# Nutritional Value of Mediterranean Sheep's Burnet (*Sanguisorba minor* Ssp. *muricata*)

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A survey of compositional characteristics of the aerial part of sheep's burnet (*Sanguisorba minor* ssp. *muricata*) growing in Mediterranean French pastures has been undertaken. Investigations with scanning electron microscopy gave the morphological structure of this plant, in particular for akene ornamentation. Taxonomic characters confirmed the identification of the *muricata* subspecies. Moisture, ash, free sugars, cellulose, amino acids, and fatty acids of the whole aerial part were determined. Besides the major component, cellulose (20.4%), amino acid analysis showed that proteins contained mainly glutamic acid plus glutamine (0.67%) and aspartic acid plus asparagine (0.56%). The main fatty acids were palmitic (29.1%), linoleic (22.6%), and linolenic (21.4%).

**Keywords:** *Sanguisorba minor ssp. muricata; Rosaceae; French Mediterranean pastures; scanning electron microscopy (SEM); akene; fatty acids; amino acids*

## INTRODUCTION

Following our southern French pastures study on the characterization of the nutritional value of several meadow species (Viano et al., 1995, 1996), we have made investigations on *Sanguisorba minor* ssp. *muricata*, commonly named sheep's burnet. This species, considered as a good forage (Fournier, 1948), is a condiment in cooking. Moreover, Leclerc (1929) reports that its medicinal properties, against diarrhea or hemorrhoids, have been known since the 16th century. *S. minor* is widespread throughout Europe, northern Africa, the Canary Islands, and Southeast Asia. This species has been introduced in North America, New Zealand, and Great Britain; common in England, it grows as far north as Scotland. *S. minor* ssp. *muricata* produces a good quality forage, well adapted to sheep and rabbits. Several cuttings are possible each year, for 5−6 years. To our knowledge, scarcely any chemical studies of *S. minor* have been done, and only on the *magnolii* subspecies (Rodriguez and Bermejo, 1986). *S. minor* "sensu lato" contains triterpenoids (Pourrat, 1966; Reher et al., 1991), phytoalexins (Kolubun et al., 1994), tannins (Pourrat, 1966; Lamaison et al., 1991), and flavonoids (Kiselev et al., 1971).

The present research deals with *S. minor* ssp. *muricata* as a forage plant. This work completes recent studies, led in New Zealand, to improve the growth of this species and to increase the yields of forage production (Douglas et al., 1990, 1991, 1993, 1994; Douglas and Foote, 1993, 1994; Calviere, 1995). To point out the nutritional value of sheep's burnet, we have measured on the whole plant the contents of water, ash, starch, free sugar, cellulose, fatty acids, lipids, protein, and amino acids, as these chemical components are the most representative of the nutritional value of plants. Because this species shows a wide range of morphological variations, we have previously performed a scanning electron microscopy study (SEM) on the testa of the akenes before the chemical analysis.

## MATERIALS AND METHODS

**Materials.** The aerial part of the plant was collected in April−May, during florescense, in the Parc Naturel Régional du Lubéron (PNRL) located 60 km north of Marseilles (France). The whole plant was dried at ambient temperature for 2 weeks and ground through a Tecator cyclone mill with a 0.5 mm mesh width standard seive.

For the SEM study, samples were harvested during frutescence and akenes were separated using a magnifying glass. Akenes were then washed with alcohol, dried, protected from atmospherical dusts, and fixed on metallic plots using double-sided adhesive tape. These samples were then metallized with red gold film (thickness = 2−4 $\mu$m). Microphotographs were carried out on an SEM JEOL-JSM 35 CF, from Mediterranean University of Marseilles.

**Methods.** Standard methods were used to determine moisture, protein, ash, starch, free sugar, and cellulose contents (AFNOR, 1993). A micro method for the estimation of oil content and fatty acid composition was used (Viano et al., 1995; Gaydou et al., 1983). The fatty acid methyl esters (FAME) were analyzed using gas chromatography (GC) with 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 (25m × 0.32 mm, 0.15 $\mu$m phase thickness) was used to separate the FAME.

The amino acid analysis procedure was described in detail in earlier papers (Bourreil et al., 1991, 1995). 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).

