Evolution of the feeding value of sainfoin as affected by the phenological development

Delgado I., Muñoz F., Demdoum S.

in

Porqueddu C. (ed.), Ríos S. (ed.).
The contributions of grasslands to the conservation of Mediterranean biodiversity

Zaragoza : CIHEAM / CIBIO / FAO / SEEP
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92

2010
pages 193-197

Evolution of the feeding value of sainfoin as affected by the phenological development

I. Delgado, F. Muñoz and S. Demdoum

Centro de Investigación y Tecnología Agroalimentaria de Aragón,
Avda. Montañana 930, 50059 Zaragoza (Spain)
e-mail: idelgado@aragon.es

Abstract. The evolution of the feeding value of sainfoin (*Onobrychis viciifolia* Scop.) during blooming and fruiting periods was evaluated in the two first productive cycles of the plant. Six phenological stages previously defined as early bud, early bloom, mid bloom, late bloom, early seed pod and late seed pod were assessed for chemical composition in crude protein, acid-detergent fibre, neutral-detergent fibre and lignin-detergent fibre contents of the stems, leaves, and racemes and of the whole plant. Results showed that the six phenological stages could be included in two groups on their nutritive value.

Keywords. *Onobrychis viciifolia* Scop. – Plant partitioning – Blooming – Crude protein – Fibres.

Influence du développement phénologique sur l'évolution de la valeur nutritive du sainfoin

Résumé. *L'évolution de la valeur nutritive du sainfoin (*Onobrychis viciifolia *Scop.) fut évaluée au cours de la floraison et de la fructification durant les deux premiers cycles productifs de la plante. Six stades phénologiques préalablement définis comme "bouton floral, début de floraison, pleine floraison, fin de floraison, jeune gousse, gousse mature" furent évalués pour la composition chimique en protéine brute, fibre acide-détergente, fibre neutre-détergente et fibre lignine-détergente des tiges, des feuilles ou de la plante entière. Les résultats indiquent que les stades phénologiques peuvent être rassemblés en deux groupes selon leur valeur nutritive.*

Mots-clés. Onobrychis viciifolia *Scop. – Partitionnement de plante – Floraison – Protéine brute – Fibres.*

I – Introduction

Sainfoin (*Onobrychis viciifolia* Scop.) is a perennial forage legume much appreciated by farmers for its rusticity, its ability to restore soil fertility, its feed value, and its not-bloating qualities. One special feature of this crop is the repartition of the annual forage production through the cut. Two thirds of the forage yield are obtained from the first cut in spring that is used for hay-making. The remaining production is distributed between one or two light regrowths in the summer-autumn period (Delgado *et al*., 2008). Optimal management of the crop aims at the largest forage yield of the best possible nutritive quality without endangering the persistence of the stand. The first cut is usually practiced when the crop is at full blooming (Alibés *et al*., 1979; Martiniello *et al*., 2000; Iwaasa *et al*., 2006). The determination of this stage may be complicated as plants often display many stems at different phenological stages. Borreani *et al*. (2003) studied the development of forage yield and quality along the first productive cycle in ten phenological stages. Their scale was from 0 (rosette stage) to 9 (pods turning to brown). These authors concluded that the proposed scale was not sensitive enough to remark changes in forage quality between early buds and full bloom and should be redefined before being applied by technicians and farmers.

This points up the need for a precise criteria to establish the different phenological stages of sainfoin, not only according to the percentage of bloomed stems but also to the rate of open flowers the racemes present or to the ripening stage of the seed in the raceme. The aim of this

study was to follow the blooming process of sainfoin, and to assess how the phenological development of the plant affects its chemical composition, and therefore, its feeding value.

II – Materials and methods

This study was carried out under irrigation in Zaragoza, Spain, (41º 45' N, 0º 47' W, 225 m altitude a.s.l.) during 2005, using a collection of sainfoin accessions coming from the NE Spain (Delgado *et al*., 2008). Annual mean temperatures were 7.6°C minimum and 20.7°C maximum. They were sown in silty-loam soils; salinity 0.41 CE (1:5 dδ/m); pH (H_2O) 8.26; P (Olsen) 4.16 mg/kg; K (extracted in NH_4NO_3) 90.0 mg/kg; and organic matter 1.39%. Plants were established in September 2002 within a 1 x 0.5 m frame. Thirty six plants with two-three bloom buds were randomly selected during the first productive cycle. These plants were harvested for their chemical analysis by groups of six according to the following schedule:

(i) "Early bud": at least 50% stems present flower buds.

(ii) "Early bloom": at least 10% of blooming stems present racemes with 2-3 open flowers.

(iii) "Mid bloom": at least 50% of blooming stems present racemes with 50% of open flowers.

(iv) "Late bloom": at least 50% of blooming stems present racemes with open flowers only in the upper part of the raceme.

(v) "Early seed pod": at least 50% of blooming stems present racemes with only green pods.

