Captivating Camelina…

Camelina, also known as false flax or wild flax, is a flowering plant in the family Brassicaceae. Native to Northern Europe and to Central Asian areas, it has recently been introduced to North America, where it is currently grown only in Montana. Even higher than flaxseed in omega-3 ALA, Camelina also contains high quantities of vitamin E, a powerful antioxidant.

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Camelina

Camelina is a genus within the flowering plant family Brassicaceae. One species, *Camelina sativa*, is a historic and potentially important oil plant. In the United States, Montana has recently been growing more and more Camelina for its potential as a biofuel and bio-lubricant.

Scientific classification

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Brassicales

Family: Brassicaceae

Genus: *Camelina*

Species:
Camelina alyssum (Mill.) Thell.
Camelina microcarpa Andrz. ex DC.
Camelina rumelica Velen.
Camelina sativa (L.) Crantz

Camelina Sativa

**courtesy of Wikipedia*

Camelina sativa, usually known in English as gold-of-pleasure, false flax, wild flax, linseed dodder, Camelina, German sesame, or Siberian oilseed, is a flowering plant in the family Brassicaceae, which includes mustard, cabbage, rapeseed, broccoli, cauliflower, kale, brussels sprouts. It is native to Northern Europe and to Central Asian areas, but has been introduced to North America, possibly as a weed in flax.

It has been traditionally cultivated as an oilseed crop to produce vegetable oil and animal feed. There is ample archeological evidence to show it has been grown in Europe for at least 3,000 years. The earliest findsites include the Neolithic levels at Auvernier, Switzerland (dated to the second millennium BC), the Chalcolithic level at Pefkakia in(dated to the third millennium BC), and Sucidava-Celei, (circa 2200 BC). During the Bronze and Iron ages it was an important agricultural crop in northern Greece beyond the current range of the olive. (*This observation is first made in Jones and Valamoti 2005, p. 575, not in Megaloudi 2006. The full reference is as follows: Jones, G. and Valamoti, S.M. 2005. Lallemantia, an imported or introduced oil plant in Bronze Age northern Greece. Vegetation History and Archaeobotany 14, 4, 571-577.*)

It apparently continued to be grown at the time of the Roman Empire, although its Greek and Latin names are not known. According to Zohary and Hopf, until the 1940's *C. sativa* was an important oil crop in eastern and central Europe and currently has continued to be cultivated in a few parts of Europe for its seed which was used, for example, in oil lamps (until the modern harnessing of natural and propane gas and electricity) and as an edible oil.

The crop is now being researched because of its exceptionally high levels of omega-3 fatty acids (up to 45%), which is uncommon in vegetable sources. Over 50% of the fatty acids in cold pressed Camelina oil are polyunsaturated. The major components are alpha-linolenic acid - C18:3 (omega-3-fatty acid, approx. 35-45%) and linoleic acid - C18:2 (omega-6 fatty acid, approx. 15-20%). The oil is also very rich in natural antioxidants, such as tocopherols, making this highly stable oil very resistant to oxidation and rancidity. It has 1-3% erucic acid. The vitamin E content of Camelina oil is approximately 110mg/100g. It is well suited for use as cooking oil with an almond-like flavor and aroma. It may become more commonly known and become an important food oil for the future.

Because of its certain apparent health benefits and its technical stability, gold-of-pleasure and camelina oil are being added to the growing list of foods considered as functional foods. Gold-of-pleasure is also of interest for its very low requirements for tillage and weed control. This could potentially allow vegetable oil to be produced more cheaply than from traditional oil crops, which would be particularly attractive to biodiesel producers looking for a feedstock cheap enough to allow them to compete with petroleum diesel and gasoline.

References

- Daniel Zohary and Maria Hopf, Domestication of plants in the Old World, third edition (Oxford: University Press, 2000), pp. 138f
- Megaloudi, Fragkiska (2006), Plants and Diet in Greece from Neolithic to Classic Periods: the archaeobotanical remains, Oxford: Archaeopress, p. 57)
- Dalby, Andrew (2003), Food in the ancient world from A to Z, London, New York: Routledge, p. 161

Camelina in Montana

courtesy of Great Northern Growers, Montana Producer Cooperative, http://www.greatnortherngrowers.com

Introduction

Camelina (*Camelina sativa*), a member of the mustard family, is a summer annual oilseed plant. Leindotter, False flax and Gold of Pleasure are the popular common names for the crop. Seeds and capsules of the crop have been found in archaeological excavations from the Bronze Age in Scandinavia. The crop was widely grown in Eastern Europe up to the early 1940's but was replaced with the introduction and widespread use of oilseed rape (canola).

The revival of interest in Camelina oil is due to its high linolenic acid (38%) content. Linolenic acid is one of the omega-3 fatty acids which are generally found in substantial commercial quantities only in linseed (flax) and fish oils. Camelina offers an opportunity to supply the growing demand for high quality edible oils rich in OMEGA-3 fatty acids. The oil contains 35 to 40% linolenic acid compared to 8% in Canola and 1% or less in soy bean and corn oils. Camelina oil does not deteriorate during refining or storage like linseed (flax) oil or fish oil and can be used in a number of oil based products such as spreads and salad dressings. Camelina oil, unlike linseed and fish oil, is oxidatively stable and palatable.

Health and Nutrition

Camelina sativa, with the popular names leindotter, false flax or gold of pleasure, is a cruciferous oilseed plant. It was an important oil crop during the Bronze and Iron Ages and it is still not clear why it was gradually replaced in the Middle Ages and thereafter. Recently, interest in Camelina sativa has been renewed due to the fact that the crop does not require high inputs of nutrients and pesticides, it grows well in semiarid regions, and in soil with low fertility.

The main product of Camelina sativa is the oil produced by crushing and pressing the seeds, which contain about 30-40% of oil on a dry matter basis. Camelina oils are high, about 50%, in polyunsaturated fatty acids. Their composition varies with the agrotechnical measures used in their production but primarily linoleic (18:2) and linolenic acid (18:3) are found in the oil. Recent studies in the field of human nutrition have focused attention on the relative nutritional value of various oils or fats. A low proportion of saturated fatty acids and a high ratio of omega-3 to omega-6 fatty acids have been identified as desirable in edible oils.

Camelina, with its high content of omega-3 fatty acids (38% of the total fatty acid content), offers an opportunity to supply the growing demand for high quality edible oils. Camelina oil is a rich source of essential fatty acids and an excellent source of omega-3 fatty acids. These compounds may have favorable nutritional implications and beneficial physiological effects. Camelina oil can reduce serum triglycerides and cholesterol.

The production of edible oil from crops has enjoyed unremitting growth during the latter part of the 20th century. This trend shows no signs of relenting. The demand for edible oils is increasing most in the heavily populated regions of South Asia, China, and the Far East, where vegetable oils are an important part of the diet. But demand for meal and oil is also high in the European and American markets.

The development of soybean, sunflower, and canola, the three most significant edible oils for temperate climates, represent important new crop successes. It is likely that these crops will continue to expand in acreage, given increasing demand for high quality edible oils and meals, the wide adaptation of these crops, and new, improved cultivars.

However, each of these major oilseeds has its limitations. For example, soybean, though ideal for most regions of the corn belt, is not well adapted to more northerly regions of North America, Europe, and Asia. Canola and sunflower are better adapted to northern climates but have high nitrogen requirements and are susceptible to insect or bird predation as well as diseases. These oilseed crops are often not suitable to marginal lands, low moisture, low fertility, or higher pH soils. In recent years, there has been increasing interest in developing agronomic systems with low requirements for fertilizer, pesticides, and energy, and which provide better soil erosion control than conventional

systems. This led to examination of the viability of developing Camelina as an oilseed with reduced input requirements and as a crop well suited to marginal soils, or soil- and resource-conserving agronomic practices.

