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LESQUERELLA

Family: *Cruciferae*

Genus: *Lesquerella*

Species: *fendleri, communis*

Source: http://www.mobot.org/CPC/peril/image/image_64.jpg

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General Background

The genus *Lesquerella* originates from the dry areas of south west USA where it is grown as a winter annual. The genus consists of about 70 species which are widely genetically variable, about 30% of species are annuals. Of the species tested for agronomic evaluation, *L. fendleri* is the only one currently being domesticated although several others may have potential. Some 23 species from the genus *Lesquerella* have been tested as potential oleaginous crops for arid areas in USA. Lesquerella is sometimes called Bladder-pod.

Plants have an indeterminate growth habit, reaching a height of up to 45cm in a cultivated field with an erect usually branched stem. The plant has densely pubescent, silvery leaves. Basal leaves are between 1-4cm long and 1-6mm wide, leaf margins are entire to coarsely dentate. Yellow flowers occur on inflorescences that usually extend beyond the leaves. Seeds are contained in pods, each capsule usually contains between 6 and 20 seeds. Seeds are flattened, 1.3-2.0mm long and yellow to orange-brown in colour. *L. fendleri* can be distinguished from other species by the combination of the yellow flowers with glabrous siliques and trichomes that are fused not more than half their length. Although flowering and seed production is indeterminate, ripe capsules tend to remain closed until the entire plant is mature and dry (unless shattered near to maturity by heavy rain).

Lesquerella mainly occurs in the wild on limestone soils, it does best in production on well-drained calcareous soils. The plants geminate in late summer – early autumn, exhibiting little vegetative growth during winter but then increased growth, flowering and seed set by late spring.

Details of Quality Characteristics

Seeds of *L. fendleri* contain lesquerolic acid (systemic name: 14-hydroxy-*cis*-11-eicosenoic acid). Seeds contain up to 30% oil and 59% lesquerolic acid. Lesquerolic acid is analogous to ricinoleic acid produced from castor (*Ricinus communis*), although ricinoleic acid comprises ~95% of castor oil fatty acids, the castor meal

contains ricin, one of the most toxic substances known to man. Ricinoleic acid is the only other commercial source of hydroxy fatty acids (HFA's). HFA's are used as a raw material in the production of lubricants, plastics and coatings.

Oil from *L. fendleri* is compositionally similar to and in some ways structurally superior to castor oil. Although products derived from lesquerella oil can be similar to those obtained from castor oil, dehydration of lesquerella oil produces a drying oil that is superior to dehydrated castor oil.

Seed from *L. fendleri* contains over 25% oil by weight where the primary fatty acid (~55-60%) content is the C20:1 lesquerolic hydroxy fatty acid. Epoxy compounds have also been discovered in *L. fendleri* and very long chain fatty acids to C-30 albeit at low levels. Once the seed has been pressed amino acid distribution is high in lysine, methionine and threonine similar to crambe meal.

Lesquerella meal derived from oil extraction is rich in lysine and appears to have potential as a protein supplement in animal feed. Protein content is thought to be in the region of 34.3%.

Current Production and Yields

No commercial data is yet available on current production and yields. However, trials are currently being carried out in a number of countries across Europe, particular scientific interest and development is currently taking place in Belgium, Italy, Netherlands and UK.

From these trials it has been established that *L. fendleri* is not well adapted to temperate western European climate, the crop showed very poor establishment and germination. In the UK a modest plant stand was established one year in three. The maximum growth achieved to date in the UK is 440kg/ha at 22% oil content. The greatest yield has been achieved in the Netherlands with production of 1,390kg/ha at 36% oil content.

In USA where the crop is better suited the seed yields are currently 950-1120kg/ha at 21% oil content, this figure needs to be improved through breeding to allow commercialisation to occur. In small scale trial plots yields of up to 1,600kg/ha have been achieved whereas on large scale field trials this has been reduced to only 800-900kg/ha.

Lesquerella was grown worldwide, mostly in experimental plots in 1993, at a total of approximately 20ha. It is anticipated that over 40,000 hectares of lesquerella will be required in the next few years for domestic production and this will expand further as other applications are developed.

Constraints upon Production

Four areas are lacking in developing lesquerella as an oilseed crop: (1) Products unique to lesquerella must be developed, (2) Products must be tested and evaluated to demonstrate their superiority to petroleum based, imported or synthetic alternatives, (3) Large amounts of seed must be provided to industry for product development, and (4) The economics of the crop must be improved.

Plant establishment is a major constraint due to the seeds tendency towards dormancy and weak seedling vigour. Due to the plants slow initial growth rate competition with early weeds is poor and establishment is reduced. Poor establishment, weed control and harvest losses are the major constraints to increased production in Europe.

Oil recovery from lesquerella is difficult due to the small size of the seed. Pre-treatment of small seeds may result in large losses and percolation of solvents may block the process. This problem can be overcome by performing oil extraction, however this method is not commercially viable when large quantities are to be extracted.

