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in

López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.).
Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125

2021
pages 569-573

Proposal of some promising native species for forage crops in the Saharan areas and the Eastern High Atlas

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Abstract. Natural pastures are the initial food base for cattle, goats and sheep. Forage exploitation species allowing an increase of the animal productions must pass initially by the identification of the local existing flora. As part of our various surveys and studies on pre-Saharan pastures, we have been able to identify a number of promising species based on their productivity and palatability. These species could be used as fodder crops in the Saharan areas and the Eastern High Atlas. We describe in this paper eight species belonging to the two great families of fabaceae and poaceae. Among these eight species, one is an endemic of Morocco.

Keywords. Autochtone plants – Forage crops – Palatability – Saharan areas.

Proposition d'espèces indigènes prometteuses pour les cultures fourragères dans les zones sahariennes et le Haut Atlas oriental

Résumé. *Les pâturages naturels constituent la base alimentaire initiale des bovins, des caprins et des ovins. L'exploitation des espèces fourragères permettant une augmentation des productions animales doit passer dans un premier temps par l'identification de la flore existant localement. Dans le cadre de nos différentes prospections et études sur les pâturages présahariens, nous avons pu identifier un certain nombre d'espèces prometteuses sur la base de leur productivité et appétibilité. Ces espèces peuvent être utilisées comme cultures fourragères dans les zones sahariennes et le Haut Atlas oriental. Nous décrivons dans cet article huit espèces appartenant aux deux grandes familles des fabacées et graminées. Parmi ces huit espèces, une endémique du Maroc.*

Mots-clés. *Espèces autochtones – Fourrage – Appétibilité – Zones sahariennes.*

I – Introduction

Rangelands of Morocco are homes of biodiversity and main feed resources for livestock. Arid rangelands-based livestock production systems face the challenge of producing more meat and milk to meet increasing demands and achieve this using fewer resources. We found in these areas many herbaceous and shrubby plants that are consumed by ruminants and represent possible potential as forage crops to overcome the scarcity of resources and the increasing number of livestock. The objective of this paper is to describe eight potential species for forage farming identified in the south-east of arid rangelands in Morocco.

II – Description of the species

1. *Lupinus tassilicus* Maire

Lupins are forage legumes commonly used as natural green manure. They are also used for food and feed thanks to their high protein content (Guillemand, 1999). The genus Lupinus belongs to the fabaceae family and includes about 267 species from the Americas, Europe, and North Africa

(Drummond *et al.,* 2012). Only six species are spontaneous in Morocco. Among these six species, a particularly interesting species capable of colonizing the sandy and poor rocky lands of Saharan Morocco and the Anti-atlas, is *Lupinus tassilicus* Maire (vernacular name: Oum Kfifat). This plant was called by ancient "the golden rose of the sands" (Dahi, 2008) and it is adapted to the arid climate. It is an annual plant of 30-50 cm, unicaules, villous on the lower surface and glabrous on the upper surface. The leaves are long petiolate, palmately compound with 9-11 oblong-obovate leaflets; stipules welded to petiole. Dark blue flowers briefly pedicellate (3 mm) fairly close in raceme little interrupted, provided with a linear-lanceolate bract and 2 lateral protective leaves opposite to the lateral sinuses of the calyx. Blue corolla, exceeding the calyx. Stamens 10; the filament welded into a closed glabrous tube; Anthers basifixed longer than dorsifixed. Ovary silky, sessile; glabrous style. Pod compressed ± villous with a wavy structure of 2-5 large seeds, filling the whole cavity of the pod. It is a plant less appreciated by camels and sheep prefer to eat fruit. It's grows naturally on sandy well-aerated soil. Neverless, the nutritive value should be studied.

2. *Cullen plicatum* (Delile) C.H. Stirton (vernacular name: Tatrâret)

Cullen is a genus of dicotyledonous plants of the family Fabaceae, subfamily Faboideae, native to Africa, Asia and Australia, which includes 13 accepted species. It is an herbaceous green herb, perennial, covered with white hairs, very short and appressed. Stems and twigs striated. The leaves are alternate, stipulated, long petiolate, greyish lanceolate trifoliate; median leaflets not more than 2 (3) cm long and about 4 times longer than wide. The stipules are entire margin, free and persistent. The leaflets are petiolate, sinuate-crenellated margins. The flowers are small, 3-5 mm long with pink corolla, short pedicel, arranged in 2 or 3 spike-like, raceme elongated, axillary, long pedunculated. The fruit is ovoid, warty, monosperm, indehiscent. Axis of fruiting bunches persist after falling of the fruits. It is a plant that colonizes especially the beds of valleys, the regs and sandy, stony soils of desert Morocco. This species contains 10.3% of the protein and is consumed mainly by camels (Kadi and Zrimi, 2016).

