing local compression and necrosis.

iii. The light weight (10 *versus* 70 g of conventional cannulae) reduces discomfort and compression considered responsible for the increase in fistula diameter.

Preliminary results on 3 goats have been encouraging, but the new prosthesis is still easily dislodged and the loss of saliva is not prevented. Research is still in progress to avoid these complications.

Grazing behaviour of anosmic and non-anosmic goats

Preliminary trials have been carried out on 12 goats to develop an appropriate method of observation. Briefly, three natural pasture fields have been divided in square grids of 16 m² by means of wooden poles. Poles were alternately painted white and red to identify the animals in the field. This has also allowed the distance between the animals and the distance covered during grazing to be evaluated. The floral

composition of each grid has also been determined. Each pasture field was approximately 6600 m².

The grazing activity has been recorded by direct observation (Arnold, 1964; Ellis *et al.*, 1984; Marinier and Alexander, 1992; Ramos and Tennessen, 1992), with the animals being located within grid. Focal and scan sampling methods (Altmann, 1974; Martin and Bateson, 1987) have been employed. Each goat was observed for 15 min and all instances of its behaviour were recorded by a fixed videocamera (JVC-BY-110 with a 70-210 mm and 28 mm lenses) placed on top of the hill. In addition, the group of goats was scanned every 10 min and the behaviour of each individual at that instant recorded.

These two recording methods are time consuming and can be particularly difficult under field conditions because the animal may be partially obscured or move completely out of sight (Martin and Bateson, 1987). However, in our field conditions these difficulties have been overcome. These preliminary trials have allowed to conceive a suitable plan of observation and the research will virtually start in spring 1992.

Isolation and characterization of natural bioactive substances in herbage

The agricultural Industry Institute (University of Naples) has extracted compounds from herbaceous edible plants which are not always ingested by goats. Briefly, six different types of herbaceous plants (*Festuca, Ranunculus, Dactylis, Rumex, Galium, Medicago*), edible as far as goats are concerned, have been separated into three samples of equal weights. After fine chopping, the samples have been allocated to different extraction methods:

i. With a minimum amount of water for 24 h at room temperature and then filtered. The filtrate has been gathered (sample A).

ii. With air at 40°C, bubbling in 200 cc of pure tripalmitine. After 3 h the solution has been collected (sample B).

iii. With ethyl ether. The organic has been dried under low pressure and the bath kept at 35°C. The residue has been resuspended in water/ethanol 1% (sample C).

The research is still in progress. The three samples A, B and C, with known concentrations will be tested *in vivo* and *in vitro* (see Biondi and Fabbri's communication). The active part of each sample will then be fractionated using different chromatographic techniques. The fractions obtained should then be tested *in vivo* and *in vitro* and their chemical composition determined using spectroscopic techniques. In addition, these fractions will be injected into goats for detecting toxicity and immunogenicity.

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