Agricultural History

Although Camelina is known in North America primarily as a weed, it was known as "gold of pleasure" to ancient European agriculturists. Cultivation probably began in Neolithic times, and by the Iron Age in Europe, when the number of crop plants approximately doubled, Camelina was commonly used as an oil-supplying plant. Carbonized seed evidence has shown cultivation in regions surrounding the North Sea during the Bronze Age. Camelina monocultures occurred in the Rhine River Valley as early as 600 BC.

Similar to small grains, which also often spread as crop mixtures, Camelina probably spread in mixtures with flax and as monocultures. It was cultivated in antiquity from Rome to southeastern Europe and the Southwestern Asian steppes. The crop was widely grown in Eastern Europe and Russia up to the early 1940's with some production lasting up to the 1950's.

Camelina was replaced with the introduction and widespread use of oilseed canola. It is suggested that Camelina, with its high content of unsaturated fatty acids (approx. 90%), was more difficult and expensive to hydrogenate than oilseed rape (canola), and this led to its decline. Hydrogenation is the process that creates trans-fatty acids.* However, because of the link between trans-fats and obesity, CVD, diabetes and other health disorders, as of January 1, 2006, trans-fats must be listed on nutritional panels.

Today Camelina is produced in Slovenia, Ukraine, China, Finland, Germany, Austria and Montana.

**Trans fat is the common name for a type of unsaturated fat with trans isomer fatty acid(s). Trans fats may be monounsaturated or polyunsaturated. Most trans fats consumed today are industrially created by partially hydrogenating plant oils — a process developed in the early 1900s and first commercialized as Crisco in 1911. The goal of partial hydrogenation is to add hydrogen atoms to unsaturated fats, making them more saturated. These more saturated fats have a higher melting point making them attractive for baking, and extending their shelf-life.*

Great Northern Growers

Great Northern Growers is a Montana Producer Cooperative dedicated to producing, processing, packaging, marketing, distributing and adding value to Montana grown agricultural products with a health and/or nutrition advantage to the worldwide market. GNG is a group of Montana professional producers working together to provide natural, nutritional, agricultural produce which is high in protein, beta glucan, omega-3, Tocopherols, glycosinolates, wheat free and other key nutritional qualities.

Camelina Oil: Brief History and Health Facts

History

Camelina Sativa, also known as Gold of Pleasure, False flax, German Sesame, Siberian oilseed, is actually a member of the Brassicaceae (mustard and cabbage) family. Seeds of this plant have been found in archaeological excavations from the Bronze Age in Scandinavia and Europe. It was used as a lamp oil until the 18th century. Camelina was grown as an agricultural crop in Europe and Russia before WWII and up to the fifties. The recent search for new sources of omega-3 fatty acids has led to a revived interest in this crop. Currently, Camelina is grown in Slovenia, Ukraine, China, Finland, Germany, Austria and Montana.

Unique Properties

Camelina is unique among vegetable oils because it is high in both vitamin E and omega-3 ALA essential fatty acid, which is beneficial to cellular health. Camelina seeds are approximately 43% oil, 90% of which is unsaturated fatty acids. Approximately 50% of the total fatty acids are polyunsaturated-linoleic acid and α-linolenic acid.

Healthy Body

Camelina oil has a golden color and a delicate, almond-like flavor, somewhat stronger than the flavor of flax oil. The high content of ALA omega-3 and vitamin E in Camelina oil makes it a terrific, healthful option for cooking and salad oils to add both flavor and nutrition to any meal.

Omega-3 essential fatty acids

Omega-3 essential fatty acids are important for proper growth, brain development and immune function in children. They have been shown to be beneficial in raising HDL cholesterol, lowering LDL cholesterol and improving overall heart health. Extensive research indicates that omega-3 fatty acids reduce inflammation and help prevent certain chronic diseases such as heart disease and arthritis. These essential fatty acids are highly concentrated in the brain and appear to be particularly important for cognitive and behavioral function. In fact, infants who do not get enough omega-3 fatty acids from their mothers during pregnancy may be at risk for developing vision and nerve problems.

Vitamin E

Vitamin E is a fat-soluble vitamin that exists in eight different forms. Each form has its own biological activity, the measure of potency or functional use in the body. Alpha-tocopherol is the most active form of vitamin E in humans, and is a powerful biological antioxidant. Antioxidants such as vitamin E act to protect your cells against the effects of free radicals, which are potentially damaging by-products of the body's metabolism. Free radicals can cause cell damage that may contribute to the development of cardiovascular disease and cancer. Studies are underway to determine whether vitamin E might help prevent or delay the development of those chronic diseases. Camelina oil blends smoothly with other flavors such as vinegar, garlic and spicy peppers, offering a nutritious base for creative cooking oil blends. Like flax oil, Camelina oil can also be taken as a health supplement and would be beneficial to all members of the family including pets.

Healthy Skin

Camelina (Gold of Pleasure) oil exhibits good emollient properties (soothing and calming), aids in skin's elasticity and has a high level of natural tocopherols (Vitamin E) which helps guard against oxidation and allows a longer shelf life. Leading cosmetic companies use Camelina oil in hair products as it provides lubricity and provides a protective coating to hair follicles. Camelina may be used in creams, lotions, balms and lipsticks, bar soaps or any formulation where the skin nutritive properties of the Camelina oil are promoted. It is a superior oil for good skin care.

Camelina oil is an excellent carrier oils for fragrance and essential oils. It is of a golden color and if tasted, has a delicate, almond-like flavor. As a massage oil or a carrier oil Camelina has many potential benefits. It has been called the oil of the future.

Free radicals show up on your skin as wrinkles, blemishes, brown or white spots, cancerous and pre-cancerous lesions, little warts, along with sagging and deterioration of the skin. All of these things can result from exposure to environmental pollution ultraviolet radiation from TV's, microwaves, radio waves, computer terminals, auto exhaust, etc. It is now recognized that free radicals are contributing causes to more than 60 diseases, such as heart disease, cataracts and rheumatoid arthritis. If left unchecked, free radicals may cause heart damage, cancer, cataracts, and a weakened immune system functions. Free radicals may be involved with aging of tissue and, coupled with sun damage, could promote skin cancers. While free radicals are produced by normal human metabolism, they can be increased by smoking, alcohol, exposure to heavy metals, and radiation. Vitamin E, which is present in high quantities in Camelina oil, is a powerful antioxidant that fights the damaging effects of free radicals.

Healthy Environment

Interestingly, the high content of vitamin E in Camelina oil makes it very shelf stable, which makes it an excellent choice for biodiesel, an environmentally friendly alternative to diesel fuel. Alternative fuels are a major focus of Montana State University's Institute for Biobased Products, which is developing crops that can be used to make biodiesel, ethanol and biolubricants to replace motor oils. Biobased hydraulic oils for motor vehicles are biodegradable and are as much as 370,000 times less toxic than an equal amount of petroleum. Other oilseeds have shown potential for biodiesels and biolubricants, but have been cost prohibitive to produce. Camelina, however, is a low input crop, meaning it prefers low tillage of the soil and requires no irrigation or pesticides. In fact, studies have shown it can be broadcast seeded right on top of the snow in late winter and require nothing else. Camelina can be produced for much less than other biodiesel crops, for the first time making a biodiesel or biolubricant product competitive in price with its petroleum counterpart.

Camelina: A Promising Low-Input Oilseed

D.H. Putnam, J.T. Budin, L.A. Field, and W.M. Breene, Purdue University

The production of edible oil from crops has enjoyed unremitting growth during the latter part of the 20th century. In a six year period in the 1980s, a 26% increase in production of oils from ten oilseeds was realized. Much of this growth has been in tropical oils (oil palm, *Elaeis guinensis* L.) or high quality (low saturated fat) edible oils such as soybean [*Glycine max* (L.) Merr.], canola (*Brassica napus* L.), and sunflower (*Helianthus annuus* L.). This trend shows no signs of relenting. The demand for edible oils is increasing most in the heavily populated regions of South Asia, China, and the Far East, where vegetable oils are an important part of the diet, but demand for meal and oil is also high in the European and American markets and the Commonwealth of Independent States.