3. *Bituminaria bituminosa* (L.) Stirton (Resin clover)

Bituminous Psoralea (asphalt clover) is a dicotyledonous perennial plant of the Fabaceae family widely distributed in the countries of the Mediterranean basin and which could potentially serve as a forage crop in Mediterranean grasslands (Sternberg *et al*., 2006). It has been traditionally used to feed goats in the Canary Islands (Ventura *et al*., 2004) and is supposed to tolerate intensive pastures (Sternberg *et al*., 2006). There is a growing international interest in the use of *B. bituminosa* as forage crop, currently used as a model plant in forage production programs in Australia (Real and Verbyla 2010). This species grows abundantly in several regions of Morocco and in desert parts. It is a perennial herb that forms a tuft of 50 cm to 1.5 m high, pubescent-glandular, erect. The stems are long, thin and not very branched. The leaves are trifoliate with three thin elliptical or lanceolate leaflets, entire, punctate-glandular and sparsely hairy. A characteristic feature that easily distinguishes the plant is the smell coming from crushed stems and leaves. The stipules are free, linear acuminate. The bluish flowers are held a long peduncle (2-4 times longer than the leaf). They are gathered into a tight, rounded false capitule with 10-15 semi-spherical heads (packed raceme). The keel is white and the wings, longer than the keel, have a beautiful lilac color. The calyx is hairy, bell-shaped, with 5 unequally long teeth, lanceolate-linear, equaling the tube; banner oblong, exceeding the wings and the keel obtuse. The stamens are diadelphous and the stigma in head. The flowers, rich in nectar, are attractive to pollinators and many useful insects. The fruits are pods of about 2 cm. The pod is oval-compressed, beak-shaped, 2 times longer, not stipitate, hairy, indehiscent, single-seeded. Seed nearly spherical and dark brown, is about 5mm in size. It is a species that can be disseminated abundantly on stony or on recently labored soil. Several varieties have been described in Spain. The field of research in Morocco is still blank, a new endemic species

has just been added to the list of Morocco (*Bituminaria antiatlantica*) previously described by Maire as variety of *Bituminaria Bituminos*a (Brullo *et al.,* 2017). The level of drought tolerance varied according to the variety. The 'albomarginata' is one of the most drought tolerant variety according to Martinez-Fernández *et al*. (2010). This species should be developed in Morocco as forage crop.

4. *Vicia onobrychioides* L.

Vicia is a genus of dicotyledonous plants of the Fabaceae family, subfamily Faboideae, with near-cosmopolitan distribution, which includes about 200 accepted species. This is the genus of vetches, beans and fababeans. False Sparrow Vetch or False Sainfoin (*Vicia onobrychioides*) is an upright or climbing herbaceous of montain with paripinnate leaves, composed of 4-8 lanceolate leaflets, 1-4 mm wide, obtuse, mucronate and terminated by a tendril that allows them to climb by hanging on nearby plants. The stipules are toothed or incised. The purple flowers (1.8 to 2.5 cm) –with a long corolla 15-20 mm, keel and wings often paler– are grouped by six to twelve in cowardly raceme, longer than the corresponding leaf. Calyx with unequal teeth, the lowers ones are longer. Podsare flattened, generally pendulous, glabrous, 3.5-6 cm long, 6-10-seeds. It flowers in June in hot and dry places, mainly near meadows and matorrals, up to 2200 m.

5. *Hedysarum boveanum* subsp. europaeum Guitt. & Kerguélen

The genus *Hedysarum* L. (Fabaceae: Hedysareae) consists of about 160 species of perennial herbs to rarely shrublets. It mainly distributes in temperate Eurasia, with a few species in North Africa and North America (Choi and Ohashi, 2003). Some *Hedysarum* species are good forages (Bonanno *et al*., 2010, Kadi *et al*., 2011). Hedysarum species adapt to various habitats in temperate forests, steppes and alpine regions. Dwarf Sainfoin of Europe (*Hedysarum boveanum* subsp. *Europaeum*) is a suffrutescent plant with glabrous stems, whitish and slightly pubescent (applied hairs) with a height of 15 to 50 cm. Imparipinnate leaves with 7-15 pairs of linear to oblong leaflets slightly folded, glabrous above and hairy beneath. The stipules are scabrous welded and amplexicaules. Inflorescence are in elongated raceme containing up to 20 flowers on peduncles exceeding adjacent leaves. The flowers are bright pink. Calyx 4 to 6 mm, pubescent, with teeth shorter than the tube, tinged with purple. Corolla 13-17 mm, keel (10) 11-18(20) mm, usually much longer than the banner. The fruit is glabrous or slightly pubescent, usually spiny, rarely smooth or tubercular, with (1) 2-4 segments. This plant is found in several places in the oriental High Atlas of Morocco but also in other places of Morocco (Rif and Middle Atlas) (Fennane and Ibn Tattou, 2007).

