Compositional Characteristics of 10 Wild Plant Legumes from Mediterranean French Pastures

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Moisture, lipid, fatty acid, protein, amino acid, ash, starch, free sugars, and cellulose concentrations in the aerial part of 10 wild plant legumes, growing in Mediterranean French pastures (*Anthyllis vulneraria, Coronilla emerus, Coronilla minima, Coronilla varia, Cytisus sessilifolius, Dorycnium suffruticosum, Lotus delortii, Onobrychis saxatilis, Ononis minutissima*, and *Psoralea bituminosa*), were determined. The dried aerial part of these plants contained 8.4–15.7% protein and 1.2–1.8% lipids. Amino acid analysis showed that proteins contained mainly glutamic acid + glutamine and aspartic acid + asparagine. The main fatty acids were palmitic and linolenic acids.

Keywords: *Anthyllis vulneraria; Coronilla emerus; C. minima; C. varia; Cytisus sessilifolius; Dorycnium suffruticosum; Lotus delortii; Onobrychis saxatilis; Ononis minutissima; Psoralea bituminosa; legumes; fatty acids; amino acids*

INTRODUCTION

The knowledge of metabolic constituents of wild plants consumed by cattle is important from the nutritional point of view. Since wild legumes constitute an important source of fats, proteins, and minerals for sheeps, horses, goats, and cows, our interest has been mainly focused on the analysis of plants consumed by these animals. Precedent studies have shown that some species are grazed selectively, such as Leguminosae and Cyperaceae (Clark and Harris, 1985; Garde, 1990). This paper reports the chemical composition, lipid and fatty acid, protein and amino acid, ash and starch, free sugars, and cellulose of wild plant legumes common in southern France meadows, but also widespread in meridional Europe, occidental Asia, and northern Africa. Among these plants, 10 species belonging to 8 genera, *Anthyllis, Coronilla, Cytisus, Dorycnium, Lotus, Onobrychis, Ononis*, and *Psoralea*, have been the subject of this investigation. Other species belonging to three of these genera, such as *Cytisus proliferus* (Snook, 1982), *Lotus corniculatus* (Marta Vargas, 1982), and *Psoralea candicans* (Groenewald and Joubert, 1982), have been investigated for their proximate composition, to our knowledge. The aerial parts of the 10 species cited above have not been investigated for their chemical composition.

MATERIALS AND METHODS

Materials. The aerial parts of the wild legumes were collected in April–May in the Parc Naturel Régional du Lubéron (PNRL) located 60 km north of Marseilles. Table 1 lists the scientific and local names of the 10 plants investigated and the number of samples analyzed following their location. The whole plants were dried at ambient temperature for 2 weeks and ground through a Tecator cyclone mill with standard seive with mesh width 0.5 mm.

Methods. Standard methods were used to determine moisture, protein, ash, starch, free sugars, and cellulose concentrations (Association Française de Normalisation, 1993). A micromethod for the estimation of oil content and fatty acid composition was used (Gaydou *et al.*, 1983b). For fatty acids analysis, samples of dried powder (150 mg) were put into an universal bottle (25 mL) with 4 mL of a solution containing 0.5% of sodium methoxyde and 1 mL of heptadecanoic methyl ester in anhydrous methanol (10 mg mL^{-1}) as internal standard. The bottle sealed with a screw cap was heated in an oven at 80 ± 1 °C. After 45 min, the solution was cooled with 9 mL of distillated water and the fatty acid methyl esters (FAME) were extracted with 10 mL of hexane. The FAME solution was evaporated to dryness in a stream of nitrogen before gas chromatography (GC) analyses. The separation and quantitation of FAME was done using a Delsi 30 gas chromatograph fitted with a flame ionization detector. Helium was used as carrier gas, and the column, injection port, and detector were maintained at 190, 220, and 230 °C, respectively. A polar (Carbowax 20M) capillary column (25 m × 0.32 mm, 0.15 μm phase thickness) was used to separate the FAME. The peaks were identified by comparison with standard FAME.

The amino acid analysis procedure was described in detail in an earlier paper (Bourreil *et al.*, 1991). Amino acids were measured in samples hydrolyzed with HCl (6 N) for 18 h at 120 °C with a Technicon amino acid analyzer. Cysteine and methionine were determined separately as cysteic acid and methionine sulfone after performic acid oxidation as described by Moore (1963).