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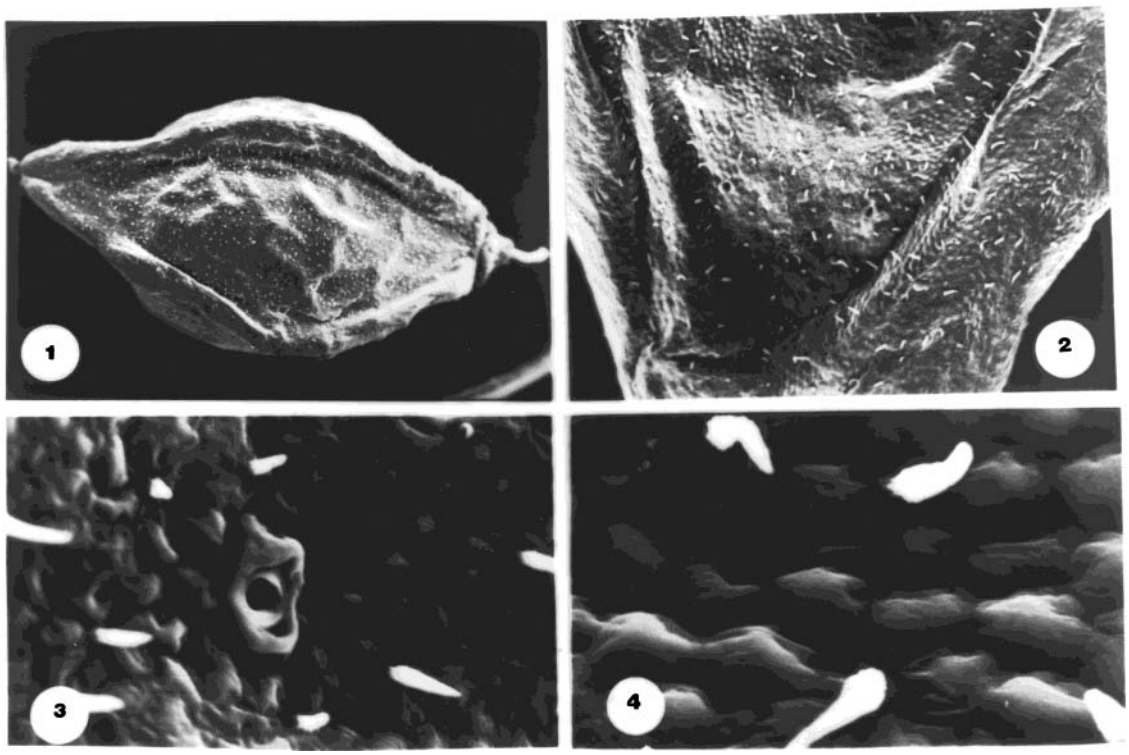


**Figure 1.** Ultrastructure of the akenes of *S. minor* ssp. *muricata* (Rosaceae): 1, general view (magnification 32×); 2, central area (magnification 100×); 3, surface of the testa (magnification 720×); 4, simple hairs (magnification 1300×).

## RESULTS AND DISCUSSION

**Taxonomical Analysis.** The differences between the subspecies *muricata* and *magnolii* are difficult to define because these taxa have the same growing habitats in southern France. Hybridizations are possible between these subspecies, which are both genetically unstable; many chromosomical races ($2n = 28, 48, 56, 58$) were identified for the subspecies *muricata* (Tyge and Bôcher, 1957; Bosc, 1992). Therefore, before the biochemical results, we will briefly detail the testa ultrastructure of sheep's burnet akenes, to confirm the nomenclature of this species.

*S. minor* ssp. *muricata* belongs to the Rosaceae family. Linné (1753) first named this species *Poterium sanguisorba*; then, many binomes were used to characterize this taxon, so we have defined our samples on the basis of Norborg's results (1967) and those of well-known botanists such as Bonnier (1990), Fournier (1977), and Guinochet and Vilmorin (1984) and on *Flora Europea* (Tutin et al., 1980). According to Nordborg's research, we have considered that the single reliable criterion is the akene morphology. As shown on microphotographs 1 and 2 of Figure 1, akenes are tetragonal, with winged awns. The surface of the testa is reticulate and alveolated. Simple hairs can be located in the center of circular edged alveoles (microphotographs 3 and 4).

**Chemical Analysis.** Proximate composition (water, ash, starch, free sugars, cellulose, and protein) of the whole plant of *S. minor* ssp. *muricata* is reported in Table 1. Sheep's burnet contains 20.4% of cellulose; similar values were reported for Graminaceae from the same meadows [*Anthyllis vulneraria, Coronilla emerus, C. minima, C. varia, Cytisus sessilifolius, Dorycnium suffruticosum, Lotus delortii, Onobrychis saxatilis, Ononis minutissima,* and *Psoralea bituminosa* (Viano et al., 1995)]. On the other hand, most of the Liliiflorae (*Aphyllantes monspeliensis, Carex humilis, Brachypodium phoenicoides, B. ramosum, Bromus erectus, Dactylis glomerata, Festuca glauca,* and *Phleum nodosum*) contain less cellulose (11.9−20.1%) (Viano et al., 1996)

**Table 1. Proximate Composition of *S. minor* Ssp. *muricata***

| analysis | content[a] (%) | analysis | content[a] (%) |
|---|---|---|---|
| moisture[b] | 7.39 | cellulose[c] | 20.4 |
| ash[c] | 5.91 | protein[c,d] | 5.20 |
| fat[c] | 1.51 | Na[c] | 0.002 |
| starch[c] | 0.74 | K[c] | 0.932 |
| free sugar[c] | 2.90 | Ca[c] | 0.985 |

[a] Dried aerial part of the plant. [b] Free moisture. [c] Moisture basis. [d] Conversion factor used: N × 5.20.

The contents of 17 amino acids are reported in Table 2. The main amino acids are dicarboxylic acids (glutamic and aspartic) and their amine derivatives (glutamine and asparagine, respectively, 0.67 and 0.56% of dried aerial part). Sulfured amino acid amounts are low (cysteine = 0.03% and methionine = 0.02%), below the values recommended by the FAO (1970) for the complete nutrition of cattle: rabbits, sheep, and goats.