6. *Onobrychis Kabylica* (Bornm.) Sirj

Onobrychis is one of the most difficult genus to study. We found a lot of confusion and contradiction in the *Onobrychis* taxonomy. Guner *et al*. (2000) estimated that 54 species can be identified in the *Onobrychis* genus and are divided into 5 sections. Aktoklu (1995) (in Akçelik *et al*., 2012) reports that the genus is represented by 162 species of which 27 are endemic to Turkey. The sainfoin is an herbaceous plants of the Fabaceae family; some species such as *Onobrychis viciifolia* are grown as fodder plants. Kabylie sainfoins is a perennial herb with composed leaves, imparipinnate, formed up to 10 pairs of leaflets. 2 scarious stipules are always free. The flowers are pink grouped in elongated axillary raceme; The calyx is campanulate, with 5 subequal teeth. The corolla is pink; the banner is pubescent on the back, the keel is obtuse-truncated, almost straight with small wings. The androecium is diadelphous (9 + 1) and the filament is dilated at the top. The fruit is an indehiscent pod with 2 rows of marginal spines and a broadly-winged vertical crest. It is a very rare plant and very localized in the Eastern High Atlas.(Taxontaxon critically endangered in Morocco).

7. *Brachypodium atlanticum* Dobignard

The grasses family (Poaceae) includes the most important crop plants for human and animal nutrition and includes several subfamilies such as Pooideae (wheat, barley and oats), Ehrhartoideae (rice) and Panicoideae (maize, sorghum, sugar caneand millet). The genus *Brachypodium* belongs to the tribe Brachypodieae, a sister tribe of Triticeae in the subfamily Pooideae (Mochida and Shinozaki 2013). *Brachypodium* and wheat diverged from a common ancestor 32 to 39 million years ago (IBI, 2010). *Brachypodium* (especially *B. distachyon*) More than 10 years ago, has been suggested as a model plant for molecular studies on C3 cereals thanks to: its simple diploid genome, its close phylogenetic links with other temperate grasses, its relative simplicity genetic transformation, its short life cycle and its simple growth needs (Bevan *et al* 2010, Brkljacic *et al* 2011, Mur *et al* 2011). *Brachypodium* is a relatively small genus with about 18 species distributed worldwide (Schippmann 1991; Catalan and Olmstead 2000, Catalan *et al.,* 2012). Among these 18 species *Brachypodium atlanticum* Dobignard is an endemic grass to Morocco with a very restricted distribution in the High Atlas of Morocco. It is a perennial with an ordinarily flag leaves of 0.5-0.7 mm diameter. The sheath is split to the base. The raceme is simple, spiciform. The spikelet is hairy very shortly pedicelled, cylindraceous, then ± compressed laterally, multiflores. The upper flowers are male. The rachole is ± fragile. The glumes are ciliated towards the margins and often have some hairs on the rounded back. The lemma is rounded on the back, usually aristate, long ciliated towards the margins and covered on the back with a ± appressed and dense villus hairs. The palea with pectinate-ciliated keel. Both lodicules are ± fimbriated or ± ciliated. The anthers equal or exceed the middle of the palea. The ovary is glabrous or short-haired; the styles are apical. The caryopsis loosely adheres to the palea, linear oblong, furrowed with linear hilar macule that occupying its entire length.

8. *Centropodia forsskalii* (Vahl) Cope

It is a hemicryptophyte (Raunkiaer 1934), with caespitose stems, one or more kneeed stubble, strong, distal and pubescent culm-internodes. The leaves are stark and glaucous. Leaf-blade surface ribbed; pubescent; Leaf-blade apex pungent. The lower leaves reduced to sheath, without blade or very small limb. Leaf-blade leaves up to 8 x 0.5 cm, attenuate callus; ligule reduced to a row of hairs of about 2 mm long. The sheath of the lower leaves with short and long hairs mixed. The inflorescence is a short contracted panicle (5-15 cm) embraced at base by subtending leaf. The flowers are cuneiform and fleshy. Spikelets are multiflores comprising 2-3 fertile pedunculate florets, lanceolate, 6-11 mm long. Rhachilla internodes elongated between glumes; definite. Floret callus evident; curved; 1 mm long; pubescent; pungent; disarticulating obliquely. The glumes are subequal 5-10 mm long, without keels, 7-9 – veined, with bands of whitish hairs between the veins, acute at the apex; the lower glume is elliptical with asperulous surface; upper glume lanceolate chartaceous; without keels. Lemma is bilobed, acuminate; 1 –awned. Principal lemma awn from a sinus; straight, or geniculate; 3-4 mm long overall. The anthers 3, 0.7-1.2 mm long. The fruit is a caryopsis with adherent pericarp. This species colonizes the deep sands of the Saharan regions and is able to take advantage of low rainfall.

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