RESULTS AND DISCUSSION

Scientific, local, and English names of the 10 wild plant legumes investigated are given in Table 1. Proximate analyses are given in Table 2. The moisture content ranged between 5.7 and 8.5%. The total (Kjeldahl) N value ranged from 1.34% in the case of *A. vulneraria* to 2.49% for *C. varia*. The protein contents observed in *L. delortii* and *P. bituminosa* (11.2% and 11.7%, respectively), using 6.25 as nitrogen to protein (N:P) factor ratio (Mosse, 1990) were in the same order than that observed for *L. corniculatus* (13.4%, Marta Vargas, 1982) and *P. candicans* (14.7%, Groenewald and Joubert, 1982). A significative difference in protein content between *Cytisus sessilifolius* and *Cytisus proliferus* was observed since Snook (1982) obtained 25.0% of protein in the aerial part of this plant. The fat content of the

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Table 1. Scientific, Local, and English Names of Wild Plant Legumes Investigated

scientific name	local name	English name	abbreviation[a]	N[b]
Anthyllis vulneraria	vulnéraire	kidney vetch, woundwort	A.v.	5
Coronilla emerus	faux baguenaudier, sénébâtard	scorpion senna	C.e.	3
Coronilla minima	coronille minime	crownvetch coronilla	C.m.	2
Coronilla varia	coronille variée	crownvetch	C.v.	2
Cytisus sessilifolius	cytise à feuilles sessiles	sessile-leaved broom	C.s.	2
Dorycnium suffruticosum	badasse sous-ligneuse	canary clover	D.s.	4
Lotus delortii	lotier	deervetch, bird's foot trefoil	L.d.	2
Onobrychis saxatilis	sainfoin des rochers	holyclover	O.s.	2
Ononis minutissima	bugrane, arrête-boeuf	restharrow	O.m.	2
Psoralea bituminosa	psoralée bitumineuse	scurf pea	P.b.	4

[a] Abbreviation used in this paper. [b] Number of samples investigated (total 28).

Table 2. Proximate Composition of Wild Plant Legumes Investigated

	plant name[a]									
analysis (%)	A.v.[h]	C.e.[e]	C.m.[f]	C.v.[f]	C.s.[f]	D.s.[g]	L.d.[f]	O.s.[f]	O.m.[f]	P.b.[g]
moisture[b]	8.48	7.21	7.73	8.04	7.03	7.27	5.88	7.00	7.21	5.70
N value[c,d]	1.33	1.95	1.56	2.49	1.98	1.74	1.79	1.68	1.90	1.87
ash[c]	6.74	8.31	9.48	8.13	4.98	4.75	8.80	5.19	5.79	6.57
fat[c]	1.23	1.44	1.85	1.51	1.52	1.44	1.32	1.40	1.16	1.59
starch[c]	1.00	0.51	0.87	0.69	0.97	0.80	1.01	0.77	0.55	4.00
free sugar	2.10	1.85	2.00	1.25	2.35	2.54	2.25	1.83	2.00	2.61
cellulose	17.3	22.3	18.5	20.9	20.7	18.6	24.3	18.3	18.3	19.1

[a] See Table 1 for abbreviations used for scientific plant names. [b] Free moisture. [c] Moisture basis. [d] Kjeldahl determination. [e] Mean of three samples. [f] Mean of two samples. [g] Mean of four samples. [h] Mean of five samples.