The development of soybean, sunflower, and canola, the three most significant edible oils for temperate climates, represent important new crop successes (Robinson 1973; Hymowitz 1990; Downey 1990). It is likely that these crops will continue to expand in hectarage, given increasing demand for high quality edible oils and meals, the wide adaptation of these crops, and new, improved cultivars. However, each of these major oilseeds has its limitations. For example, soybean, though ideal for most regions of the corn belt, is not well adapted to more northerly regions of North America, Europe, and Asia. Canola and sunflower are better adapted to northern climates but have high nitrogen requirements (especially canola), and are susceptible to insect or bird predation as well as diseases. These oilseed crops are not often suitable to marginal lands (low moisture, low fertility, or saline soils).

In recent years, there has been increasing interest in developing agronomic systems with low requirements for fertilizer, pesticides, and energy, and which provide better soil erosion control than conventional systems (NRC 1989). This led us to examine the viability of developing Camelina as an oilseed with reduced input requirements and as a crop well suited to marginal soils, or soil- and resource-conserving agronomic practices.

Description and Adaptation

Camelina sativa (L.) Crantz., Brassicaceae (false flax, linseed dodder, gold-of-pleasure) originated in the Mediterranean to Central Asia. It is an annual or winter annual that attains heights of 30 to 90 cm tall (Fig. 1) and has branched smooth or hairy stems that become woody at maturity. Leaves are arrow-shaped, sharp-pointed, 5 to 8 cm long with smooth edges. It produces prolific small, pale yellow or greenish-yellow flowers with 4 petals. Seed pods are 6 to 14 mm long and superficially resemble the bolls of flax. Seeds are small (0.7 mm x 1.5 mm), pale yellow-brown, oblong, and rough, with a ridged surface. Morphology and distribution of Camelina species has been described by Polish and Russian botanists (Mirek 1981). Camelina has been shown to be allelopathic (Grummer 1961; Lovett and Duffield 1981).

Camelina is listed as being adapted to the flax-growing regions of the northern Midwest (Minnesota, North Dakota, South Dakota) (NC-121 1981). It is primarily a minor weed in flax and not often a problem in other crops and does not have seed dormancy (Robinson 1987). However, the adaptation of Camelina as a crop has not been widely explored. Similar to the other Cruciferous species, it is likely best adapted to cooler climates where excessive heat during flowering is not important. There are several winter annual biotypes available in the germplasm, and it is possible that Camelina could be grown as a winter crop in areas with very mild winters. Camelina is short-seasoned (85 to 100 d) so that it could be incorporated into double cropping systems during cool periods of growth, possibly in more tropical environments.

Agricultural History

Although Camelina is known in North America primarily as a weed, it was known as "gold of pleasure" to ancient European agriculturists. Cultivation probably began in Neolithic times, and by the Iron Age in Europe when the number of crop plants approximately doubled, Camelina was commonly used as an oil-supplying plant (Knorzer 1978). Cultivation, as evidenced from carbonized seed, has been shown to occur in regions surrounding the North Sea during the Bronze Age. Camelina monocultures occurred in the Rhine River Valley as early as 600 BC. Camelina probably spread in mixtures with flax and as monocultures, similarly to small grains, which also often spread as crop

mixtures. It was cultivated in antiquity from Rome to southeastern Europe and the Southwestern Asian steppes (Knorzer 1978).

Camelina declined as a crop during medieval times due to unknown factors, but continued to coevolve as a weed with flax, which probably accounts for its introduction to the Americas. Like rapeseed oil, Camelina oil has been used as an industrial oil after the industrial revolution. The seeds have been fed to caged birds, and the straw used for fiber. There have been scattered hectarages in Europe in modern times, mostly in Germany, Poland, and the USSR, and some efforts were made in the 1980s at germplasm screening and plant breeding (Enge and Olsson 1986; Seehuber and Dambroth 1983; Seehuber and Dambroth 1984: Kartamyshev 1985). Camelina has been evaluated to some extent in Canada (Downey 1971) and to a larger extent in Minnesota where R.G. Robinson conducted agronomic studies on Camelina (Robinson 1987). However, there has been relatively little research conducted on this crop worldwide, and its full agronomic and breeding potential remains largely unexplored.

Unique Agronomic Qualities

Yield Potential

Field studies on Camelina have been conducted at the University of Minnesota for over 30 years (Robinson 1987). In one 9-year/location yield comparison, Camelina was shown to have a yield potential similar to that of many other Cruciferae (Table 1), but it differed in seed size, maturity, lodging resistance, and oil percentage. Yields of Camelina cultivars (Table 2) have been in the 600 to 1,700 kg/ha range at Rosemount, Minnesota (45° N latitude), averaging about 1,100 to 1,200 kg/ha over many years of trials. It should be noted that the yield of many of these oilseeds (especially *B. napus*) has been improved significantly through plant breeding and improved agronomic practices, whereas Camelina has largely not had the benefit of plant breeding. Under Minnesota conditions, yields of all spring-sown cruciferous oilseeds are much higher at more northerly locations (1,736 kg/ha long term average canola yield--Roseau, Minnesota), compared with yields at Rosemount, which is located near St. Paul. Camelina is much smaller seeded and earlier maturing than the other cruciferae tested. Lodging was comparable to or fact slightly superior to the other cruciferae oilseeds tested (Table 1), and there was significant variation for lodging among Camelina varieties (Table 2).

Some variation in Camelina maturity, lodging resistance, seed weight, and oil percentage was exhibited by the lines tested and by other germplasm screening not reported here, but many of these lines were similar in yield at Rosemount (Table 2). Certainly increases in yield might be generated through plant breeding. German plant breeders using the single-seed descent method, have found transgressions over parental lines in many yield traits for Camelina, demonstrating both the high yield potential and capacity for yield improvement in this species (Seehuber et al. 1987). This experience indicates that Camelina, unlike some wild species undergoing domestication, exhibits yield potential and oil content which are both currently agronomically acceptable and amenable to improvement through plant breeding.

Winter Seeding

The practice of broadcasting Camelina seed on frozen ground in late November or early December has been tested over a number of years at Rosemount, and the practice appears to be viable (Table 3). In one four-year study, crops were sown with standard farm machinery on large plots. Camelina was sown in late fall on stubble, without seedbed preparation or herbicides, or conventionally in the spring and compared with flax sown conventionally and sprayed with herbicides (dalapon and MCPA). Performance of winter-sown Camelina was equal or superior to conventionally-sown flax in these studies.

To confirm these results, a separate two-year study was conducted where Camelina and flax were surface-seeded by hand in both winter and spring on tilled or stubble ground, broadcast or by machine without herbicides (Table 4). In 1990-91, surface seeding in winter was unsuccessful with flax, but was successful with Camelina, producing significantly earlier emergence and fewer weed problems. However, in the 1989-90 study, the winter seeding was unsuccessful for both crops, probably due to an open winter. Surface seeding of Camelina seemed to work better

under no-till conditions, possibly due to superior microsite protection for the small seed and seedling, and prevention of wind dispersion of the seed. Machine planting was no better than broadcasting in the spring sowings. Machine planting in December was not feasible. A winter-sown stand of Camelina emerges mid-April in Minnesota, before most other spring-sown crops, and before significant weed flushes.

These trials showed that Camelina sown without herbicide or tillage yielded as well or better than flax grown conventionally. These studies also showed that Camelina, unlike flax, can be surface-sown on frozen ground in the late fall or winter or early spring and produce good stands and yields comparable to conventionally-sown Cruciferae crops.

