

Historical and botanical evidence of distribution, cultivation and utilization of *Linum usitatissimum* L. (flax) in China

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Abstract *Linum usitatissimum* L. (flax) has been cultivated for more than 2,000 years in China. Throughout the history of its cultivation, flax was mainly used for oil and medicine. It was not until the last 100 years that fibre flax began to be cultivated and used. This paper discusses the distribution, cultivation and use of flax in China especially in the past, based on literature reviews and ethnobotanical surveys for its traditional uses. The modern distribution of wild flax species in China is also presented in this paper.

Keywords Ancient China · Flax · Cultivation ·
Linum usitatissimum · Medicines · Oil

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Introduction

Linum usitatissimum L. (flax) is an ancient textile fibre and oil crop that has been divided into three types: oil flax, fibre flax and oil-fibre flax, based on their agronomic traits and practical use. Kvavadze et al. (2009) reported an identification of 30,000 year old wild flax fibres from a series of Upper Palaeolithic layers at Dzudzuana cave, Georgia, which should be the oldest evidence for people using flax fibres. However, it is widely known from archaeobotanical evidence that the use of flax in human history can be traced back to more than 8,000 years ago (van Zeist and Bakker-Heeres 1975). According to ancient written sources, flax has been used in China for more than 2,000 years and was called “Huma”, “Yama” (Li and Liu 1982) and “Bishi (tick, an arachnid Huma)” (Chen 1983; Wu et al. 2007). In some areas of China, oil flax was known as “Huangma” (Xu 2004) (in fact, a mistaken pronunciation of “Huma”). The name “Huma” is still used today. The records of “Huma” in ancient China referred to oil flax only, because fibre flax was not introduced to China until the beginning of the 20th century (Li et al. 2006).

Materials and methods

Ancient literature relating to flax in China has been investigated. In total over 60 copies of books, archives, handwritten documents and records were checked carefully. The most important literature was double-checked, including *Ben Cao Gang Mu* (Li 1999), *Shen Nong Ben Cao Jing* (or *Shên Nung Pên Ts'ao Ching*) (Wu et al. 2007), *Zhi Wu Ming Shi Tu Kao* (Wu 1848), *Ben Cao Yan Yi* (K'o Fêng-shih 1905), *Si Min Yue Ling* (Shi 1965) and others. Moreover, modern literature, mainly journal articles, was checked

carefully to discover the origin of Chinese cultivated flax and the distribution of *Linum* species in China.

We conducted field surveys in the flax growing areas to investigate the traditional uses of flax. These areas cover northeast China, northern China, northwest China, central China and southwest China as well. The ethnic groups we visited included Han, Miao, Yao, Yi, Korean, Uigur, Dong, Buyi, Dai and others. Questionnaires, semi-structured interviews and ethnobotanical approaches were used to collect the information of traditional uses of flax by different ethnic groups.

Results and discussion

Distribution of flax in China

As narrated in the *Flora of China* (Liu and Zhou 2008), there are nine *Linum* species distributed in China. Among them, *L. corymbulosum* and *L. heterosepalum* are found in Xinjiang, *L. altaicum* in mountain meadows, flat or sparse thickets at 600–4,000 m a.s.l in Xinjiang, *L. stelleroides* grows on mountain slopes, along trails and in wastelands at 600–2,800 m a.s.l in as many as 17 provinces and regions, and *L. perenne* on dry mountain slopes, sparse thickets, grasslands, dry plains, sandy and gravelly floodplains below 4,100 m a.s.l. in at least 11 provinces and regions. *L. amurense* and *L. nutans* exist in grasslands, sandy and gravelly floodplains, dry mountain slopes at 600–4,000 m a.s.l in north and northeastern China; *L. pallescens* on dry mountain slopes, sandy and gravelly floodplains, wastelands at 500–1,200 m a.s.l in west China. The cultivated flax, *L. usitatissimum*, is grown throughout China except in Hainan and Taiwan.

The centre of origin of cultivated flax is uncertain, with many existing theories. Some scholars suppose that flax originated from the Near East and Mediterranean littoral while others hypothesize that flax originated in central Asia and in the Near East (Helbæk 1959; van Zeist and Bakker-Heeres 1975; Li and Liu 1982; Guo and Xu 2000). While Allaby et al. (2005) suggested a single domestication origin for modern cultivated flax, based on the analysis of 34 alleles of 2.5 kb sized stearoyl-ACP desaturase II (*sad2*) in 25 samples of cultivated flax, only two of them came from China.

The geographical origin of cultivated flax and the place where Chinese wild flax came from still remains uncertain. Wild flax is mainly distributed in northern, northeastern and northwestern China, in provinces and regions such as Shaanxi, Gansu, Inner Mongolia, Ningxia, Qinghai, Xinjiang, Shanxi and Heilongjiang, while *L. usitatissimum* (cultivated flax) has been planted all over the country (Table 1, Fig. 1). The wild flaxes, grouped into types of

perennials, prostrate or semi-prostrate annuals with multiple stems, mainly grow on slopes, wastelands, humid regions and grasslands at 1,500–2,000 m a.s.l. A few species can even grow in places as high as 3,000–4,000 m a.s.l. such as *L. perenne* and *L. nutans* in Qinghai Province (Table 1). Some wild flax species are very widely distributed in China, such as *L. stelleroides* which occurs in many different provinces from north to south, from west to east (Fig. 1). Among them, *L. stelleroides* and *L. perenne* show important characters similar to those of cultivated flax (Wang and Wu 1983; Mi et al. 2003).

