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Effect of the physiological stage of dairy goats on intake frequency and feed preferences in a free-choice feeding system

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SUMMARY – Six Maltese goats were used to measure voluntary dry matter intake (DMI) at different physiological stages (70 and 130 days of pregnancy and 20 and 130 days of lactation) of alfalfa hay, annual forage crop hay, two different types of pasture hay, barley, maize, beet-pulps, chick-peas, broad-beans and lentil, offered in an unlimited amount. Within each physiological stage, individual DMI was measured for five consecutive days at 8:30, 10:30, 12:30, 14:30, 16:30, 18:30, 20:30 h. The results showed that the physiological stage modified the total DMI, the chemical and feed composition in the diet in each interval. In early pregnancy, about 70% of the total DMI was consumed within the hours 14:30 and 16:30, while 25% was consumed in the morning. In late pregnancy the DMI increased in the afternoon until 16:30, and again in the night. During lactation, goats showed a tendency to ingest the same percentage of feeds for each interval. According to their physiological stage, goats successfully regulated their diet composition. During the entire pregnancy they replaced barley, maize and pasture hay by beet-pulps, chick-peas and alfalfa hay, in order to increase the diet protein content and to better regulate the digestion process. During lactation they increased barley and maize to better meet energy requirements.

Key words: Intake frequency, feed preferences, free-choice feeding, goat.

RESUME – *"Effet du stade physiologique sur la fréquence d'ingestion et sur le comportement alimentaire des chèvres alimentées en libre choix". L'expérience a été menée sur six chèvres placées dans des boxes de 2,5 x 1,5 m. Les chèvres reçoivent, séparément, 4 types de foin (luzerne, prairie temporaire, 2 prairies naturelles) et 6 types de concentrés (orge, maïs, pulpes de betterave déshydratées, fèves, pois chiches et lentilles) en libre choix. L'ingestion de matière sèche (MSI) a été enregistrée dans 4 stades physiologiques (70 et 130 jours de gestation et 20 et 130 jours de lactation) à 8:30, 10:30, 14:30, 16:30, 18:30, 20:30 h et pendant 5 jours consécutifs. Les résultats ont montré des différences, entre les stades physiologiques, en ce qui concerne la MSI, l'ingestion et la composition alimentaire et chimique du régime. Au début de la gestation, environ 70% de la MSI étaient consommés entre 14:30 h et 16:30 h, tandis que 25% étaient consommés le matin. Au contraire, à la fin de la gestation, la chèvre augmente la MSI la nuit. Au cours de la lactation, les chèvres ont ingéré la même quantité d'aliments dans un même intervalle de temps. La nature des aliments choisis par les chèvres ne semble pas aléatoire mais orientée vers l'obtention d'une ingestion optimale de nutriments.*

Mots-clés : *Fréquence d'ingestion, comportement alimentaire, alimentation en libre choix, chèvre.*

Introduction

Animal performance depends on their genetic characteristics and can be modified by the farmers through the feeding. In fact, recent knowledge on animal requirements, the digestive-metabolic processes and the nutritive value of feeds, gives them the opportunity to improve animal performance. Moreover, a part of the performance remains unexpressed, but there is a possibility of obtaining it. Some researchers retained that the increase of feeding frequency was a valid mean for improving milk production, while others did not. In fact, Gibson (1984) in his review, reported that in 35 experiments only 4 had an increase in milk production, whilst in another 7 experiments the opposite was observed. In all these experiments the rations, the quantity and the time of distribution were decided by man and perhaps, due to this, not always adequate for the biological rhythm of the animals. Only in extensive grazing systems the animal has the opportunity to choose a preferred type of feed and a digestive rhythm.

It is difficult to create in the stable the conditions of the pasture, although Fedele *et al.* (in press) proposed a system to simulate it. In this system, animals were fed with hay and grains of different

species in unlimited amount, each of them put in a single pail. In this condition, animals ate more often small quantities during the day, probably because they were sure to find always feed available.

Following these visible observations, trials were conducted by Fedele *et al.* (in press) on lactating goats. The results confirmed that goats prefer an intake in small portions at frequent intervals: in this way, probably, optimising the efficiency of feed use, hence intake maximisation. The observed phenomenon required further confirmation and exploration. The objectives of this study were to assess the repeatability of the previous results and to verify if the physiological state of the animal influences the observed feeding behaviour.

Materials and methods

Six Maltese goats, aged 2.5 years, were used. The animals came from a three-year period of consolidated feed conditions, having been fed with the same free-choice system. Each animal was housed in a 2.5 x 1.5 m box where a long feeding trough was attached. The trough was subdivided into 10 sections. Four different types of hay were used: alfalfa, annual forage crop and mountain and valley pasture. Six different grains were also used: flakes barley, flakes maize, chick-pea and broad-bean grain (hydrated in water), lentil grain and dehydrated beet-pulps. Feeds were always available in unlimited amount, each of them in a single pail. The animals were able to eat whatever they wanted because the feed was readily available from the trough.