Compatibility with Cover Crops

In a three-year study, winter-sown Camelina yielded an average of 9% more when seeded with a fall-sown cover crop than without (Table 5). In this and in subsequent studies (Robinson 1987), Camelina has produced better stands, weed control, and yields when planted in the winter with a cover crop compared with seeding after conventional tillage in the spring or surface seeding on bare ground in the fall. These data indicate that Camelina is highly compatible with cover crops used for fall and early spring soil erosion control.

Fertilizer and Water Needs, Insects and Diseases

The soil fertility needs of Camelina are likely similar to those of other crucifers with the same yield potential. Camelina has been shown to respond to nitrogen similarly to mustard or flax (Robinson 1987).

Bramm et al. (1990) found that Camelina was better able to compensate for early water deficits than flax or poppy. This drought-avoidance characteristic might make Camelina better suited to drier regions than other oilseeds.

Downy mildew (*Peronospora camelinae*), a white or gray mold on the upper part of the stem is sometimes observed in Camelina (Robinson 1987). Transmission of Turnip Yellow Mosaic virus by Camelina seed has been reported (Hein 1984). However, Camelina has been reported to be highly resistant to blackleg (*Lepotosphaeria maculans*) which is a significant disease problem with canola (Salisbury 1987). Camelina has also been found to be very resistant to *Alternaria brassicae*, compared with turnip rape or swede rape (Grontoft 1986; Conn et al. 1988).

Flea beetle [*Phyllotreta cruciferae* (Goeze)] is also sometimes observed on Camelina, although it is not nearly the problem it is with canola. However, in extensive multi-year small-plot trials, damage due to insects and diseases in Camelina have not been sufficient to warrant control measures (Robinson 1987).

Weed Control

The compatibility of canola with commonly used herbicides is not widely known. In one three-year trial, Camelina was not injured by trifluralin incorporated either in the fall or spring, but yields were not improved over winter-seeded Camelina planted without herbicide (Robinson 1987). No herbicides are currently labeled for use with Camelina, and herbicides would comprise a significant cost of production should any in the future even become labeled for such use. These data however, suggest that the use of preemergence herbicides may not be necessary in Camelina if it is seeded in the winter or very early spring. Winter-seeded Camelina emerges earlier than conventionally seeded Camelina or other cruciferous crops, and normally before any substantial weed germination in the spring. The seedlings are quite cold-tolerant, surviving several freezes in the spring. For example, in one trial, a May 12 frost (-2°C) injured mustard, rape, and flax, but did not affect Camelina (Robinson 1987). Individual Camelina seedlings are fairly small and non-competitive, but this early-emerging, cold-tolerant characteristic, especially when planted at high densities, provides excellent competition with many annual weeds.

Perennial or biennial weeds are likely to be more difficult to control in Camelina. However, the competitiveness of Camelina with annual weeds presents the possibility that Camelina could be grown both without tillage and without preemergence weed control, both significant costs of production and environmental risk-factors.

Utilization

Seed Composition, Oil Content and Meal Quality

The oil content of Camelina seed has ranged from 29 to 39% in our studies. There appears to be some variation for oil content among the cultivars tested (Table 2), but the germplasm has not been widely characterized. Studies in Germany have shown oil content to range between 37 and 41% and seed protein content 23 to 30% (Marquard and Kuhlmann 1986). Camelina appears to be similar in protein content and elemental composition to flax (*Linum usitatissimum* L.), with the exception of a higher sulfur content (Robinson 1987). Camelina meal is comparable to soybean meal, containing 45 to 47% crude protein and 10 to 11% fiber (Korsrud et al. 1978).

Zero to trace levels of volatile isothiocyanates have been found in Camelina meal (Peredi 1969; Korsrud et al. 1978; Sang and Salisbury 1987) compared with crambe (*Crambe abyssinica* Hochst) or industrial rapeseed meal which contains substantially higher levels of glucosinolates. Laboratory mice fed Camelina meal gained less weight than those fed casein or egg control diets, but more than those fed crambe meal (Korsrud et al. 1978). Although some essential amino acids may have been limiting in the Camelina meal diets, some growth depressing factor other than glucosinolates may have been present (Korsrud et al. 1978).

Camelina has been fed to wild (Fogelfors 1984) or caged (Mabberly 1987) birds, and this is one potential use. Other potential uses include applications as an ornamental, a cover or smother crop, a border row for experimental field plots, or in dried flower arrangements (Robinson 1987).

Fatty Acid Composition and Use of the Oil

Oil was extracted from Camelina and other oilseeds by the Soxhlet method using diethyl ether, and fatty acids determined using the method of Enig and Ackerman (1987). The fatty acids in Camelina oil are primarily unsaturated, with only about 12% being saturated (Fig. 2). About 54% of the fatty acids are polyunsaturated, primarily linoleic (18:2) and linolenic (18:3), and 34% are monounsaturated, primarily oleic (18:1) and eicosenoic (20:1) (Table 6).

Our values for fatty acid composition of *Camelina sativa* are generally similar to those reported for *Camelina rumelica* (Umarov et al. 1972), or other reports on *Camelina sativa* (Seehuber and Dambroth 1983). With its low saturated fat content Camelina oil could be considered a high quality edible oil, but it is also quite highly polyunsaturated, which makes it susceptible to autoxidation, thus giving it a shorter shelf life. With an iodine value of 144, it is classified as a drying oil (Robinson 1987). Camelina oil has been used as a replacement for petroleum oil in pesticide sprays (Robinson and Nelson 1975).

Camelina oil is less unsaturated than linseed (flax) oil and more unsaturated than sunflower or canola oils (Fig. 2, Table 6). The balance of saturated vs. unsaturated fats is similar to that of soybean, but Camelina contains significantly higher proportion of C18:3 fatty acids. Camelina seems to be unique among the species evaluated in having a high eicosenoic acid content in the oil, but the potential value or disadvantage of this is currently unclear.

The erucic acid content is probably too low for use in the same applications as crambe or high erucic acid rapeseed, where a high erucic acid content is desired. Most of the camelina lines evaluated contain 2 to 4% erucic acid (Table 6), which is greater than the maximum (2%) limits for canola-quality edible oil. However, in a preliminary germplasm screen, we have identified lines with zero erucic acid content (data not shown), so it is likely that this trait could readily be removed through plant breeding, as it has been with canola.

The lack of clear utilization patterns for Camelina oil currently limits its use. The fatty acid composition does not currently uniquely fit any particular use. Manipulation of Camelina fatty acid content, which has been achieved in other oilseeds, could greatly improve the utilization possibilities of this crop.

Suitability for Sustainable Agriculture

When analyzing the potential role of a new crop, *unique* attributes of that species must be established; it must contribute something not already provided by existing crop species. It is not sufficient, for example, for a crop simply

to become "another oilseed." There must be unique and compelling properties of that crop to provide incentives for further development.

The research reported here has shown that Camelina possesses unique agronomic traits which could substantially reduce and perhaps eliminate requirements for tillage and annual weed control. The compatibility of Camelina with reduced tillage systems, cover crops, its low seeding rate, and competitiveness with weeds could enable this crop not only to have the lowest input cost of any oilseed, but also be compatible with the goals of reducing energy and pesticide use, and protecting soils from erosion. Camelina is a potential alternative oilseed for stubble systems, winter surface seeding, double cropping, or for marginal lands. At a seeding rate of 6 to 14 kg/ha, Camelina could be inexpensively applied by air or machine-broadcast in early winter or spring on stubble ground without special equipment. Although these unimproved lines have been shown to be agronomically acceptable, modern history has indicated the Cruciferae to be highly manipulatable through plant breeding or biotechnology, and so the promise of improvement is also high. The meal does not contain glucosinolates, but the fatty acid composition of the seed needs to be modified to provide a role for the crop in the oilseeds market.

Lack of clear utilization patterns currently limit the crop, and further work on oil, meal, and seed use is required. The possibilities of using Camelina in human food, as birdseed, as an edible or industrial oil, a fuel, or other applications remains largely unexplored. Further utilization and breeding research is required to more fully make use of the unique agronomic qualities that this crop possesses.