The FAO (1970) gives the ratios of the essential amino acids (valine, leucine, isoleucine, lysine, threonine, methionine, phenylalanine, and tryptophan, including cysteine from methionine metabolism and tyrosine from phenylalanine metabolism) in a standard protein; therefore, it is possible to define the chemical index of an essential amino acid following the formula

$$\text{chemical index of X} = \frac{\text{level of essential amino acid X}}{\text{level of the corresponding amino acid in the standard protein}}$$

Chemical indices <1 represent the limiting amino acids. Amino acids are frequently underevaluated, due to the degradation that occurs during the hydrolyzation of the plant material involving Maillard and Strecker

**Table 2. Average of Amino Acid Content of *S. minor* Ssp. *muricata***

| amino acid | abbrev | content (g/100 g of dried aerial part of plant) |
|---|---|---|
| aspartic acid + asparagine | Asp + Asn | 0.56 |
| threonine | Thr | 0.30 |
| serine | Ser | 0.31 |
| glutamic acid + glutamine | Glu + Gln | 0.67 |
| proline | Pro | 0.32 |
| glycine | Gly | 0.36 |
| alanine | Ala | 0.29 |
| valine | Val | 0.27 |
| cysteine | Cys | 0.03 |
| methionine | Met | 0.02 |
| isoleucine | Ile | 0.25 |
| leucine | Leu | 0.46 |
| tyrosine | Tyr | 0.17 |
| phenylalanine | Phe | 0.28 |
| lysine | Lys | 0.28 |
| histidine | His | 0.39 |
| arginine | Arg | 0.27 |
| Σ | | 5.23 |

**Table 3. Chemical Indices of Essential Amino Acids of *S. minor* Ssp. *muricata***

| essential amino acid | FAO recommended level[a] | level in *S. minor* ssp. *muricata*[b] | chemical index |
|---|---|---|---|
| Thr | 4.0 | 5.74 | 1.44 |
| Val | 5.0 | 5.16 | 1.03 |
| Cys + Met | 3.5 | 0.96 | 0.27 |
| Ile | 4.0 | 4.78 | 1.18 |
| Leu | 7.0 | 8.80 | 1.26 |
| Tyr + Phe | 6.0 | 8.60 | 1.43 |
| Lys | 5.5 | 1.35 | 0.25 |
| Σ | 35.0 | 39.4 | |

[a] Percent by weight of total amino acids in standard protein. [b] Percent by weight of total 17 amino acids in dried aerial part of the plant.

**Table 4. Fatty Acid Composition of *S. minor* Ssp. *muricata***

| fatty acid | content (% by wt of total fatty acid)[a] |
|---|---|
| myristic (14:0) | 1.00 |
| palmitic (16:0) | 29.1 |
| palmitoleic (16:1*n*−2) | 1.30 |
| stearic (18:0) | 6.90 |
| oleic (18:1*n*−9) | 12.2 |
| linoleic (18:2*n*−6) | 22.6 |
| linolenic (18:3*n*−3) | 21.4 |
| arachidic (20:0) | 2.30 |
| behenic (22:0) | 1.40 |
| total unsaturated | 57.5 |
| unsaturated/saturated | 1.41 |

[a] Identified by GC as FAME in the aerial part of the plant.

reactions [in Vernin and Metzger (1981)]. Chemical indices of amino acids from *S. minor* ssp. *muricata* are reported in Table 3. The values, ranging between 0.25 and 1.44, are low and show that this species is not at the maximum nutritional level. Two amino acids present a chemical index <1: cysteine and lysine. We have to point out that lysine is very important in mammalian growth, and its amount is really low in sheep's burnet. Companions of this species, in the same meadows, show the same lack in essential amino acids, as their chemical indices (calculated on the basis of our previous studies) range between 0.09 and 1.93.

As shown in Table 4, *S. minor* ssp. *muricata* contains 5.9% oil. Palmitic is the main fatty acid (29%), with linoleic, linolenic, and oleic acids, respectively, at levels of 22.6, 21.4, and 12.2%. High amounts of all of these compounds are frequent, as they are the most common plant seed fatty acids: 80% of plant seed fatty acids are palmitic, linoleic, or oleic acids (Gaydou and Ramanoelina, 1983), and plant aerial parts are characterized by notable quantities of linolenic acid (Viano et al., 1995, 1996).

## CONCLUSION

As *S. minor* ssp. *muricata* is used not only for cattle feeding but also in cooking and traditional medicine for humans, this species has required particular attention in our study of Mediterranean meadows (further work is needed and is in progress in our laboratories to determine vitamin content and unsaponifiable matter).

Otherwise, following the research of Douglas (1990−1994), it may be interesting now to improve the protein and amino acid, lipid, and fatty acid patterns before and after sheep grazing, to assess the knowledge of the agronomic potential of this species. Furthermore, sheep's burnet shows an ability to grow in semiarid regions such as Mediterranean areas, even during the summer months, and thus will provide a fair quantity of green forage all year long.

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