For 5 consecutive days, at 8:30, 10:30, 12:30, 14:30, 16:30, 18:30, 20:30 h, for each goat and single feed the ingested quantity was measured. The trial began when the animals were at 70 days of pregnancy (P1) and was repeated at 130 days (P2) and also at 20 and 130 days of lactation (L1 and L2 respectively). The data was analysed by GLM procedure of SAS (SAS, 1987).

Results and discussion

The results (Table 1) showed that the physiological stage modified the behaviour of goats. The total dry matter intake (TDMI) varied from 927 g/h at P2 to 2.412 g/h at the L1 physiological stage. In the P1 physiological stage, about 70% of the TDMI was ingested within the hours 14:30 and 16:30, while 25% was ingested in the morning hours. In the P2 period these percentages, in the same intervals, decreased at 50% and 17%. This behaviour changed further during lactation, in fact the goats tended to eat the same quantity of feed at each interval. In L1 physiological stage, the oscillations between one interval and another were higher.

In L1 the values varied from a minimum of 7.2% at 20:30 h to a maximum of 25.9% at 16:30 h. In L2 from 5.1% at 10:30 h to 21.6% at 18:30 h. During the night goats ingested 15.4% and 9.8% respectively for the L1 and L2 physiological stage. The physiological stage also modified the diet composition. During pregnancy the intake of chick-peas, alfalfa hay and beet-pulps increased and decreased for the other feeds. The contrary was observed during lactation (Table 2). Greater variations were observed for the chick-peas, beet pulps, alfalfa hay, barley, maize and lentil grains. During pregnancy the first mentioned three types of feed (chick-peas, beet pulps, alfalfa hay) increased by 12, 7 and 8 percentage points respectively, and decreased by 4, 6 and 3 percentage units during lactation. In contrast, barley, maize and lentil decreased by 2, 12 and 6 percentage points during pregnancy and increased by 5, 6 and 7 percentage points during lactation.

The values for all the other types of feed varied less than yet, they were not always linear.

The different behaviour caused by physiological stage indicates that animals are capable of activating mechanism which affect selection of feeds.

The different mechanism that regulates the behaviour (homeostasis and homeorhesis, feedback control, physiological and psycogenic control system, efficiency of oxygen use, etc.) described by Campling (1970), Forbes (1983), Ketelaars and Tolkamp (1992), Mertens (1985, 1996), Sauvant (1994, 1996) could not completely explain the results obtained in this research, because in their experiment the animals were not completely free to decide the access time to the feeds and the

Table 1. Dry matter intake (% on total) at each interval in four different physiological stages (mean ± s.d.)

Physiological stage	8:30 h	10:30 h	12:30 h	14:30 h	16:30 h	18:30 h	20:30 h	Night	Total DMI (g)
P1	6.7^{b} ± 4.9	8.0 ± 6.1	10.3 ± 5.7	25.0^{a} ± 6.8	44.1^{a} ± 7.2	1.7^{c} ± 1.2	3.0^{b} ± 2.1	1.0^{c} ± 2.9	997^{c} ± 342.2
P2	6.0^{b} ± 4.6	5.6 ± 4.9	5.7 ± 6.2	19.4^{a} ± 6.4	29.6^{b} ± 6.6	13.2^{b}± 6.8	3.1^{b} ± 3.8	17.4^{a} ± 7.3	927^{c} ± 292.2
L1	18.2^{a} ± 8.2	14.3 ± 8.4	9.7 ± 5.3	10.3^{b} ± 3.2	25.9^{b} ± 6.6	17.2^{ab} ± 6.2	7.2^{ab}± 2.1	15.4^{ab} ± 6.2	2412^{a} ± 635.5
L2	15.4^{a} ± 7.3	5.1 ± 4.2	10.3 ± 6.6	7.7^{b} ± 5.8	16.8^{c} ± 7.2	21.6^{a} ± 7.6	13.4^{a}± 5.4	9.8^{b} ± 6.7	1593^{b} ± 470.3
Effect	*	NS	NS	**	***	*	*	*	***

$^{a, b, c}$Results in columns are different P < 0.05.
*P < 0.05; **P < 0.01; ***P < 0.001; NS: not significant.

Table 2. Diet composition (%) of goats in four different physiological stages (mean ± s.d.)

Physiological stage	Barley	Maize	Beet pulps	Chick Peas	Lentil	Broad beans	Alfalfa hay	Grassland hay	Mount. pasture hay	Valley pasture hay
P1	18.4 ± 11.3	17.3^{a} ± 7.1	6.7 ± 7.1	22.6 ± 17.7	15.2 ± 11.4	0	5.4 ± 6.2	5.8 ± 4.1	2.4 ± 2.5	6.2 ± 5.7
P2	15.9 ± 16.0	5.1^{b} ± 4.9	13.6 ± 18.7	34.2 ± 26.8	9.6 ± 12.2	0.8 ± 2.3	13.3 ± 11.5	3.9 ± 4.6	2.0 ± 3.5	1.6 ± 2.5
L1	18.6 ± 8.9	12.0^{b} ± 8.8	10.2 ± 11.0	24.1 ± 6.8	9.4 ± 9.3	1.9 ± 2.1	10.9 ± 3.6	5.9 ± 2.8	3.3 ± 2.6	3.7 ± 2.2
L2	23.4 ± 10.7	17.5^{a} ± 13.2	4.1 ± 2.2	19.8 ± 14.6	16.7 ± 15.6	0.4 ± 1.0	7.8 ± 3.1	5.2 ± 2.2	1.6 ± 0.9	3.5 ± 3.2
Effect	NS	*	NS	NS	NS	NS	NS	NS	NS	NS

