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Effects of the inclusion of *Knautia arvensis* in the concentrate for fattening lambs on feed intake, digestibility and growth performances

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Abstract. *Knautia arvensis* has shown antiproteolytic activity on ruminal fluid *in vitro*, suggesting a potential use as a natural plant additive to decrease feed protein degradation in the rumen. In the current experiment, twenty-four Assaf lambs (15.0 ± 0.38 kg) were used to investigate the effects of the inclusion of 12% of *K. arvensis* in the concentrate on feed intake, digestibility and animal performance. Animals were allocated into two groups (Control and Knautia) and fed concentrate and barley straw *ad libitum*. From day 21 to 27 of the experimental period, a digestibility trial was conducted using 4 lambs per group. Lambs were slaughtered when they reached 25 kg. No negative effects were observed on feed intake (P>0.05) (average concentrate and barley straw intakes of 791 and 35 g/day, respectively). Likewise, dry matter, fibre and crude protein digestibilities resulted statistically unaffected (P>0.05). There were no effects of *K. arvensis* on growth rate and feed to gain ratio (P>0.05), and similar carcass weights and killing out percentages were observed (P>0.05). In conclusion, regardless of its potential as an antiproteolytic agent, the inclusion of *K. arvensis* in the concentrate had no significant effects on feed utilization and performance of growing-fattening lambs.

Keywords. Rumen – antiproteolysis – phytochemical – *Knautia*.

Effet de l'incorporation de* Knautia arvensis *dans le concentré pour les agneaux d'engraissements sur l'ingestion, la digestibilité et les performances de croissance

Résumé. Knautia arvensis *a une activité antiprotéolitique dans le liquide du rumen in vitro. Vingt quatre agneaux de race Assaf ont été utilisés pour étudier l'effet de l'incorporation de 12% de* K. arvensis *dans le concentré, sur l'ingestion, la digestibilité et la croissance. Ces animaux ont été répartis en deux groupes et ont reçu du concentré et la paille d'orge à volonté. Un essai de digestibilité a été mené sur quatre moutons de chaque groupe entre le 21ème et le 27ème jours de la période expérimentale. Les agneaux ont été abattus lorsqu'ils ont atteint un poids vif de 25 kg. Aucun effet négatif n'a été détecté sur l'ingestion du concentré (791 g/jour) et de la paille (35 g/jour). La digestibilité de la matière sèche, des glucides pariétaux et des matières azotées totales, le gain moyen quotidien et l'indice de consommation n'ont pas été affectés par l'incorporation du* K. arvensis dans le concentré*. Le poids et la longueur de l'animal ainsi que le rendement commercial ont été similaires entre les groupes d'agneaux. En dépit de son activité antiprotéolytique démontré auparavant dans un essai in vitro, l'incorporation de* K. arvensis *dans le concentré s'est avérée sans effet sur l'ingestion, la digestion et la croissance des agneaux à l'engrais.*

Mots-clés. *Rumen – anti-protéolyse – phytochimique* – Knautia*.*

I – Introduction

In ruminants, the amount of protein available to the animal arises from the mixture of microbial protein reaching the small intestine and the amount of dietary protein that escapes microbial degradation (by-pass protein). In an ideal situation, rations are formulated so that protein degradability is optimal to yield balanced amounts of both fractions (microbial and feed undegraded protein). In intensive production systems, protein-rich diets are used to assure the supply of by-pass protein,

to match the elevated amino acid requirements of high-yielding animals. In this case, if dietary protein is broken down in excess of the requirements for maximal microbial growth, proteolysis by ruminal micro-organisms becomes a waste of nitrogen. With an optimal extent of degradation of protein in the rumen it is possible to reduce the supply of dietary protein to a minimum, with important benefits such as reduced feeding costs, improved animal health and decreased nitrogen emissions with animal excreta. In this sense, several studies have aimed to identifying natural substances as potential inhibitors of ruminal proteolysis to enhance N utilization (Wallace, 2004).

One of the objectives of the EU Project "Rumen-up" (QLK5-CT-2001-00992) was to discover and identify new plants and extracts as dietary supplements for ruminants to decrease N excretions. After a screening of 500 samples of plants and their extracts, *Knautia arvensis* was identified as a potential anti-proteolytic feed additive for ruminants. This activity seemed to be related to its saponins content, as well as to its activity reducing the numbers of protozoa (Selje *et al.*, 2007; Goel *et al.*, 2008) and a patent was filed (patent no. WO2005099729) for the application of *K. arvensis* in ruminant nutrition.

Results of studies carried out *in vitro* with different extracts of *K. arvensis* suggest that this plant has the potential to increase ruminal escape of protein, thus reducing protein microbial breakdown and enhancing the efficiency of utilization of dietary protein (Hoffmann *et al.*, 2008). The aim of the present work was to study the effects of the inclusion of 120 g of this plant per kg of concentrate feed for fattening lambs on food intake, digestibility and animal performance.