References

- Bramm, A., M. Dambroth, and S. Schulte-Korne. 1990. Analysis of yield components of linseed, false flax, and poppy. Landbauforschung Volkenrode 40:107-114.
- Conn, K.L., J.P. Tewari, and J.S. Dahiya. 1988. Resistance to *Alternaria brassicae* and phytoalexin-elicitation in rapeseed and other crucifers. Plant Sci. (Irish Rep.) 55:21-25.
- Downey, R.K. 1971. Agricultural and genetic potential of cruciferous oilseed crops. J. Amer. Oil Chem. Soc. 48:718-722.
- Downey, R.K. 1990. Canola: A quality Brassica oilseed, p. 211-215. In: J. Janick and J.E. Simon (eds.). Advances in new crops. Timber Press, Portland, OR.
- Einig, R.G. and R.G. Ackerman. 1987. Omega-3 PUFA in marine oil products. J. Amer. Oil Chem. Soc. 64:499.
- Enge, G. and G. Olsson. 1986. Svavlof varieties release for cultivation in the period 1886-1986. Sveriges Utsadesforenings Tidskrift (Sweden) 96:220-235.
- Fogelfors, H. 1984. Useful weeds? Part 5. Lantmannen (Sweden) 105:28.
- Grontoft, M. 1986. Resistance to *Alternaria* spp. in oil crops. Sveriges-Utsadesforenings Tidskrift (Sweden) 96:293.
- Grummer, G. 1961. The role of toxic substances in the interrelationships between higher plants, p. 226-227. In: Mechanisms in biological competition. Academic Press, New York.
- Hein, A. 1984. Transmission of turnip yellow mosaic virus through seed of *Camelina sativa* (gold of pleasure). Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz 91:549-551.
- Hymowitz, T. 1990. Soybeans: The success story, p. 159-163. In: J. Janick and J.E. Simon (eds.). Advances in new crops. Timber Press, Portland, OR.
- Kartamyshev, B.G. 1985. The development of oil crop breeding on the Don. Selektsiya i Semenovodstvo (USSR) 6:9-11.
- Knorzer, K.H. 1978. Evolution and spread of Gold of Pleasure (*Camelina sativa* S.L.). Bererichte der Deutschen Botanischen Gesellschaft 91:187-195.
- Korsrud, G.O., M.O. Keith, and J.M. Bell. 1978. A comparison of the nutritional value of crambe and camelina seed meals with egg and casein. Can. J. Anim. Sci. 58:493-499.
- Lovett, J.V. and H.F. Jackson. 1980. Allelopathic activity of *Camelina sativa* (L.) Crantz in relation to its phyllosphere bacteria. New Phytol. 86:273-277.
- Lovett, J.V. and A.M. Duffield. 1981. Allelochemicals of *Camelina sativa*. J. Appl. Ecol. 18:283-290.
- Mabberley, D.J. 1987. The plant book. A portable dictionary of higher plants. Camb. Univ. Press, New York.
- Marquard, R. and H. Kuhlmann. 1986. Investigations of productive capacity and seed quality of linseed dodder (*Camelina sativa* Crtz.) Fette Seifen Anstrichmittel (Germany) 88:245-249.
- Mirek, Z. 1981. Genus *Camelina* in Poland--Taxonomy, distribution and habitats. Fragmenta Floristica et Geobotanica. Ann. 27:445-507.
- National Research Council (NRC). 1989. Alternative Agriculture/Committee on the role of Alternative Farming Methods in Modern Production Agriculture. National Academy Press, Washington, DC.
- North Central Regional Technical Committee NC-121. 1981. Weeds of the North Central States. North Central Regional Res. Pub. 281. Bul. 772. Agr. Expt. Sta., Univ. Illinois, Urbana-Champaign.

- Peredi, J. 1969. Fatty acid composition of the oils of Hungarian rape varieties and of other cruciferous plants, and the contents of isothiocyanates and vinyl thiooxazolidon of the their meals. Olag Szappan Kozmetika 18:67-76.
- Robinson, R.G. 1973. The sunflower crop in Minnesota. Ext. Bul. 299. Agr. Ext. Serv., Univ. of Minnesota, St. Paul.
- Robinson, R.G. 1987. Camelina: A useful research crop and a potential oilseed crop. Minnesota Agr. Expt. Sta. Bul. 579-1987. (AD-SB-3275).
- Robinson, R.G. and W.W. Nelson. 1975. Vegetable oil replacements for petroleum oil adjuvants in herbicide sprays. Econ. Bot. 29:146-151.
- Salisbury, P.A. 1987. Blackleg resistance in weedy crucifers. Cruciferae Newsl. 12:90.
- Sang, J.P. and P.A. Salisbury. 1987. Wild Crucifer species and 4-hydroxyglucobrassicin. Cruciferae Newsl. 12:113.
- Seehuber, R. and M. Dambroth. 1983. Studies on genotypic variability of yield components in linseed (*Linum usitatissumum* L.), poppy (*Papaver somniferum* L.) and *Camelina sativa* Crtz. Landbauforschung Volkenrode (Germany) 33:183-188.
- Seehuber, R. and M. Dambroth. 1984. Potential for the production of industrial raw materials from home-grown oil plants and prospects for their exploitation. Landbauforschung Volkenrode 34:174-182.
- Seehuber, R., J. Vollmann, and M. Dambroth. 1987. Application of single-seed-descent method in false flax to increase the yield level. Lanbauforschung Voelkenrode (Germany) 37:132-136.
- Umarov, A.U., T.V. Chernenko, and A.L. Markman. 1972. The oils of some plants of the family cruciferae. Khimiya Prirodnykh Soedinenii (USSR) 1:24-27.

Table 1. Comparison of Camelina with other oilseeds[z].

Species	Yield (kg/ha)[y]	Oil (%)	Seed size (g/1,000 seeds)	Maturity date	Lodging (%)
Camelina sativa	1277	31	0.6-1.2	7/1-7/28	20-30
Crambe abysinica	1317	32	6-8	7/15-8/10	30-50
Brassica napus	1273	39	2.9-4.0	8/1-8/20	40-80
Brassica hirta	1319	24	4.8-5.1	7/20-8/3	20-80

[z]Data from trials conducted 1960-1985 in Rosemount and Roseau, MN; 9 year/location means (Robinson 1987).
[y]Yields of some species, especially B. napus *have improved due to plant breeding efforts since these trials were conducted. Yields of all cruciferae were at least 50% higher at Roseau (near Canada) vs. Rosemount in these trials.*

Table 2. Yield and characteristics of *Camelina sativa* lines grown in Rosemount, Minnesota, 1991.

	Days from planting to						
Line (origin)	Full bloom	Maturity	Height (cm)	Lodging rating[z]	1,000 seed weight (g)	Seed yield (kg/ha)	Oil (%)
C028 (USSR)	42	77	58	7.2	1.08	1007	37.5
C037 (Germany)	45	79	67	3.4	0.98	1085	35.3
C046 (Germany)	45	78	63	1.6	1.14	1159	37.3
C053 (Germany)	46	80	64	4.2	0.72	1065	36.4
C054 (Germany)	45	81	68	1.0	1.22	1140	35.1
C082 (Germany)	45	80	67	3.1	0.94	1218	35.9
C088 (Germany)	45	79	60	2.4	0.83	1148	35.5
'Robbie' (USA)	46	78	56	1.5	0.65	1067	34.3
LSD (P<=0.05)	2	1	6	1.8	0.10	173	2.4
C.V. (%)	4	2	6	39	7	11	---

[z]1 = no lodging; 10 = severe lodging.

Table 3. Comparison of winter-sown Camelina with spring-sown Camelina and flax.

				Seed yield (kg/ha)					
Crop[z]	Sowing date	Sowing rate (kg/ha)	Tillage	Weed control (%)[y]	1970	1971	1972	1973	Ave.