^{a,b}Results in columns are different.P < 0.05.
*P < 0.0NS: not significant.

quantity of feed to eat. The animals demonstrated that they were "more than capable" of exercising freedom in choice. Gradually, at the nutrients demand by the foetus and by milk production increase, goats increased DMI to better balance the quantity ingested at different intervals and thus modifying the diet composition. In a restricted confinement system, where the access to feeds and the quantity of feeds were limited, the colonisation of bacteria suffered variations as much higher as higher was the interval between a meal and another (Van Milgen *et al.,*1993). The best equilibrium in the ingested quantity probably reduced the variation of the bacteria colonisation, improved the digestion activity and, therefore, increased feed intake. The choice of feeds appeared to be due to a nutritive and physiological need. In fact, in late pregnancy, when the protein requirements and the risks of digestive disorders were very high, goats increased the intake of chick-peas, alfalfa hay and beet-pulps, while in lactation they increased the intake of barley and maize to meat their energy requirements. Goats substituted one feed with another making a precise choice. The alfalfa hay was substituted by maize while the chick-peas by barley + maize (Fig. 1) the lentil by beet-pulps (Fig. 2).

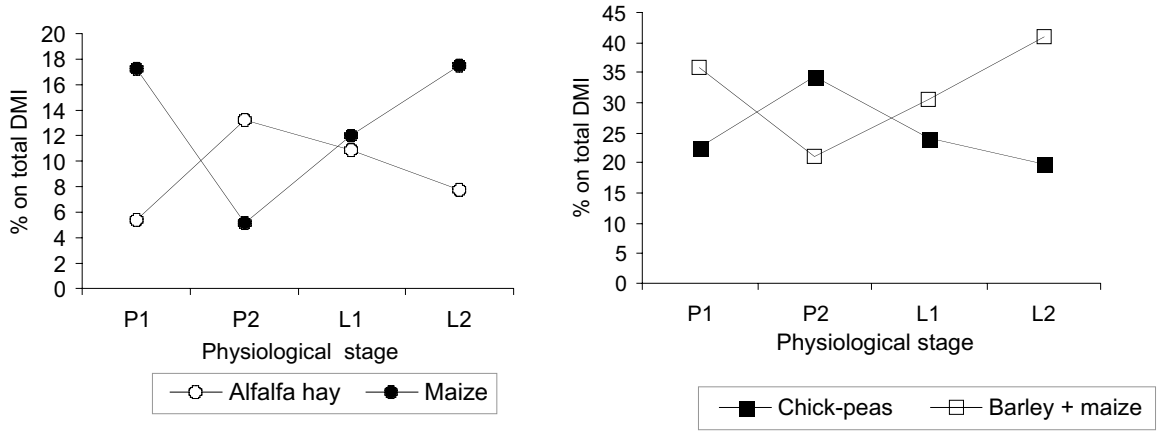

Fig. 1. Variation of alfalfa hay and maize (on the left) and variation of lentil and beet-pulps in the diet (on the right).

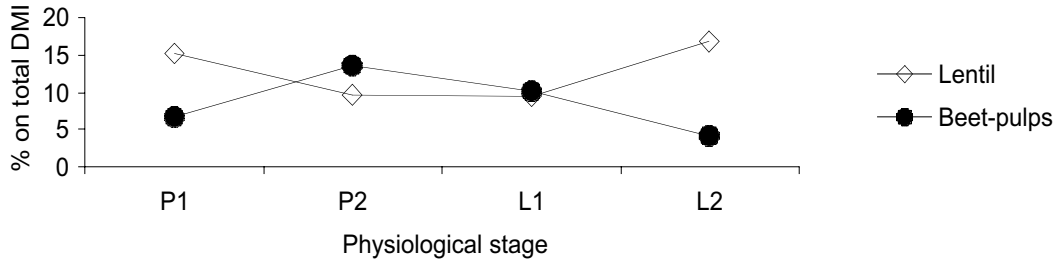

Fig.2. Variation of lentil and beet pulps in the diet.

The observed high standard deviation indicated that each goat chose the feeds and the meals frequency that better satisfied its needs.

The milk yield, much higher in comparison with the traditional feeding system (520 kg vs. 235 kg), (Fedele *et al.,* in press) denoted that the goats, through their behaviour, were capable of well adapting the selected diet to their requirements.

Conclusions

The goats showed a good ability to modify their intake, meals frequency and the diet composition according with their physiological state. This behaviour was possible because the animals had continuous availability and accessibility to feeds.

The variation in the number of offered feeds, (four in plus in comparison with the previous research, Fedele *et al.,* in press) modified the strategy of substitution, but not the ability of goats to arrange at best the feeds offered.

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