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Feeding behaviour, intake, apparent digestibility and plasma metabolites of Latxa dairy ewes as affected by cold-pressed oilseed cakes and sainfoin

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Abstract. The hypothesis tested was that the tanniferous forage sainfoin, given as hay, has an advantage over a typical fescue in dairy ewes with respect to intake, ruminal fermentation and ingestive behaviour when cold pressed oilseed cakes rich in crude fat are formulated in the concentrate. A lactation trial was carried out with 72 blackfaced Latxa dairy ewes at early lactation in a 2 x 3 factorial arrangement involving two forages (fescue and sainfoin hay) and 3 experimental concentrates. Concentrates were formulated to contain cold-pressed rapeseed cake, cold-preseed sunflower cake or palm as fat sources and to provide equal amounts of crude protein fat and energy. No interactions between concentrate and forage were observed. None of the measured traits was affected by concentrate. However, feeding sainfoin increased forage eating time (356 vs. 279 min/d, P<0.001), reduced rumination time (325 vs. 422 min/d, P<0.001), increased forage dry matter intake (1.84 vs. 0.99 kg/d, P<0.001), apparent organic matter digestibility (613 vs. 580 g/kg, P = 0.011) and IGF-1 plasma concentration (110.7 vs. 98.6 ng/ml, P = 0.014). In conclusion, cold pressed oilseed cakes can be used as feedstuffs regardless of the forage used.

Keywords. Tannins – Rapeseed – Sunflower.

Comportement alimentaire, ingestion, digestibilité apparente et métabolites plasmiques des brebis laitières Latxa affectées par les tourteaux d'oléagineux pressés à froid et le sainfoin

Résumé. *L'hypothèse testée était que le sainfoin, donné comme du foin, a un avantage sur une fétuque chez les brebis laitières par rapport à la ingestion, la fermentation ruminal et au comportement ingestif lorsque des tourteax d'oléagineux pressés à froid riche en graisse brute sont formulés dans le concentré. Un essai de lactation a été mené avec 72 brebis laitières au début de l'allaitement dans un arrangement factoriel 2 x 3 impliquant deux fourrages (fétuque et sainfoin) et 3 concentrés expérimentaux. Les concentrés ont été formulés pour contenir tourteau de colza, tournesol ou palme comme sources de graisse, et pour fournir des quantités égales de graisse, de protéines brutes et d'énergie. Aucune interaction entre le concentré et le fourrage n'a été observée. Aucun des caractères mesurés n'a été affecté par le concentré. Cependant, sainfoin a augmenté le temps d'ingestion (356 vs. 279 min/d, P<0.001), a réduit le temps de rumination* (325 vs. 422 min/d, P<0.001), *a augmenté l'ingestion de fourrage* (1.84 vs. 0.99 kg/d, P<0.001), la digestibilité *apparente (613 vs. 580 g/kg, P = 0.011), la concentration plasmatique d'IGF-1 (110.7 vs. 98.6 ng/ml, P = 0.014). En conclusion, les tourteaux d'oléagineux pressés à froid peuvent être utilisés comme aliments pour LES animaux quel que soit le fourrage utilisé.*

Mots-clés. *Tanin – Colza – Tournesol.*

I – Introduction

Cold-pressed oilseed cake (CPOC) is a cheap by-product of oil-manufacturing. It is widespread in the European area and it can be obtained on-farm after simple mechanical extraction of the oil from the seeds. CPOC has been shown to have higher crude fat content than those of conventional solvent and expeller meals (up to 230 g kg^{-1} compared to 30 and 100 g kg^{-1}, respectively,

Benhissi *et al*., 2014) which make it an attractive energetic feedstuff for livestock. Sainfoin (*Onobrychis viciifolia*) is a temperate forage legume which has a moderate to high content of condensed tannins (Scharenberg *et al*., 2007). Condensed tannins are known to alter rumen microflora activity, inhibiting the last step of rumen biohydrogenation (Vasta *et al*., 2009). The hypothesis tested was that sainfoin, given as hay, has an advantage over a typical fescue in dairy ewes with respect to intake ruminal fermentation and ingestive behaviour when cold pressed oilseed cakes rich in crude fat are formulated in the concentrate.