Camelina	Early Dec.	12	No	77	862	840	1243	1747	1176
Camelina	Mid-April	8	Yes	69	762	840	1288	1725	1154
Flax	Mid-April	56	Yes	76	963	336	952	1848	1019
LSD (P<=0.05)				202	157	146	146	78	

[z]Camelina was grown without herbicides and flax was sprayed with dalapon and MCPA. Data from Robinson (1987).

[y]Percent of weeds controlled estimated by visual rating (100 = least weedy).

Table 4. Effect of tillage, seeding method, and time of seeding on Camelina and flax, Rosemount, Minnesota, 1990-91.

		Days from planting to					
Treatments	Stand (%)	Full bloom	Maturity	Lodging rating[z]	Weeds (%)[y]	Height (cm)	Seed yield (kg/ha)
No-till stubble							
Flax winter scatter	4	6/15	7/21	1	100	52	91
Flax spring scatter	35	6/15	7/22	1	75	51	801
Flax spring machine	98	6/15	7/22	1	61	47	851
Camelina winter scatter	93	6/1	6/28	1	16	59	749
Camelina spring scatter	64	6/9	7/7	1	48	41	1008
Camelina spring machine	100	6/13	7/12	2	63	52	888
Tilled							
Flax winter scatter	3	6/14	7/21	1	100	51	142
Flax spring scatter	68	6/12	7/21	1	80	56	837
Flax spring machine	100	6/14	7/21	2	85	53	937
Camelina winter scatter	71	6/1	6/30	2	51	60	850
Camelina spring scatter	95	6/12	7/8	2	34	57	1147
Camelina spring machine	98	6/11	7/9	2	42	55	865
LSD (P<=0.05)	28	4	3	n.s.	36	15	312
C.V. (%)	27	22	15	50	32	17	28

[z]1 = no lodging; 10 = severe lodging.

[y]Weed pressure estimated by visual rating, with 100 = most weedy, 0 = least weedy.

Table 5. Influence of a cover crop on winter-sown Camelina performance.
Camelina was planted broadcast-sown in early December on either bare ground or on flax stubble sown in late August or early September; data from Robinson (1987).

					Seed yield (kg/ha)			
Treatment	Stand (%)	Maturity	Weed control (%)[z]	Lodging (%)	1971	1972	1973	Ave.
No cover crop	77	7/11	78	37	840	1243	1747	1277
Flax cover crop	89	7/9	83	18	1120	1176	1870	1389
LSD (P<=0.05)	---	---	---	---	157	146	146	90

[z]Percent of weeds controlled estimated by visual rating (100 = least weedy).

Table 6. Fatty acid composition of Camelina compared with 5 other oilseeds, grown at Rosemount, Minnesota, 1991.

	Fatty acid content (% of oil)

Fatty acid	Canola	Soybean	Sunflower	Crambe	Flax	Camelina
Palmitic (16:0)	6.19	10.44	6.05	2.41	5.12	7.80
Stearic (18:0)	0	3.95	3.83	0.40	4.56	2.96
Oleic (18:1)	61.33	27.17	17.36	18.36	24.27	16.77
Linoleic (18:2)	21.55	45.49	69.26	10.67	16.25	23.08
Linolenic (18:3)	6.55	7.16	0	5.09	45.12	31.20
Arachidic (20:0)	0	0	0	0.50	0	0
Eicosenoic (20:1)	0	0	0	2.56	0	11.99
Erucic (22:1)	0	0	0	54.00	0.88	2.80
Other FA	4.38	5.79	3.5	6.01	3.80	3.40

Fig. 1. Camelina plant nearing maturity. Camelina superficially resembles flax.

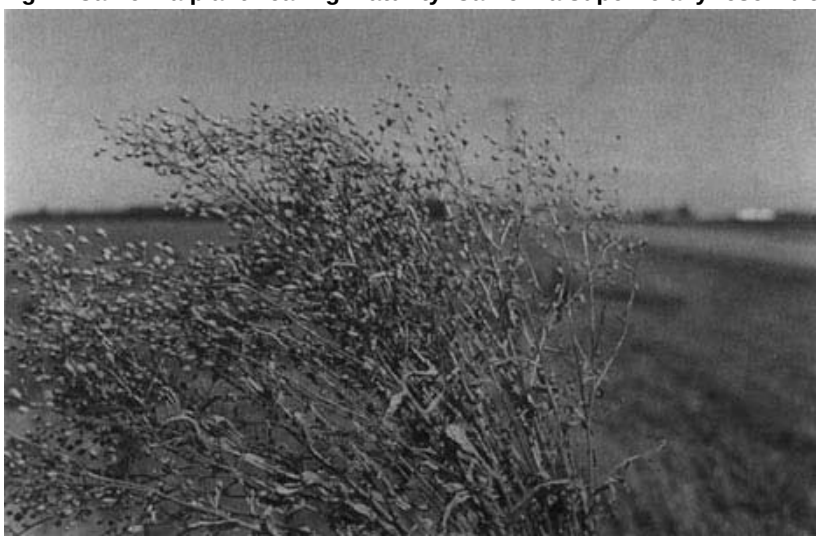
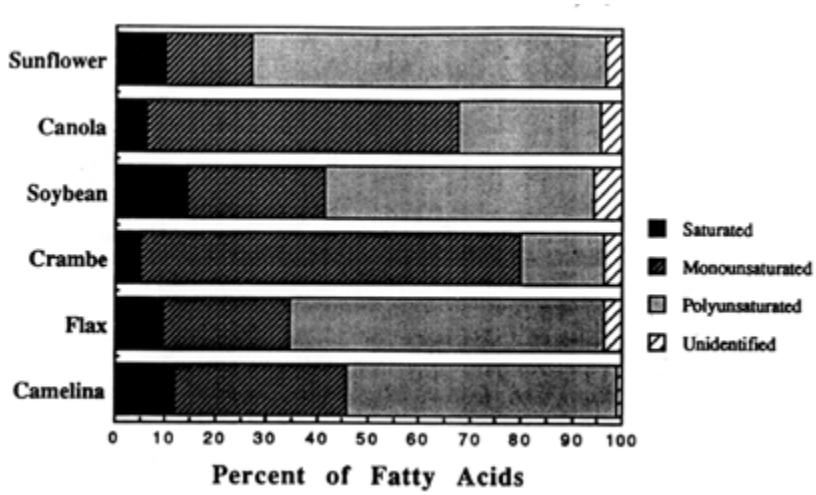


Fig. 2. Percent saturated and unsaturated fatty acids in Camelina compared with other oilseeds grown at Rosemount, Minnesota, 1991. Unidentified fatty acids are those which did not match standards. Camelina is similar to soybean in balance of saturated vs. unsaturated fats, but is higher in C18:3 fatty acids.



Camelina: All-star crop for all-star producers

Staff Reporter, The Prairie Star, Monday, March 5, 2007

BIGFORK, MT - Area growers know spring training is almost over and the big game is about to begin. The days are growing longer; planting is just around the corner. Good farmers are finding their seed, making final equipment repairs and getting that seed in the ground.

Camelina is the new game in town and it can't be beat.

Tested throughout Montana, Camelina offers farmers a home run in crop rotation benefits, guaranteed cash and a growing market. In fact, Great Plains – The Camelina Company wants to contract as many acres as Montana farmers will grow for biodiesel. And they will pay for the privilege of helping producers join the big leagues.

Farmers who contract with Great Plains – The Camelina Company will receive $45 an acre when the crop is in the bin. The total contract calls for nine cents a pound, with an average yield of 1,200 to 1,500 pounds per acre. Conrad farmer Steve Keil, who has already grown the dryland crop for two years, averaged about 2,400 pounds per acre when he seeded it correctly.

And for once, farmers will be treated as pros. Producers who sign up by March 15 will receive an additional $10 an acre signing bonus.