(vi) "Late seed pod": at least 50% of blooming stems present racemes with pods turning to brown.

Three of this plants were dried in a ventilated stove at 60ºC till reaching a constant weight for the determination of crude protein, acid-detergent fibre, neutral-detergent fibre and lignin-detergent fibre concentrations of the whole plant (AOAC, 1990). The three remaining plants were brought directly into the laboratory and partitioned into stems, leaves with peduncle and racemes with peduncle. Every fraction was weighted, dried individually and submitted to the same chemical analysis as described previously. The remaining plants from the collection were cut at full bloom. During the second productive cycle, 36 plants from the collection were marked again and the process described previously for the first cycle was repeated. The partitioning of the plant was not carried out in the subsequent cuts as they usually grow in rosette and do not present blooming stems.

The percentages were arcsine-transformed prior to statistical analysis. All data were analysed by ANOVA. Comparisons between means were performed using the LSD test. All statistical procedures were undertaken using the SAS statistical package (SAS, 2004).

III – Results and discussion

The partitioning of plants into stems, leaves and racemes in each phenological stage is given in Table 1. It shows that the weight of the plant and the proportion of stems presented slight variations ($P < 0.05$) along the blooming period. However, the proportion of leaves was significantly reduced ($P < 0.01$) from full blooming; inversely, there was an increase in the proportion of racemes ($P < 0.001$). In the second productive cycle, the process was repeated, though the proportion of stems in the plant decreased notably with respect to the first cycle.

The chemical composition of the whole plant in the different phenological stages is presented in Table 2. All the analysed parameters were stable till full blooming and changed significantly at the end of blooming.

Table 1. Partitioning of the whole sainfoin plant according to the phenological stages

Cut	Date	Phenological stage	g DM/plant	% stems	% leaves	% racemes
1	22.4.05	Early bud	230.2 a	48.5 a	44.7 a	6.8 b
1	25.4.05	Early bloom	177.2 ab	41.1 ab	46.8 a	12.1 b
1	28.4.05	Full bloom	143.8 b	40.1 ab	44.9 a	15.0 b
1	03.5.05	Late bloom	140.8 b	45.6 ab	30.6 b	23.8 a
1	16.5.05	Early seed pod	208.0 ab	43.8 ab	32.0 b	24.3 a
1	25.5.05	Late seed pod	235.8 a	38.2 b	32.0 b	29.8 a
		Significance	*	*	**	***
2	09.6.05	Early bud	33.3 a	28.6 ab	56.8 a	14.6 c
2	12.6.05	Early bloom	40.6 a	41.1 a	35.8 b	23.2 bc
2	14.6.05	Full bloom	43.9 a	27.7 ab	41.5 b	30.9 abc
2	17.6.05	Late bloom	46.9 a	30.7 ab	42.8 ab	26.5 bc
2	22.6.05	Early seed pod	41.8 a	24.0 b	37.1 b	39.0 ab
2	01.7.10	Late seed pod	51.4 a	23.3 b	30.7 b	46.0 a
		Significance	NS	*	*	**

NS: P >0.05; *: P <0.05; **: P <0.01; ***: P <0.001. Different letters within each column indicate P<0.05%.

Table 2. Chemical composition of the sainfoin whole plant according to the phenological stages

Cut	Phenological stage	CP	NDF	ADF	ADL
1	Early bud	19.78 a	39.18 c	27.17 c	6.56 d
1	Early bloom	18.21 ab	43.36 bc	30.16 bc	7.72 bc
1	Full bloom	19.72 ab	39.09 c	27.41 c	7.03 cd
1	Late bloom	15.67 bc	47.14 ab	33.89 ab	8.19 ab
1	Early seed pod	12.96 c	51.27 a	37.82 a	9.02 a
1	Late seed pod	13.15 c	49.56 a	35.01 a	8.60 ab
	Significance	**	***	***	***
2	Early bud	18.59 ab	36.98 c	26.68 b	8.58 ab
2	Early bloom	16.97 ab	39.88 c	27.29 b	8.40 b
2	Full bloom	20.70 a	41.13 bc	28.54 ab	8.42 b
2	Late bloom	15.51 b	43.25 ab	29.34 ab	8.23 b
2	Early seed pod	18.40 ab	42.78 abc	29.01 ab	8.35 b
2	Late seed pod	15.75 ab	47.01 a	31.27 a	8.80 a
	Significance	*	**	*	*

CP: crude protein; NDF: neutral-detergent fibre; ADF: acid-detergent fibre; ADL: acid-detergent lignin. *: P<0.05; **: P<0.01; ***: P<0.001. Different letters within each column indicate P<0.05%.

The chemical composition of the different partitions of the plant is presented in Table 3. The decrease of feeding value of the full plant at the end of blooming period during the first cycle (Table 2) was mainly due to a decrease in the crude protein contents of stems and racemes. The leaves crude protein contents remained stable. In the second cycle, the decrease of forage

quality was reduced since the stems, the part with the lowest crude protein contents, were present in reduced proportion in the plant (Table 2).