II – Material and methods

The experiment was carried out in accordance with Spanish Royal Decree 53/2013 for the protection of animals used for experimental and other scientific purposes.

1. Animals and experimental diets

The trial was carried out at the Neiker-Tecnalia experiment station. A lactation trial utilized 72 black-faced Latxa dairy ewes at early lactation in a 2 x 3 factorial arrangement involving two forages (fescue and sainfoin hay) and 3 experimental concentrates. Concentrates were formulated to contain cold-pressed rapeseed cake (RPS), cold-preseed sunflower cake (SUN) or palm (CTR) as fat sources. Concentrates were formulated to provide equal amounts of crude protein (CP), energy and fat. Ingredients of experimental concentrates and forages are shown in Table 1. Ewes were divided into 6 equilibrated groups of 12 ewes each, according to milk yield (2094 ± 520 ml) and days in milk (15 ± 8 d postpartum). The experimental concentrates were offered in individual feeders in the milking parlour as two equal meals (450 g DM) during the morning and evening milkings. Tall fescue (*Festuca arundinacea*) hay or sainfoin hay was group fed *ad libitum* in a feed bunk and water. The quantity of offered fescue or sainfoin hay was based on morning bunk readings, and the amount of feed offered was adjusted daily to allow 10% refusals. The experimental period lasted for 56 d, of which the first 7 d were for covariate determinations, the following 7 d were for treatment adaptation to experimental concentrates, and the last 42 d for measurements and samplings.

2. Measurements and samplings

Quantities of concentrate offered and refused were recorded 7 d/wk on an individual basis throughout the experiment. Individual forage hay dry matter intake (DMI) and diet organic matter apparent digestibility (OMD) were estimated using two markers. Acid insoluble ash (AIA) was used as an internal marker and chromium sesquioxide (Cr_2O_3) as an external. Beginning on d 29 ewes received, during 10 days, twice daily, at 07.30 h and 18.00 h, one gram of Cr2O3, stored in gelatin capsules, and placed directly in the esophagus with an esophageal tube.

Animal behaviour data were recorded for 48-hr observations beginning on d 39 and finishing on 41. The measurement period commenced at 9:20 am and the ewes were kept under observation by one observer. Eating, ruminating, and other activities of the 72 animals were recorded. The actual behavioral observations were recorded at 10-min intervals. The total time spent in a given behaviour was calculated on the assumption that the animal observed in a particular behaviour pattern remained in that pattern until the next observation. Behaviour activities were averaged by ewe.

Blood samples (10 mL) were collected on d 55, 2 h after morning milk feeding via jugular venipuncture into plain vacutainers without anticoagulants (Becton & Dickinson USA). Once collected, blood samples were centrifuged (2800 × g for 10 min at 4°C), and plasma was recovered and frozen at -20°C for non esterified fatty acids (NEFA), blood urea nitrogen (BUN) and IGF-1.

Table 1. Ingredients and chemical composition (g kg^{-1} DM) of experimental concentrates (CTR: control; SUN: sunflower; RPS: rapeseed), sainfoin (SAIN) and fescue (FES) hay

Item	Concentrate			Hay	
	CTR	SUN	RPS	SAIN	FES
Ingredients					
Cold pressed rapeseed cake	0	0	400		
Cold pressed sunflower cake	0	560	0		
Soybean meal	150	0	0		
Barley	160	150	360		
Corn	180	210	100		
Oats	200	0	0		
Molasses	50	50	50		
DDGs	150	0	60		
Hydrogenated palm fat	80	0	0		
Vitamin-mineral premix*	30	30	30		
Chemical composition					
Dry matter	904	902	901	897	905
Organic matter	847	833	862	903	919
Crude protein	185	180	180	139	117
Neutral detergent fibre	201	286	196	375	594
Acid detergent fibre	53	200	123	254	285
Fat	107	108	109	18	19
Starch	338	267	302	43	0
UF	1.1	1.1	1.1		

CON: concentrate, FOR: forage, CTR: control, SUN: sunflower, RPS: rapeseed, FES: fescue hay, SAIN: sainfoin hay,*Vitamin and mineral premix contained per kg of DM: 2500 IU of vitamin A, 400 mg of vitamin D, 2.5 IU of vitamin E, 4.9 mg of Zn, 4.05 mg of Mn and 0.1 mg of Se (Calseaphos, Saint Malo, France).