Native to northern Europe, Camelina is in the same family as mustard and canola. Yet its yields are better and it requires very few expensive inputs.

"For four years, Montana State University put all of the oilseeds in a horse race for cost efficiency and returns. At seven research centers, Camelina won hands down," said Duane Johnson, vice-president of agricultural development for Great Plains. Johnson recently stepped down as director of the Montana State University Agricultural Innovation Center where he helped develop Camelina as an alternative crop that fits well in small grains rotations.

Johnson recently conducted packed Camelina grower meetings at Fort Benton, MT, Shelby, MT, and Havre, MT, where enthusiastic producers were eager to learn more.

"As spring planting plans are now being made, Great Plains' mission is to provide a guaranteed cash contract marketing base so Camelina becomes a sustainable alternative crop for Montana," Johnson said.

Camelina needs very little nitrogen or moisture. "If you have a two-inch moisture base on Jan. 1 and you get 6 inches of moisture sometime from January through June, you're good to go," Johnson said.

The secret to increasing yields is to get the seed in the ground early.

MSU research shows yields cut in half with late seedings. Seed that was no-tilled and packed by March 15 yielded 1570 pounds while a crop planted the same way by April 20 only produced 750 pounds per acre.

"You need to plant it early and no-till or minimum till is the answer," said Keil. "You need a firm seed bed."

Great Plains - The Camelina Company - knows experienced insights will make or break any new crop so the company has teamed with local Certified Crop Advisor Brad Birch and his business partner Nina McCracken at Dryfork Ag to help producers from planting to harvest.

"Northern Montana growers are excited about how well Camelina fits into their current crop rotation," said McCracken. "It has been successfully grown by many Montana farmers and at many of the Montana State University research centers, so we have a wealth of agronomic information to be able to help first-time growers."

“We are pleased to have the opportunity to provide Montana growers with a new and profitable cropping option,” said Birch. “We share Great Plains’ vision that this cold-tolerant, low-input oilseed crop grown by top Montana growers will make Camelina ‘The Future of Fuel.’”

Great Plains - The Camelina Company - has an exclusive contract with Peter Cremer, one of the largest biodiesel producers and marketers in the United States, for the entire oilseed processed. In preparation for the Camelina harvest, Great Plains has committed to building oilseed crushing facilities before the end of 2007, which will initially employ 12-14 people. A second site has been selected in the Judith Basin of Montana area and will receive the oilseed in 2008.

“Camelina oil fits perfectly into our premium branded nexsol™ biodiesel and we could use more of it this year than could possibly be produced,” said Ray Bitzer, Peter Cremer North America president. “We believe in Great Plains’ mission and the State of Montana and that is why we have provided Great Plains with an exclusive contract for as many acres as Montana growers are willing to plant this spring.”

To learn more about Great Plains - The Camelina Company, Camelina contract specifics, or for information on upcoming grower meetings in MT, visit www.CamelinaCompany.com, call toll-free 1-877-922-6645, call Duane Johnson directly at 406-471-0671, or e-mail him at duane.johnson@CamelinaCompany.com. Growers in the Ledger, MT, area may call Brad Birch or Nina McCracken at 406-278-3388, or stop in and visit them at their Dryfork Ag office.

Crazy for Camelina

By Nicholas Zeman, Biodiesel Magazine

Montana Gov. Brian Schweitzer has referred to Camelina as his new girlfriend. Although he can't put his arm around her, he believes that Camelina Sativa, a plant known primarily in North America as a weed, has potential as a feedstock for biodiesel production could be just the ticket to revive the economy in eastern Montana.

Recently a crop has surfaced for Montana growers that responds well to northerly climes, can be grown on marginal lands and is high in oil content, which may help the state break into biodiesel production. Its appearance seems to have been so magical, in fact, that it has been referred to as a "fairy tale" in the state press. Among those with high hopes for Camelina is Montana Gov. Brian Schweitzer, who is also an agronomist.

Camelina originates from an area ranging from central Europe to Turkey, and has been produced there and used as cooking oil. Although it has been researched for the past two years as a biodiesel feedstock, it has essentially no cultivation history in North America. Often called "gold of pleasure," the crop has high potential for the "Big Sky" country, the governor says. Less than 18 months ago, most people (outside of researchers) weren't even aware of the existence of Camelina, he says. "What we do know is that when everything clicks, you can make out some nice yields with the stuff," Schweitzer says.

Farm subsidy programs supporting commodity crops throughout the world have severely reduced Camelina production, Schweitzer says. In particular, he blames U.S. trade practices that provide economic incentives for certain crops like wheat. The crops are then exported at prices so low that it puts overseas farmers out of business. Schweitzer believes this practice is wrong, especially when there are crops available that can contribute to the nation's energy-efficiency and environmental conservation. It's time for the United States to start making different choices and to start growing different crops, says Schweitzer, who was described in a Denver Post article as "a 6-foot-2-inch back-slapping, bear-hugging guy's guy, who gave his wife a revolver for her birthday and takes his dog to the office—every day." The article also called Schweitzer an expert on renewable resources.

"I run a car on only biodiesel, not biodiesel mixed with petroleum" Schweitzer says. "I'm off oil. All the people that we have fighting to protect the dictator's oil could be home making our own fuels right now."

Camelina's Characteristics

Camelina has been grown since ancient times and was commonly cultivated in Europe during the Iron Age for its oil-supplying characteristics, according to Great Northern Growers, a food producing cooperative based in Montana. The seeds were collected, crushed and boiled in water, and the oil was used for lamp fuel and ointment among other things. It was cultivated in antiquity from Rome to southeastern Europe and the southwestern Asian steppes.

Considering its history and the fact that Camelina is higher in oil content than canola or soybeans, it seems strange that the crop is basically unknown to commercial farming in the United States. Other than the subsidization of some commodity crops, it is suggested that Camelina, with its high content of unsaturated fatty acids, was more difficult and expensive to hydrogenate than canola and rapeseed, which may have been another factor that led to its dismissal.

Duane Johnson, superintendent of the Northwestern Agricultural Research Center in Havre, Mont., learned of Camelina when he was looking for an oilseed crop with reduced input requirements that was capable of growing on marginal land. "The advantage with Camelina is that it's a superior product for lubricants," Schweitzer says. "For health purposes, its level of omega-3 is as high as fish oil."

This low-input, high-yielding oilseed contains about 34-36% omega-3 oil and is also high in gamma tocopherol, a superior vitamin E that acts as an antioxidant. Antioxidants give oils a longer shelf life, which should make it a superior feedstock for the biodiesel industry.

The plant appears to be able to adapt to different climates and soil types. The arrow-shaped leaves have smooth edges and are five to eight centimeters long. Johnson considers Camelina a replacement for fallow, and a crop that could be used in rotation with spring wheat, which can only be grown on the same ground every other year. Supporting research confirms that following small grains in a rotation is ideal for this oilseed.

Production expenses vary, but based on Montana data, variable and fixed costs are $45-68 per acre—between one-third and one-fourth the cost of growing canola, another feedstock that is gaining in popularity in the biodiesel industry. “This is a low-input crop that doesn’t have to compete with the food industry, and could add about 4 million acres of production to Montana agriculture,” Johnson says. “So we’re really excited.”

Camelina yields average 1,200-1,400 pounds per acre. However, the minuscule size of the seed could cause problems with handling. It takes 345,000-465,000 seeds to make a pound, but the seed is dense and weighs 50 pounds a bushel. “Camelina looks like canola,” Schweitzer says. “It’s a brassica, which is the same family, and it’s a little smaller seed, but you crush it the same way.”

The crop can be grown at a variety of elevations, which is an important quality for Montana producers. Also, there are millions of Conservation Reserve Program (CRP) acres and fallowed land in the state that could support Camelina production. CRP landholders currently receive a $40 payment for each acre, Johnson says, but the program is winding down.

