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LUPIN: AN ECOLOGICALLY CLEAN MEDITERRANEAN CROP

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SYNOPSIS

The use of legumes in crop rotations was historically, and indeed continues to be, an important element of Mediterranean farming systems. The lupin clearly has great expectations within the framework of the sustainable agriculture. The lupin crops contribute to farming systems in various ways. Lupin in Mediterranean region is used for different purposes: grain production in crop rotations, green manure, soil conservation, establishment of forest systems, permanent pastures for direct use by livestock. The lupin is grown in a wide range of climates and is well adapted to poor, light and acid soils. Average grain yield is between 1.2 and 2 t per hectare. At present time three species are grown (*Lupinus albus, L. angustifolius* and *L. luteus*). New lupin species are being domesticated: *L. consenyinii, L. atlanticus, L. digitatus* and *L. pilosus*. One of the main benefits of lupin is the increases yield of the following grain crop. It is known that the lupin in crop rotation is a valuable cash crop, which increases soil fertility and enhances soil properties. In grain crop rotations it can “breaks” the cycle of crop disease.

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The genus *Lupinus* (Tourn.) L. concerns to division Magnoliophyta, ordo Fabales Nakai, familia Fabaceae Lindl, tribus Luppineae Hutch. The name of the genus descends from the Latin word “lupus” – wolf. Wild species of *Lupinus* occur in North and South America, the Mediterranean region and northern Africa. They are most commonly known today for their attractive flowers, and several lupin species have been selected as ornamentals. Many lupin species were used by early agriculturalists

for seed, green manure or forage. A few were fully domesticated and became important crop plants in the latter half of the 20th century.

The ancient Greeks and Romans used the white lupin for soil improvement and to precede cereals in crop rotation, and seeds were soaked to debitter them prior to consumption by stock or humans (Gladstones, 1970). The debittered lupin seeds are still an important snack food in many countries in the Mediterranean region.

A parallel domestication and use of lupin occurred in South America more than 2000 years ago. *Lupinus mutabilis* is still cultivated on a small scale and eaten by indigenous populations in the high Andes. The seeds are soaked to debitter them then ground into flour soups, drinks or desserts.

Fig. 1. *Lupinus albus* subsp. *albus* plant of sweet variety.

Two major isolated groups of species (New World and Old World) are recognized in the genus *Lupinus*. Several hundred species have been named in the New World, where they extend from Alaska to Argentina (Dunn, 1984). Species in the New World include both annual and perennial types, and simple and compound-leaf types. Only 11 or 12 species exist in the old World, and they are divided into smooth- and rough-seeded types (Plitman and Heyn, 1984). Twelve of Mediterranean and African species occur in Greece including islands, on Balkan, Apennine and Iberian Peninsulas, Morocco, Tunisia, Algeria, Egypt, Israel, Ethiopia and others countries. All Old World species are annual compound-leaf types. The New World lupins are mostly

small-seeded, whereas the Old World lupins are mostly large-seeded. Only one New World species has large seeds (*Lupinus mutabilis*).

The lupin crops contribute to farming systems in various ways. Lupin in Mediterranean region is used for different purposes: grain production in crop rotations, green manure, soil conservation, establishment of forest systems, permanent pastures for direct use by livestock. The lupin is grown in a wide range of climates and is well adapted to poor, light and acid soils. Average grain yield is between 1.2 and 2 t per hectare.

The agricultural potential of *Lupinus* is just beginning to be realized. In 20th century, three lupin species have been fully domesticated and have gained commercial acceptance (*Lupinus albus, L. angustifolius* and *L. luteus*). Modern lupin breeding started in Germany in 1920s, where Dr von Sengbusch developed several alkaloid-fre mutants of *Lupinus albus, L. angustifolius* and *L. luteus* . This pioneering work laid the foundations for later development of “sweet” lupins in different countries: Australia, USSR, Germany (West and East), Poland, Chile, USA, and South Africa. New lupin species are being domesticated: *L. consenyinii, L. atlanticus, L. digitatus* and *L. pilosus*. Others Mediterranean and African species *L. hispanicus* Boiss et Reut., *L. micranthus* Guss. *L.cosentinii* Guss., *L.digitatus* Forsk., *L.princei* Harms, *L. pilosus* Murr., *L. palaestinus* Boiss., *L. atlanticus* Gladst. and *L. somaliensis* Baker also have great potential and agricultural importance. Domestication of new lupin species will provide new legume crops for a wider range of soil types and environments (Cowling et al., 1998).

