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Annual clovers performance in a dairy cows grazing system compared to perennial ryegrass. I – Yield, nutritive value and fatty acids composition of pasture during the spring grazing season

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Abstract. This paper presents a comparison, in terms of dry matter yield, nutritive value and fatty acid composition of two swards: a mixture of a hybrid ryegrass with three annual clovers (Berseem clover, Crimson clover and Persian clover ssp. *resupinatum*) and a pure perennial ryegrass pasture which were rotationally grazed by dairy cows during the spring season in the Atlantic area of Galicia (NW Spain). Pasture quality quickly decreased with the advance of grazing season for both treatments, and the hybrid ryegrass with clovers sward showed higher average values for crude protein (133.55 *vs* 103.5 g kg^{-1} dry matter) and lower neutral detergent fiber content (471.9 *vs* 553.8 g kg^{-1} dry matter) compared with the perennial ryegrass all along the season whilst sugar content and digestibility was better for the perennial ryegrass pasture. The hybrid ryegrass with clovers sward showed lower concentration in the dry matter of total fatty acids, polyunsaturated fatty acids and alpha-linolenic acid compared with perennial ryegrass. Due to the semi-prostrated habit of annual clovers, post-grazing pasture mass in the mixture was much higher along the grazing season compared with the ryegrass sward. Despite the initially good nutritive value of the herbage from the hybrid ryegrass with clovers sward, the low efficiency of herbage utilization by cows in this sward and the rapid decline in quality possess a serious inconvenient for the inclusion of annual clovers in the dairy grazing systems.

Keywords. Annual clovers – Grazing – Nutritive value – Fatty acids.

Comparaison des performances de trèfles annuels et de ray-grass pérenne au sein de systèmes d'alimentation de vaches laitières en pâturages. I – Rendement, valeur nutritive et composition en acides gras de l'herbage au cours de la période d'alimentation printanière.

Résumé. *Ce travail de recherche décrit la comparaison entre deux types d'herbe cultivée en pâturage, en termes de rendement en matière sèche, valeur nutritive et composition en acides gras: un mélange de ray-grass hybride et de trois espèces de trèfles annuels (Berseem clover, Crimson clover et Persian clover ssp. resupinatum) comparé à ray-grass pérenne en rotation, tous broutés par un troupeau de vaches laitières au cours du printemps. Toutefois, la qualité globale du mélange légumineuse/ray-grass s'est avérée supérieure à celle du ray-grass pérenne, avec des valeurs moyennes de protéine brute (133,55 vs. 103,5 g kg^{-1} matière sèche) plus élevées et des valeurs de fibres neutres (471,9 vs. 553,8 g kg^{-1} matière sèche) plus faibles. Le mélange ray-grass/légumineuses a conduit à des taux d'acides gras totaux, acides gras polyinsaturés et acide alpha-linolénique plus faibles que le ray-grass pérenne. Dans les deux cas, la qualité de l'herbage s'est vue diminuée avec l'avancée de la saison des bovins en pâture. En raison du comportement semi-couché des trèfles annuels, la masse de fourrage obtenue en « post-pâturage » des bovins fut beaucoup plus élevée que la masse de fourrage de ray-grass dans les mêmes conditions d'élevage. Malgré la bonne qualité nutritive obtenue avec le mélange ray-grass/légumineuses, la faible efficacité d'utilisation de l'herbage disponible par les bovins constitue un inconvénient sérieux en vue de l'inclusion de trèfles annuels au sein des systèmes d'alimentation en pâturage de bovins laitiers.*

Mots-clés: *Trèfles annuels – Pâturages – Valeur nutritive – Acides gras.*

I – Introduction

In a context of a growing global population with a food production systems exerting an increased pressure on fossil energy and environment where agricultural land has limited possibilities to be expanded, it is necessary to strength the research efforts towards a sustainable intensification of agriculture permitting an increase in productivity whilst reducing its environmental impacts (Foley *et al*., 2011). In this scenario it has been recognized the role of forage legumes, which inclusion in the agricultural systems-grown alone or in mixtures with grasses is an important strategy for achieving the goals of food security and environmental integrity (Smith and Gregory, 2013).

In recent years the results of the evaluation of annual legumes of genus *Trifolium* in Galicia (Northwest Spain), showed a high productivity and a good nutritive value of these species grown in winter for a silage cut at the end of April-early May, integrating a rotation of two crops per year with forage maize in summer (Pereira-Crespo *et al*., 2012a). This all-silage alternative is well-fitted to the needs of the Galician dairy farms, but there is not available information about the behaviour of the annual clovers when used for grazing. In the present study, it is evaluated the nutritive value and fatty acid composition of a mixture of three annual clovers (Berseem clover, Crimson clover and Persian clover ssp. *resupinatum*) with a hybrid ryegrass compared with a perennial ryegrass pasture which were rotationally grazed by dairy cows during the spring-early summer season.