In the UK the maximum height achieved by the crop to date is 20cm, this makes hand harvesting the only viable option. Limits on commercial production are low seed yield, oil content, hydroxy fatty acid content along with indeterminate growth habit and male sterile plants at about 8%.

Markets and Market Potential

Castor oil is a major strategic vegetable oil as indicated by its many users. Vast amounts of castor oil is imported into both Europe and USA each year, this is shown in the table below (tonnes/annum), this suggests the potential market size for lesquerella oil which has the potential to serve as a partial or complete replacement.

YEAR	USA IMPORTS	EUROPE IMPORTS
1996	39,938	123,041
1997	41,025	109,581
1998	48,477	106,452
1999	46,675	99,946
2000	40,739	151,713

Source: FAO Stat (2001)

The HFA's (Hydroxy Fatty Acids) found in high concentrations in lesquerella seed oil could be used to produce speciality lubricants, heavy duty detergents, grease thickeners, inks and coatings due to the special properties of the HFA's in comparison to other fatty acids (higher viscosity and reactivity). HFA is important in raw material used by industry for making resins, waxes, nylons, plastics, corrosion inhibitors and lubricating greases.

Recent research has identified the potential for lesquerella oil for use in plastics, additional coatings, extruded closed cell foam, facial soap and cosmetics. Formulation work has begun incorporating lesquerella oil into lip care products. An initial focus for lesquerella is lipstick which contains up to 80% castor oil. Polyurethane foams which are also produced may be used for transportation or furniture applications and rigid foams for insulation and structural support.

The seed coat of lesquerella contains a natural unique gum which can be separated before or after oil extraction. This part could be as valuable as the oil, potential applications include; cosmetics, plasticisers, lubricants, coatings, food thickening agents or crude oil recovery.

The meal derived from the seed after oil extraction can be used as a protein supplement for livestock.

Other Information

Lesquerella is best suited in areas of 600-1800m above sea level and annual rainfall of 250-400mm. The plant is adapted to temperatures of below –18ºC and can therefore be grown in temperate arid regions. Lesquerella can tolerate soil pH from 5.6-8.3. The crop does not appear to be well suited to the soils and climatic conditions of Western England.

The crop is cultivated similar to a winter wheat crop, sown in October and harvested in June-July. Initial seedling growth is slow due to the low temperatures but by mid-February growth is much more rapid. A full plant canopy is usually reached by mid-March, fruits (seeds) mature around early-mid May and the plant biomass then begins to dry. When dry, to around 12% moisture, the plants can be harvested using a conventional combine (providing the plant is of sufficient height) equipped with small sieves to accommodate the small seed size. Growing the crop as a summer annual is also an option, sowing in March and harvesting in September.

Yields are increased with the application of up to 100kg/ha of nitrogen, however in some cases this can decrease the oil content of the seed. Irrigation in the drier areas and also application of Phosphorus are thought to have a positive effect on yield. Seed shattering will not be a problem prior to harvest unless heavy rain occurs, seed loss at harvest can be as low as 5% with the correct equipment available. At maturation or failing moisture the plant dries and breaks off at the taproot, allowing the dried plant to blow around like tumbleweeds, thus dispersing the seeds.

Weed control appears to be a problem within the crop, the species is very sensitive to weed competition however it is intolerant of the majority of herbicides investigated. No diseases or pests of economic importance are known to occur, however the following fungi have been found on *L. fendleri: Helminthosporium namum, Phoma punctiformis, Phymatotrichum omnivorum* and *Puccinia aristidae.*

Lesquerella attracts a variety of nectar and pollen feeding insects, including honey bees.

Research

There are many research programmes currently ongoing in lesquerella, firstly the oil content needs to be improved, this has already been achieved to some extent through breeding, increasing from 22-30% although the aim is to achieve 35% oil content. Lesquerolic oil content also needs to be improved, currently *L. fendleri* has poorer oil content than other species but greater seed yields, hybrids have now begun to show promise to increase this value from 60% to nearly 80% whilst maintaining other favourable traits.

Other aspects which are currently being looked at in technical research programmes are salt tolerance, microspore culture and mutation breeding and also germplasm collection and evaluation. More general research is taking place on dates of planting, seedling rates and plant populations, planting systems, weed control and harvesting.

Due to the vast amount of pollination carried out by bees in the crop the lack of adequate numbers of bees and insect pollinators is causing problems, auto fertility must be incorporated to overcome this problem. Already a number of male-sterile lines have been identified.

Useful Websites

http://www.hort.purdue.edu - A vast amount of information including fact sheets and research papers

BioMat Net

AIR2-CT93-1817 – Vegetable Oils with Specific Fatty Acids (VOSFA): Agricultural and Industrial Development of Novel Oilseed Crops

FAIR-PL97-3884 – CTVO-NET Chemical-technical utilisation of vegetable oils

AGRE-0046: Vegetable oil for innovation in chemical industries (VOICI)

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