One of the main benefits of lupin is the increases yield of the following grain crop. An effectively nodulated lupin crop does not need nitrogen fertilizer. Lupin is more tolerant of low surface soil potassium levels than pasture lagumes. It is known that the lupin in crop rotation is a valuable cash crop, which increases soil fertility and enhances soil properties. In grain crop rotations it can “breaks” the cycle of crop disease. The cereals benefit from the nitrogen bild-up and cleaning effect of the lupin crop.

Lupinus albus (Fig. 1) has the longest history of cultivation for human consumption of any lupin species, dating back to pre-Roman and Greek times (Gladstones, 1970).

In accordance with B. S. Kurlovich (2002) there are tree subspecies of white lupin (*L. albus*): subsp. *graecus* (Boiss. et Spun.) Franko et Silva; subsp. *termis* (Forsk.) Ponert. and subsp. *albus* L. *Lupinus albus*. subsp. *graecus* and subsp. *termis* differ from the nominotypical subspecies (subsp. *albus*) flowers and seeds. Subsp. *graecus* is a direct wild ancestor of white lupin and spread in Greece, on Crete and other Aegean islands, in Albania and western Turkey. Subsp. *termis* spread in Egypt, Libya, Sudan, Ethiopia and Israel. The nominotypical subspecies *Lupinus albus* subsp. *albus* has the longest history of cultivation for human consumption of any lupin species, dating back to pro-Roman and Greek times (Gladstones, 1970). The main agricultural traits selected by ancient farmers were large permeable seeds and no shattering pods. The gene pool of subsp. *albus* has wide variations in physiological properties of plants and cultivated in many countries of Europe, Asia and America.

However, sweet, fully domesticated cultivars not are grown in the primary or secondary centers of diversity of *L. albus*. The major reasons for this are the inability to control grazing of sweet cultivars by domesticated or wild herbivores, and the occurrence of wild or landrace bitter types which inevitably cross with sweet modern cultivars. We believe that the role of epidermal structures is especially significant in sweet lupin varieties that have lost such important immunity factor such as alkaloids during evolution. It is well-known, that the role of epidermis is significant in “passive” immunity of plants (Popkova, 1979, Shapiro, 1985). Thus the data on lupin epidermis morphology might be useful both in lupin breeding and systematics. The upper surface of leaves *L. albus* subspecies was hairless. Some differences in length and shape of hairs was observed between the latter species and its hybrid with *L. graecus.* The hairs in *L. albus* are shorter, straighter and more appressed to the surface than in the hybrid. Some differences are observed also in morphology of the regular epidermal cells. Cells of the upper leaf surface in *L. albus* are small and protuberant and in the hybrid *L. albus*×*L. graecus* are flat and much larger (Golovchenko, 2000).

It is known, that the seeds of some sweet lupin varieties can serve as an additional source of vegetative food. In the developed countries they carry out a role of the over nutrition and in the developing countries as inexpensive source of food with the high contents of protein (Feldheim, 1994). In Ukraine the new leguminous culture - white sweet lupin has been created. One grain of it contains 38-42 % of proteins, 11-14 % of fats, 10-12 % of pectins, 28 % of food fibres and rich complex of vitamins and microelements (Zilova et al., 1990). The seeds of the mentioned varieties can be processed on the following basic directions: (i) milled for flour from whole grains, or separate milling of grains without seed coat; (ii) addition of endofermented lupin seed to canned fruit and vegetable; (iii) roasted for coffee substitute, and (iv) as a sorbent for aroma compositions. In regions of ecological disasters, in particular the Chernobyl accident the development of the over a nutritional additive with enterosorptive properties is important (Golovchenko et al., 2000). Products prepared by adding lupin seed base (e.g., canned food with vegetables or fruit) contain more pectins (4.5-5.5g per 100g of product), than canned food produced by Ukrainian industry with apple or beet pectin have been added (3g per 100g of product). Thus, the seed of the nutritional white lupin plays the new role of a pectin source, i.e. as the enterosorbents both of the heavy metals ions and radioactive nuclides. In our opinion in the countries with traditional prevalence of bakeries, other flour products and porridges in the human nutrition the first direction of the seeds processing may receive the most recognition but all three mentioned ways of food use of lupin are enough perspective.

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