II – Materials and methods

This study was carried out at the Centro de Investigacións Agrarias de Mabegondo (CIAM) research station farm (Galicia, NW Spain, 43° 15´ N, 8° 18´ W, 100 m above the sea level) on a silt loam soil. The two swards evaluated were a mixture of three annual clovers composed by Berseem clover (*T. alexandrinum* L. cv. Alex), Crimson clover (*T. incarnatum* L. cv. Viterbo) and Persian clover (*T. resupinatum* L. ssp. *resupinatum* cv. Nitroplus) with a hybrid ryegrass (*Lolium hybridum* Hausskn. cv. Barsilo) (ALR), and a perennial ryegrass (*Lolium perenne* L. cv. Barsintra) (PR). Both plots, with a size of 2.0 ha each, were sown in the autumn of 2014 with a seeding rate of 30 kg ha^{-1} of PR pasture and a rate of 10 kg ha^{-1} (hybrid ryegrass), 5 kg ha^{-1} (Crimson clover), 5 kg ha^{-1} (Berseem clover) and 3 kg ha^{-1} (Persian clover) of ALR pasture. Each sward was strip-grazed by 10 dairy cows managed with electric wire fences in the spring-early summer season of 2015, from the last week of April to mid-July. The PR sward received a dressing of 50 kg ha^{-1} of nitrogen (N) in mid-March and after the first grazing, whilst the annual legumes mix did not receive any N fertilization.

At weekly intervals the herbage samples of three square quadrats (0.36 m^2) that were randomly chosen in each fresh pasture strip offered to the cows, were manually cut to a 5 cm stubble height. In a similar fashion, post-grazing samples were taken when the cows were moved into a new strip of pasture. The samples were weighed and divided into two subsamples to determine: (1) dry mater content, nutritive value and fatty acids composition and (2) botanical composition. Dry matter (DM) content of pasture samples was determined by oven-drying (80 ºC, 16 hours) and dry samples were ground in a Christy-Norris hammer mill to pass a 1 mm screen. The chemical composition, digestibility and fatty acids (FA) composition of ground samples were estimated by NIRS using two calibrations equations obtained at the CIAM (Pereira-Crespo *et al*., 2012b; Pereira-Crespo *et al*., 2014). Data were subjected to ANOVA and comparison of means by Fisher's LSD procedure using Proc GLM of SAS (SAS Institute, 2009).

III – Results and discussion

The seeded species accounted for 982 and 984 g kg^{-1} of sampled herbage DM in ALR and PR pastures. Botanical composition of the ALR pasture was dominated by legumes (941.4 g kg^{-1}

DM on average). But the proportion of each legume component of the ALR pasture changed strongly as the season progressed. The proportions of Crimson, Berseem and Persian clovers were 467, 222 and 216 g kg^{-1} DM in the first, and 7, 834 and 136 g kg^{-1} DM, respectively in the last grazing periods. Average pasture on offer was markedly higher for the ALR compared with the PR pasture (4.87 *vs* 2.41 t DM ha^{-1}) and pasture utilization by dairy cows was clearly lower for the legumes mixture (32.4%) compared with the ryegrass pasture (48.8%), with values ranging from 44.3 to 30.2% and from 61.7 to 40.0% for the first and last period, ALR and PR pastures, respectively. It is noteworthy that results observed in this experiment could be influenced by the severe drought beginning in the end of the spring of 2015 which accelerated the maturity of pasture and influenced a poor utilization of herbage on offer. It was registered a total rainfall of 9.6 mm in the months of June to mid-July compared with a normal average of 87.1 mm in this period.

Pasture chemical composition and nutritive value (Table 1) were different for the two types. ALR pasture had significantly ($p<0.001$) higher CP and lower NDF contents compared with PR pasture that showed a higher content in DM, WSC, NSC, IVOMD and energy value. The herbage quality decreased for both pastures with the advance towards maturity, being observed a reduction in the CP content of -5.1 and -2.4 g kg^{-1} DM $week^{-1}$ and of -13.3 and -16.5 g kg^{-1} $week^{-1}$ in the IVOMD value respectively, for the ALR and the PR swards. In contrast, there was an increase in the cell-wall content (FND) of 9.8 and 15.2 g kg^{-1} DM $week^{-1}$ and in FAD content of 7.0 and 7.5 g kg^{-1} DM $week^{-1}$, for ALR and PR pastures, respectively. The rapid loss of protein and energy value in ALR confirms the observations of Pereira-Crespo *et al*., (2012a) who reported a marked reduction in the nutritive value of the annual clovers once they reach the flowering stage.