Table 3. Average of Amino Acid Content[a] of Wild Plant Legumes Investigated

	plant name[b]									
amino acid	A.v.[d]	C.e.[e]	C.m.[f]	C.v.[f]	C.s.[f]	D.s.[g]	L.d.[f]	O.s.[f]	O.m.[f]	P.b.[g]
Asp + Asn	1.42	1.06	0.86	1.54	1.17	0.92	1.35	1.15	1.44	1.59
Thr	0.28	0.47	0.38	0.56	0.56	0.34	0.43	0.46	0.58	0.48
Ser	0.36	0.40	0.40	0.51	0.49	0.38	0.27	0.42	0.62	0.49
Glu + Gln	0.74	1.18	0.92	1.28	1.27	0.97	1.00	1.15	1.19	1.05
Pro	0.45	0.78	0.60	0.96	0.55	0.55	0.54	0.56	0.50	0.71
Gly	0.45	0.65	0.58	0.78	0.67	0.50	0.48	0.62	0.73	0.56
Ala	0.39	0.54	0.39	0.59	0.57	0.41	0.44	0.50	0.56	0.50
Val	0.32	0.59	0.42	0.65	0.54	0.42	0.42	0.51	0.49	0.53
Cys	0.03	0.04	0.04	0.01	0.07	0.01	0.07	0.06	0.07	0.05
Met	0.04	0.04	0.04	0.01	0.05	0.01	0.03	0.02	0.08	0.04
Ile	0.24	0.49	0.33	0.51	0.49	0.36	0.35	0.44	0.40	0.45
Leu	0.49	0.96	0.63	1.05	0.98	0.66	0.63	0.80	0.93	0.81
Tyr	0.19	0.38	0.28	0.40	0.46	0.29	0.31	0.39	0.38	0.34
Phe	0.36	0.59	0.39	0.60	0.68	0.46	0.47	0.55	0.60	0.53
His	0.20	0.28	0.25	0.27	0.28	0.31	0.22	0.42	0.25	0.31
Lys	0.36	0.62	0.42	0.66	0.59	0.45	0.46	0.57	0.66	0.53
Arg	0.32	0.59	0.43	0.60	0.57	0.46	0.44	0.55	0.58	0.55
Σ	6.56	9.60	7.36	11.0	9.91	7.48	7.91	9.11	10.0	9.50
protein content[c]	6.98	10.1	8.11	13.0	10.3	9.06	9.36	8.73	9.87	9.72

[a] Reported in grams per 100 g of powder. [b] See Table 1 for abbreviations used for scientific names. [c] Protein content using 5.2 as nitrogen to protein factor ratio. [d] Mean of five samples. [e] Mean of three samples. [f] Mean of two samples. [g] Mean of four samples.

10 wild plant legumes was poor and ranged from 1.16% to 1.85%. Although the neutral lipid content could vary significantly in seeds (Gaydou *et al.*, 1983a), the lipid content of aerial part of legumes was about 4–5% (Groenewald and Joubert, 1982; Snook, 1982; Marta Vargas, 1982). The low fat content observed might be explained by the method used, which gave only the fatty acid content. Therefore, the unsaponifiable matter, generally obtained using the Soxhlet extractor, was not determined by the micromethod used in this paper (Gaydou *et al.*, 1983b). As shown in Table 2, some minor differences in ash, starch, free sugar, and cellulose contents were also noted for these 10 wild plants legumes.

The amino acid composition of the aerial part of investigated plants are given in Table 3. The data show that the amino acid pattern falls between dried seeds and vegetables (Sosulski and Imafidon, 1990; Mazza *et al.*, 1992). The content of the sulfur amino acids cysteine (Cys) and methionine (Met) was relatively low in all species investigated in comparison with the values given by the Food and Agricultural Organization of the United Nations for recommended nutritionnal protein quality (FAO, 1970). Analyses indicated that aspartic acid (Asp) + asparagine (Asn) are the major amino acids in five species (*A. vulneraria, C. varia, L. delortii, O. minutissima*, and *P. bituminosa*) followed by glutamic acid (Glu) + glutamine (Gln), with ranges 1.42–1.59% and 0.74–1.28%, respectively. For *C. emerus, C. minima, C. sessilifolius*, and *D. suffruticosum*, Glu + Gln was slightly higher than Asp + Asn with 0.86–1.17% and 0.92–1.27%, respectively. In the case of *O. saxatilis*, the contents were the same (1.15%). It is known that the ranges in composition of each amino acid is relatively large and the proportions in the proteins and nonprotein N would have a marked influence on the N:P factor (Sosulski and Imafidon, 1990). Taking into account the N:P factors obtained by these workers for