Table 3. Chemical analysis of the parts of sainfoin plants at different phenological stages

Cut	PhS†	Stems				Leaves				Racemes
		CP	NDF	ADF	ADL	CP	NDF	ADF	ADL	PB
1	EB	10.95 a	47.89 b	34.76 b	6.36 b	23.49 a	33.66	22.08 a	7.08 ab	22.84 a
1	EF	9.28 b	45.46 b	33.12 b	6.12 b	22.73 a	29.94	21.04 ab	7.55 ab	23.14 a
1	MF	9.08 b	46.14 b	32.08 b	6.28 b	21.40 ab	30.11	19.01ab	7.29 ab	22.71 a
1	LF	7.22 c	57.53 a	43.58 a	9.85 a	19.49 ab	30.78	21.79 a	8.14 a	19.08 ab
1	ES	6.54 c	58.15 a	42.51 a	9.36 a	19.64 ab	29.56	17.74 b	6.56 b	17.19 b
1	LS	6.50 c	61.52 a	44.82 a	9.31 a	17.92 b	32.39	19.93 ab	7.32 ab	18.52 ab
Signif.		***	***	***	***	*	NS	*	*	**
2	EB	9.50 a	-	-	-	24.36 a	-	-	-	22.48 a
2	EF	7.42 ab	58.10 a	40.90 a	9.29 a	20.14 bc	32.89	19.34	9.00 b	19.83 ab
2	MF	8.14 ab	48.08 b	34.43 b	7.23 b	23.17 ab	35.29	23.67	11.58 a	17.30 b
2	LF	6.84 b	57.40 a	41.64 a	9.19 a	21.1 abc	36.05	21.79	9.79 b	17.07 b
2	ES	7.07 b	59.65 a	43.35 a	10.05 a	18.83 c	34.83	23.09	10.64 ab	16.89 b
2	LS	7.52 ab	58.00 a	42.65 a	9.61 a	20.85 bc	33.09	20.48	9.74 b	19.95 ab
Signif.		*	**	**	*	*	NS	NS	*	**

†PhS: phenological stage; EB: early bud; EF: early bloom; MF: mid bloom; LF: late bloom; ES: early seed pod; LS: late seed pod.
CP: crude protein; NDF: neutral-detergent fibre; ADF: acid-detergent fibre; ADL: acid-detergent lignin.
NS: P >0.05; *: P <0.05; **: P <0.01; ***: P <0.001. Different letters in column indicate P<0.05%.

Contents in crude protein and acid detergent fibre in the full plant were similar to those presented by Alibés and Tisserand (1990) but 32% higher than those presented by Alibés *et al.* (1979) in a previous work. The reason found was that in that work the study was made on a dense sward, thus favouring the development of stems and reducing the presence of leaves, contrary to what happened in our work. The isolation of the plants increased the development of leaves at the expense of stems.

IV – Conclusions

These results valid the farmers' practise of harvesting the crop until full blooming as there is no decrease of its feeding value. Phenological stages can be clustered in two groups depending on chemical composition similarity. The first group includes early bud, early bloom and mid bloom, and the second, late bloom, early seed pod and late seed pod, the feeding value of the first being notably higher than the second one.

References

Alibés X., Rodriguez J., Geria R. and Muñoz F., 1979. Valor alimenticio de la esparceta *(Onobrychis viciaefolia*, Scop.). In: *Pastos*, 9(1), p. 81-90.

Alibés X. and Tisserand J., 1990. Tableaux de la valeur alimentaire pour les ruminants des fourrages et sous-produits d'origine méditerranéenne. In: *Options MéditerranéEnnes,* Series B, 4, p. 137.

AOAC, 1990. *Official Methods of Analysis of the Association of Official Agricultural Chemists*, 15th ed. Arlington, (USA). 1213 pp.

Borreani G., Peiretti P.G. and Tabacco E., 2003. Evolution of yield and quality of sainfoin (*Onobrychis viciifolia* Scop.) in the spring growth cycle. In: *Agronomie*, 23, p. 193-201.

Delgado I., Andrés C. and Muñoz F., 2008. Effect of the environmental conditions on different morphological and agronomical characteristics of sainfoin. In: *Options Méditerranéennes*, SerieS A, 79, p. 199-202.

Iwaasa A.D., Jefferson P.G. and Lemke R., 2006. Beef cattle grazing and forage production comparisons of alfalfa-grass *versus* sainfoin pastures. In: *J. Animal Sci.*, 84, p.163-164.

Martiniello P., Laudadio V., Pinto V. and Ciruzzi B., 2000. Influence des techniques de culture sur la production de sulla et de sainfoin en milieu méditerranéen. In: *Fourrages*, 161, p. 53-59.

SAS, 2004. *SAS user's guide: Statistics version 9.1.2*. Cary, N.C: SAS Institute Inc.