3. Statistical analyses

Each dairy ewe was considered as the experimental unit. Total, hay and concentrate DMI, OMD, plasma concentrations and milk fatty acid profile (n = 72) were analysed using the GLM procedure. The statistical model included fixed effects of concentrate (CON), forage (FOR), their interaction and the initial record measured at week 0 (covariate). Ingestive behaviour was analysed using the previous statistical model but without including a covariate. Least squares means for treatments are reported. Treatment means were separated using a Tukey test.

III – Results and discussion

Concentrate affected neither DMI nor OMD of the diet, but forage significantly affected these traits. In this sense, SAIN increased total DMI (2.75 vs. 1.90 kg, P<0.001), forage DMI (fDMI) (1.84 vs. 0.99 kg, P<0.001) and OMD (613 vs. 580 g kg-1, P<0.001) compared to FES.

Feeding behaviour data can be seen on Table 5. No interactions between concentrate and forage were observed for any of these traits. Concentrate did not affect feeding behaviour. However, feeding SAIN increased forage eating time (356 *vs.* 279 min day^{-1}, P<0.001), while reduced rumination time (325 *vs.* 422 min day^{-1}, P<0.001) compared to FES.

Mean effects on plasma metabolites can be seen on Table 4. No interactions between concentrate and forage were observed for any of these traits. Similarly, plasma metabolites were not affected by concentrate or forage except for IGF-1 concentrations that were increased with SAIN (110.7 *vs.* 98.6 ng mL^{-1}, P = 0.014) compared to FES.

The increased OMD and changes observed in feeding behaviour in animals fed SAIN, with an increased forage eating time and a reduced rumination time could also explain increases observed in DMI. Our results agree with those of some authors who have reported no detrimental effect of SAIN on OMD (Theodoridou *et al*., 2010). Moreover, higher DMI and OMD could lead to increased energy available for microbial protein synthesis. The Higher IGF-1 plasma concentration observed with SAIN agrees with the latter, since protein is a crucial nutritional factor to regulate hepatic IGF-1 expression and secretion (Wan *et al*., 2017).

Table 2. Mean effects of feeding concentrate (CTR, SUN, RPS) and forage (FES, SAIN) on milk productive performance, intake, apparent digestibility (OMD) and plasma metabolites of lactating ewes

Item	FES			SAIN			SEM	P-value		
	CTR	SUN	RPS	CTR	SUN	RPS		CON	FOR	CONx FOR
Feeding behaviour (min day^{-1})										
Forage intake	284	253	278	344	350	356	9.6	0.072	<0.001	0.441
Rumination	397	422	450	280	359	337	20.9	0.167	<0.001	0.653
Chewing	710	706	773	654	738	735	26.1	0.202	0.536	0.498
Laying	730	734	667	786	702	705	26.2	0.203	0.528	0.510
Intake (kg day^{-1})										
DMI	1.86	1.83	2.00	2.70	2.74	2.80	0.360	0.386	<0.001	0.851
fDMI	0.96	0.92	1.11	1.79	1.83	1.90	0.360	0.347	<0.001	0.851
OMD (g kg^{-1})	583.5	584.7	572.8	602.7	590.7	645.5	52.7	0.347	0.011	0.075
Plasma metabolites										
IGF-1 (ng mL^{-1})	100.3	95.3	100.1	114.3	119.2	98.7	3.62	0.304	0.014	0.099
NEFA (mmol L^{-1})	0.216	0.247	0.228	0.215	0.225	0.223	0.007	0.197	0.294	0.583
BUN (mg dL^{-1})	19.8	20.3	19.6	22.8	19.4	17.8	1.32	0.464	0.961	0.504

CON: concentrate, FOR: forage, CTR: control, SUN: sunflower, RPS: rapeseed, FES: fescue hay, SAIN: sainfoin hay, DMI: dry matter intake, fDMI: forage DMI, IGF-1: insulin growth factor 1, NEFA: non-esterified fatty acids, BUN: blood urea nitrogen, SEM: standard error of the mean.

IV – Conclusions

Our data show that CPOCs nor SAIN had a detrimental effect on digestibility, intake or feeding behaviour. As a consequence, cold pressed oilseed cakes can be used as feedstuffs regardless of the forage used.

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