Table 1. Effect of pasture type and interaction of pasture type x period on dry matter content (g/Kg), chemical composition (g/kg DM), in vitro organic digestibility (g/kg) and net energy of lactation (Mcal/kg DM)

	Pasture type			Pasture type x Period								
	ALR	PR	p	ALR				PR				p
				P1	P2	P3	P4	P1	P2	P3	P4	
DM	204.8	251.7	***	114.9	140.2	224.5	339.5	199.4	211.1	239.8	356.4	**
OM	911.1	914.7	ns	895.8	906.7	919.9	922.0	905.2	900.9	912.9	939.7	ns
CP	133.5	103.5	***	162.6	139.2	115.9	116.2	106.6	107.7	114.8	85.0	*
ADF	361.7	310.0	***	331.4	345.7	374.6	395.1	288.3	299.9	295.1	356.5	ns
NDF	471.9	553.8	***	431.3	448.0	488.6	519.6	504.3	535.0	534.4	641.7	*
WSC	86.7	192.8	***	100.0	120.0	80.4	46.4	245.5	212.5	176.2	136.9	ns
NSC	126.6	212.2	***	130.4	145.2	127.9	103.0	254.8	213.7	202.0	178.5	ns
IVOMD	652.5	701.9	***	702.8	693.4	631.0	582.8	760.5	733.2	702.3	611.8	ns
NEL	1.34	1.47	***	1.44	1.43	1.30	1.19	1.60	1.52	1.47	1.29	ns

ALR: mixture three annual clovers with a hybrid ryegrass; PR: perennial ryegrass; P: period; P1: 27 April-17 May; P2: 18 May-7 June; P3: 8 June-28 June; P4: 29 June-19 July; DM: dry matter; OM: organic matter; CP: crude protein; ADF: acid detergent fiber; NDF: neutral detergent fiber; WSC: water-soluble carbohydrates; NSC: non-structural carbohydrates; IVOMD: *in vitro* OM digestibility; NEL: net energy of lactation; *p<0.05; **p<0.01; ***p<0.001; ns: non significant.

Fatty acids composition of both pasture types followed the polyunsaturated-dominant profile typical of forage pastures (Table 2), accounting the alpha-linolenic acid (C18:3n3) for 55.6 and 68.4% of the total FA (TFA) of the annual legumes mixture and the PR pasture, respectively). Higher concentrations of TFA, polyunsaturated FA (PUFA), alpha-linolenic acid and palmitic acid were found in PR compared with ALR, showing average values, respectively, of 7.71 *vs.* 6.51, 6.23 *vs* 4.98, 5.28 *vs* 3.62 and of 1.13 *vs* 0.93 g kg^{-1} DM. Inversely, ALR showed a higher content in linoleic acid and in oleic acid compared with PR (1.33 *vs* 0.93 and 0.21 *vs* 0.12 g kg^{-1} DM), respectively.

Fatty acid concentration in the DM decreased with advancing maturity of pasture. The TFA and the alpha-linolenic contents in the last period of grazing, compared with that of the first period, were, respectively, 38% and 26% for ALR and 50 and 41% for PR, showing a faster loss in the FA content for the mixture of annual legumes than for the perennial ryegrass pasture.

Table 2. Effect of pasture type and interaction of pasture type x period on composition of fatty acids (g/kg DM)

	Pasture type			Pasture type x Period								
				ALR				PR				p
	ALR	PR	p	P1	P2	P3	P4	P1	P2	P3	P4	
C16:0	0.93	1.13	**	1.04	1.08	0.89	0.72	1.19	1.23	1.17	0.94	ns
C18:1n9c	0.21	0.12	***	0.11	0.14	0.22	0.37	0.10	0.15	0.13	0.12	***
C18:2n6c	1.33	0.93	***	1.63	1.67	1.21	0.81	0.91	0.99	0.91	0.92	**
C18:3n3	3.62	5.28	***	5.90	4.79	2.59	1.20	6.41	6.43	6.14	2.15	*
TFA	6.51	7.71	*	9.11	8.11	5.29	3.53	8.73	9.09	8.63	4.39	ns
SFA	1.28	1.32	ns	1.40	1.43	1.22	1.09	1.29	1.47	1.38	1.15	ns
MUFA	0.24	0.15	***	0.14	0.17	0.24	0.40	0.11	0.17	0.17	0.15	***
PUFA	4.98	6.23	**	7.56	6.49	3.83	2.02	7.33	7.45	7.07	3.08	***

ALR: mixture three annual clovers with a hybrid ryegrass; PR: perennial ryegrass ; P: period; P1: 27 April-17 May; P2: 18 May-7 June; P3: 8 June-28 June; P4: 29 June-19 July; C16:0 palmitic acid; C18:1n9c9 oleic acid; C18:2n6c linoleic acid; C18:3n3 alpha-linolenic acid; TFA: total fatty acids; SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; *p<0.05;**p<0.01; ***p<0.001; ns: non significant.

IV – Conclusions

The ALR pasture showed higher DM yield but the low efficiency of herbage utilization by cows, caused by the semi-prostrated habit of growth of these species, indicating a major constraint for their inclusion in dairy grazing systems. This fact and the rapid decline of their initial good nutritive value suggest that these species are more suitable for silage production in mid-spring.

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