II – Material and methods

Twenty four Assaf lambs (initial body weight, BW 15 kg) were allocated in two experimental groups, depending on the inclusion or not of *K. arvensis* (120 g/kg) in the concentrate. Ingredients and chemical composition of experimental concentrates and barley straw are shown in Table 1.

Table 1. Ingredients and chemical composition of experimental concentrates (Control or Knautia) and barley straw (g/kg)

	Control	Knautia	Barley straw
Barley	552	552	
Peas	137	137	
Field beans	125	125	
Grass meal	122	–	
Knautia arvensis	–	122	
Palm oil	22	22	
Vitamin mineral premix	22	22	
Calcium carbonate	10	10	
Molasses	10	10	
Dry matter	893	884	944
Crude protein	117	110	21
Neutral detergent fibre	168	164	438
Ash	61	68	48

All the animals received the corresponding concentrate (Control or Knautia) and barley straw ad libitum. Concentrate and roughage were supplied in separate feeding troughs at 09:00 a.m. every day, and fresh drinking water was always available. The orts refused were also weighed daily, and samples were collected for subsequent analyses.

On day 21, eight lambs (four per group) were selected randomly and confined into metabolism cages. After 3 days of adaptation to cages, faeces of each animal were collected daily, weighed and a sample (10%) was taken for further chemical analyses.

Body weight was recorded twice a week, before morning feeding, until lambs reached 24 kg, and then daily until a BW of 25 kg. When the intended BW (25 kg) was reached, the animal was stunned, slaughtered by exsanguination from the jugular vein, eviscerated and skinned.

Chemical composition of feed, orts and faeces was determined using the procedures described by AOAC (2003) for dry matter, ash and Kjeldahl nitrogen. Neutral detergent fibre (NDF) was determined by the method of Van Soest *et al.* (1991).

Average daily weight gain (ADG) was estimated as the regression coefficient (slope) of BW against time in fattening. All data were subjected to one-way analyses of variance using the GLM procedure of SAS (1999).

III – Results and discussion

The potential of *K. arvensis* as an anti-proteolytic feed additive has been studied and confirmed *in vitro*. These effects could be due to its inhibitory effects on ruminal protozoa. However, the underlying mechanism of inhibition has not been elucidated yet, although it could resemble that of monensin (Selje *et al.*, 2007). *K. arvensis* may eventually form the basis of alternative feed additives to inhibit ruminal proteolysis and improve protein nutrition in ruminants. However, to our knowledge there is no *in vivo* study confirming *in vitro* observations. Therefore, evaluation of its effects *in vivo* and confirmation of the absence of any adverse side-effects, such as inhibited ruminal fermentation, altered food intake patterns or development of food aversion, are necessary prior to making specific recommendations for the use of this plant as feed additive.

Average values of initial and final body weight, food intake, digestibility, daily gain, feed to gain ration, carcass weight and animal performance for each experimental group are presented in Table 2. As can be seen, none of the parameters studied was statistically affected ($P>0.05$) by the inclusion of 12% of *K. arvensis* in the concentrate.

Although in the present experiment the amount of this plant added to the concentrate was moderately high (120 g/kg), neither concentrate nor barley intake were negatively affected. This fact could be interpreted as the animals did not reject the food provided because of changes in its palatability.

On the other hand, no differences were observed in nutrient digestibility. An increase in protein digestibility and, as a consequence, in N retention could be expected in Knautia lambs. However, in a study carried out with steers receiving a saponin-rich extract in the concentrate, Lila *et al.* (2005) reported no changes in protein digestibility, although they observed higher N retention values.

Regarding the effects of *K. arvensis* on average daily gain or feed to gain ratio, these parameters were not affected, nor were carcass weight or killing out percentage. The absence of any enhancing effect led us to wonder whether the animals were in a position to respond. They might have achieved their maximum growth rates, so a positive result derived from an increase in the protein flow from the rumen for example, could not be observed. Therefore, the use of challenge animals would be an alternative to better confirm the effects *in vivo* of this plant.

It can be concluded that the use of *K. arvensis* in the concentrate for fattening lambs did not affect significantly food intake, digestibility and animal performance. Nevertheless, because of its particularly promising effects observed *in vitro*, further research should focus on the effects *K. arvensis* on N retention and carcass and meat characteristics.

Table 2. Mean values of weight, intake, digestibility and performance for each experimental group

	Control	Knautia	s.e.d.	
Initial body weight (kg)	15.1	15.0	0.38	NS
Final body weight (kg)	25.2	25.2	0.16	NS
Dry matter intake (g/day)				
Concentrate	789	793	37.2	NS
Barley straw	33	36	6.0	NS
Total	822	829	36.7	NS
Digestibility (%)				
Dry matter	76.2	75.5	2.95	NS
Crude protein	70.6	66.4	3.20	NS
Neutral detergent fibre	36.5	31.4	6.02	NS
Average daily gain (g/day)	292	278	22.1	NS
Feed to gain ratio (g/g)	2.87	3.03	0.183	NS
Cold carcass weight (kg)	11.6	11.7	0.25	NS
Killing out (%)	46.5	46.7	0.89	NS

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