Necessity and Invention

Schweitzer earned a bachelor’s degree in international agronomy from Colorado State University, and later a master’s degree in soil science from Montana State University. He has owned and operated farms in several Montana counties and has been involved in successful agricultural business projects on five continents. He has also provided the encouragement that’s necessary to overcome the risks involved in agricultural experimentation.

“I think we certainly have the support of the governor,” Johnson says. “He wants to revive the economy in the eastern part of the state, and we see oilseeds as a crop for biodiesel production.” There are efforts underway and funds available to acquire the resources necessary to jump-start biodiesel production. “We already have a place in Culbertson where we can crush, but we’re putting together additional plants,” Schweitzer says. “There’s an 8 million-gallon plant being built in Havre, and there’s a company that plans on operating mobile plants and contracting with farmers to grow and crush all over Montana.”

The Montola Growers Inc. oilseed processing plant in Culbertson, Montana, now operated by Sustainable Systems LLC, has a storage capacity of 1.2 million bushels. It is located on the Burlington Northern-Sante Fe Railway main line and has a crushing capacity of about 600 pounds per hour, according to Montola’s Web site. “They’ve been struggling for years,” Johnson says. “But they’re putting in a biodiesel plant there, and that should help them.”

There could be as many as four other companies locating biodiesel operations in Montana, Johnson says. Montana is building administrative and political support to help these plants get started. “We got a $15 million grant from the labor department that we’ve called the Montana ‘agri-energy project map,’” Schweitzer says. Johnson adds, “We will distribute those dollars all over Montana to help farmers start their own biodiesel plants.” These plants would be small, allowing farmers to crush the crops that they grow, make their own biodiesel and use it in their tractors. “We don’t need Exxon-Mobil,” Johnson says. “We can do it ourselves,” he says.

The need for new crops in Montana to stimulate the economy is what drove Johnson’s prolific series of experiments. “People say he discovered Camelina,” Schweitzer says. “They don’t know the work that went into it because they haven’t been to his experiment station. You name it, he’s tried it." No matter how much research is conducted Camelina production won’t catch on until farmers are convinced to convert acreage away from traditional crops—a tough obstacle. “Farmers don’t respond to ‘new’ and ‘different’ very well,” Johnson says. But there is less risk in this situation considering the experience that Johnson and Great Northern Growers have gained, which can be shared with others. “There’s less to be afraid of,” Johnson says.

MSU Researchers Say New Crop Could Produce Affordable Biodiesel

by Walt Williams, May 19, 2005, Bozeman Daily Chronicle

It's a gamble that farmer Bruce Wright believes is worth taking.

For the first time this year, Wright planted 50 acres of the European oilseed Camelina on his farm along Springhill Road.

The reason? The plant is loaded with omega-3 fatty acids, which are good for the heart, and that's something people will pay for.

"It's got a lot of properties that sound like they can be very beneficial," he said. But Montana State University researchers see another benefit.

Camelina can be used to make biodiesel, an environmentally friendly alternative to diesel fuel. And they say it can be produced for much less than other biodiesel crops, for the first time making the fuel competitive in price with its petroleum counterpart.

Soaring gas prices at the pumps have led to renewed interest in alternative fuels as a way of curbing the nation's reliance on foreign oil. President Bush visited a biodiesel plant in West Virginia Monday to encourage the development of biodiesel and ethanol. Ethanol is blended with gasoline so it will burn cleaner.

In Montana, state lawmakers recently passed a law requiring all gasoline to be blended with 10 percent ethanol.

Alternative fuels are a major focus of MSU's Institute for Biobased Products, which is developing crops that can be used to make biodiesel, ethanol and biolubricants to replace motor oils.

The institute sees a lot of promise in Camelina, which is new to Montana but has been grown in Europe for a long time. The state's cool and dry climate is well suited for growing the crop.

"We believe it has the potential to be substantial crop in Montana over the next year," said Gary Iverson, executive director of the Great Northern Growers Cooperative, whose members have planted about 700 acres of the oilseed in their fields this year.

Still, the potential Iverson sees in Camelina is as a food crop. Its healthy oil is more likely to end up in frying pans than in fuel tanks, and the meal made from it can be fed to livestock and fish to increase their omega-3 levels.

"What people should really be doing with Camelina is eating it, not making biodiesel out of it," MSU plant pathologist and institute co-director Alice Pilgeram said, explaining the problem with marketing the plant as a fuel crop.

Currently farmers can make more money selling camelina as a crop to eat rather than a fuel to burn, she said.

Biodiesel made with traditional crops -- such as soy -- costs around $3 a gallon at the pumps. But biodiesel made from Camelina could be sold for $2 a gallon, bringing it in line with regular diesel.

Regardless whether Camelina lives up to its promise, the institute sees a bright future for biobased products.

Former director Duane Johnson has already developed several biobased hydraulic oils for motor vehicles, substances he said are biodegradable and are as much as 370,000 times less toxic than an equal amount of petroleum.

"We got everything you need to really make a vehicle operate," he said.

The problem remains price. Biobased lubricants are more expensive than their petroleum counterparts.
But Johnson said consumers will make up that cost through longer engine lives and cleaner emissions.

"When you put it all together, we are cheaper than petroleum even though you pay a little more up front," he said.

Researcher says Camelina is oilseed industry's Cinderella this year

By SHANNON BURKDOLL, Farm & Ranch Guide, Thursday, July 21, 2005

HAVRE, MT - Last year, no one knew it's potential or that it even existed.

This year, on the other hand, it has been a fairy tale experience for the Camelina oilseed crop, according to Duane Johnson, MSU agronomist and Northwestern Agricultural Research Center superintendent. "A year ago, no one knew about it. This year, Camelina is the Cinderella crop," said Johnson at the Northern Agricultural Research Center tour in Havre, MT.

Camelina is an oilseed crop marketed for its edible oils and bio-diesel potential. "Camelina has a high content of Omega 3, which is the healthier type of oil," explained Johnson. "In Europe, Camelina oil sells for $20 per gallon, but we can make it for $1 per gallon. It is also cheap for making bio-diesel."

Other Camelina uses in which Johnson is researching include feeding the byproduct to fish, chickens and cattle. "The omega-3 component has increased by four-fold the byproduct's potential as fish food," he said. "It should make fish farming interesting. We've also sent some byproduct to Georgia to feed to chickens and tested the omega-3 level increases in eggs, and there is currently some research going on here in Havre of feeding the byproduct to cattle to make beef even more healthy to eat."

Montana currently leads the Camelina market in production.

"We, Montana producers in the Great Northern Growers group, are the leaders in Camelina production with 600 acres scattered around the state," he said. "Right now, the only delivery point for Camelina is in Malta, MT, as we're working with Peaks and Prairies, LLC, now for future opportunities."

Camelina is best grown as part of a wheat rotation. "Camelina crop should be grown one year in three or one year in a four-year rotation as part of a Camelina, to flax, sunflower or safflower rotation scheme with a wheat crop," said Johnson. "As with other oilseed crop rotations, with Camelina you not only get the byproduct, but also weed control."

In addition to studying potential uses for Camelina, Johnson has been involved in canola, safflower and sunflower market research in the edible and motor oil markets, as well as bio-diesel and dust suppressants. Johnson also developed a hand lotion, named Crème de Bobcat with lavender scents, from crude safflower oil.

There are multiple uses for canola oil with a lot of lubricant work and bio-diesel potential said Johnson. "Unfortunately, you'd need 12 cents per gallon to break even with the bio-diesel," he said. "We are already developing some motor oil products and several other canola oil products like hydraulic oil, bar-chain oil and we need a patent on canola-based grease."

One drawback to canola production is its lower return per acre when compared to wheat production as it costs more for canola seed and fertilizer as well as harvest costs.

"When you look at the inputs and returns, you can break even with spring wheat at $1.81 per bushel," said Johnson, "but it takes $4.33 per bushel to break even in canola production. Camelina production needs $1.23 for a break-even price."