Table 4. Fatty Acid Composition[a] of the Wild Plant Legumes Investigated

fatty acid	plant name[b]									
	A.v.[c]	C.e.[d]	C.m.[e]	C.v.[e]	C.s.[e]	D.s.[f]	L.d.[e]	O.s.[e]	O.m.[e]	P.b.[f]
myristic (14:0)	1.50	2.38	10.7	2.73	1.88	3.81	1.66	1.58	8.07	6.23
palmitic (16:0)	26.4	43.9	22.1	48.5	36.5	34.7	39.2	32.7	66.5	40.0
palmitoleic (16:1$n-2$)	0.85	2.83	0.00	3.36	2.90	1.80	4.05	3.06	3.98	1.58
stearic (18:0)	5.44	6.94	4.53	7.47	6.15	4.49	5.30	6.13	9.47	7.18
oleic (18:1$n-9$) + vaccenic:(18$1n-7$)	8.78	8.34	1.40	8.62	2.08	6.60	4.57	12.7	2.80	3.27
linoleic (18:2$n-6$)	18.9	17.0	8.60	9.99	10.6	10.4	19.1	12.9	5.60	10.8
linolenic (18:3$n-3$)	26.6	14.7	42.2	17.2	31.2	26.2	24.0	21.0	3.55	24.1
arachidic (20:0)	3.61	2.33	1.28	2.10	5.69	3.33	1.56	4.03	0.01	2.75
gadoleic (20:1$n-9$)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03
behenic (22:0)	1.75	1.29	0.00	0.00	2.13	2.08	0.52	3.88	0.00	1.14
erucic (22:1)	0.00	0.24	0.00	0.00	0.81	1.63	0.00	1.28	0.00	0.70
lignoceric (24:0)	6.04	0.00	9.19	0.00	0.00	4.87	0.00	0.71	0.00	0.20
total unsaturated	51.0	41.2	44.9	37.3	46.9	41.0	49.8	49.9	14.8	38.4
unsaturated/saturated	1.29	0.8	1.09	0.65	0.92	1.08	1.07	2.99	0.19	0.89

[a] Percent by weight of total fatty acid identified by GC as FAME. [b] See Table 1 for abbreviations used for scientific plant names. [c] Mean of five samples. [d] Mean of three samples. [e] Mean of two samples. [f] Mean of four samples.

legumes, fresh vegetables, and fruits, we retained the 5.2 value which was multiplied by the total (Kjeldahl) N value (from Table 2), giving the protein percentages listed in Table 3. In every case, these calculated values were slightly higher but better than those obtained using 6.25, generally used for protein determination in seeds (Mosse, 1990). These results are in agreement with the fact that tryptophane (Trp) was not determined. The correlation coefficient between protein content and nitrogen content was $r = 0.6974$.

The major fatty acids of the neutral lipids are given in Table 4. Among the 13 fatty acids, 7 were present in high amount. Palmitic acid was the main saturated component in all wild legumes and ranged from 22.1 to 66.5%. The other saturated fatty acids, myristic (1.50–10.7%), stearic (4.49–9.40%), and arachidic (0.00–5.69%) acids were in low amount. Among the unsaturated fatty acids, linolenic acid was the main fatty acid (3.55–42.2%) except in *O. minutissima*. The presence of a high amount of linolenic acid in leaves was also observed in various edible plant leaves (Hitchcock and Nichols, 1971; Sundar Rao and Lakshminarayama, 1988; Sundar Rao *et al.*, 1990). Linoleic and oleic + vaccenic acids were the two other main unsaturated fatty acids (5.6–19.1% and 1.4–12.7%, respectively). Long chain fatty acids, such as gadoleic, behenic, erucic, and lignoceric acids, were identified in only some species. The unsaturated/saturated ratios were relatively low, especially in the case of *O. minutissima* which was a species containing a high amount in palmitic acid (66.5%).

CONCLUSION

The legumes studied represent a small part of the mediterranean wild flora, which could be considered as a potential source of feed for cattle. The knowledge of protein and amino acid, lipid and fatty acid patterns seems interesting for nutritional applications, for example in feeding supplementation. Another interesting factor to be considered is that some farm animals like sheeps and horses graze selectively some species. The wild plant legumes can represent a total forage material of 80%, especially for sheep.

The wild legume species in the Mediterranean area occupy about 40% of the grazed meadows. This wild pasture concerns not only the French Mediterranean area but also southern Europe, northern Africa, and western Asia. Further work is needed and is in progress in our laboratories to determine the vitamin content, mineral elements, and unsaponifiable matter to assess the agronomic potential of these wild legumes which grow in a semiarid region such as the Mediterranean area.

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