Cultivation history of Chinese flax according to written sources

Oil flax has been cultivated for more than 2,000 years in China (Wu et al. 2007). The earliest flax was planted in 119 B.C. as one of many varieties of crops, and the flax seeds were brought back from the Middle East or Central Asia by Qian Zhang who was a special envoy in the Western Han Dynasty (206 B.C.–A.D. 24) (Li and Liu 1982; Liu et al. 1982). However, many scholars are cautious of this opinion. For example, Minkevich and Borkovskii (1955) said affirmatively in their book *Oil Crops*, based on the analysis of ancient oriental literature, that it was about 5,000 years ago that flax was first cultivated as a fibre crop and then as an oil crop in India and China. Nevertheless, it is true that oil flax was planted during the Western Han and the Eastern Han Dynasties (A.D. 25–220).

The following are records of “Huma” (flax) from a book called *Si Min Yue Ling* by Cui in the 2nd century A.D. (Shi 1965):

February... cold and cloudy day is over, farmland can be tilled ... rice, bean, hemp and “Huma” can be planted.

Season around Qingming Festival (Tomb-weeping Day) (in early April) ..., it rains frequently. Rice, hemp, Hudou (a variety of introduced bean) and “Huma” can be planted.

May ... it rains all the time, “Huma” can be planted (this item might be written for north China).

Cui, the author of *Si Min Yue Ling*, was born in Anping area, Jizhou Prefecture (now Anping County, Hebei Province) and lived in Hebei, Shanxi and Inner Mongolia, as well as in the Liaodong peninsula. In those areas, oil flax is still widely cultivated and the name “Huma” is still used. This shows that “Huma” in Cui’s book referred to oil flax.

In 1930, 20,000 inscribed wooden slips dating from the Han Dynasty were found at a Beacon Tower site of Han in the river Ejinaji valley of Inner Mongolia. Most of the wooden slips were the documents of troops stationed there

Table 1 Distribution of *Linum usitatissimum* L. (cultivated flax) and its relatives in China

Taxon	Distribution	References
<i>L. corymbulosum</i> Reichb.	West and southwest Xinjiang	Huang et al. 1998
<i>L. stelleroides</i> Planch.	Yanbian Prefecture, Jilin Lindian County, Heilongjiang Taibai County, Shaanxi	Li and Jin 1986 Yan et al. 1993 Wang and Wang 2005
	Jiangsu, Guangdong, Hubei, Henan, Hebei, Shandong, Liaoning, Shanxi, Gansu, Inner Mongolia, Qinghai, Sichuan, Guizhou	Huang et al. 1998
<i>L. heterosepalum</i> Regel	Xinjiang	Zhang et al. 2006; Huang et al. 1998
<i>L. perenne</i> L.	Qinghai (3,000–4,100 m a.s.l.) Zhaosu County, Xinjiang (2,200 m a.s.l.) Zhangbei County, Hebei Easily seen in north and northwest China Lijiang or Zhongdian County, Yunnan Shanxi and Inner Mongolia	Yan et al. 1993, Xiao et al. 1978 Zhang et al. 2006 Mi et al. 2003 Wang et al. 2007 Wu 2000 Huang et al. 1998
<i>L. amurense</i> Alef.	Xianyang, Shaanxi Northeast China, Inner Mongolia, Gansu, Ningxia, Qinghai	Wang and Wang 2005 Huang et al. 1998
<i>L. nutans</i> Maxim.	Qinghai (3,000–4,100 m a.s.l.) Inner Mongolia, Ningxia, Gansu, Shaanxi	Yan et al. 1993 Huang et al. 1998
<i>L. pallescens</i> Bunge	Xinjiang Inner Mongolia, Ningxia, Gansu, Shaanxi, Xizang	Zhang et al. 2006 Huang et al. 1998
<i>L. altaicum</i> Ledep.	Xinjiang	Zhang et al. 2006; Huang et al. 1998
<i>L. usitatissimum</i> L.	Cultivated widely or naturalized in China, except for Hainan and Taiwan	Huang et al. 1998; Wang and Wu 1983

Fig. 1 Distribution of *Linum* species in China; symbols and taxa. 1 *L. corymbulosum* Reichb., 2 *L. stelleroides* Planch., 3 *L. heterosepalum* Regel, 4 *L. perenne* L., 5 *L. amurense* Alef., 6 *L. nutans* Maxim., 7 *L. pallescens* Bunge, 8 *L. altaicum* Ledep., filled triangle *L. usitatissimum* L



during the late Western Han and early Eastern Han dynasties. The character “Huma” (oil flax) was clearly recognizable on two of these slips (Wu et al. 2007). The river Ejinaji valley is located in the northwest of China, and its climate is suitable for oil flax cultivation. Even today, flax is still the main oil crop for the local people there. Therefore, the character “Huma” on the Han wooden slips is what oil flax is called there today.

Tao, during the rule of the Liang of the Southern Dynasty, A.D. 502–557, pointed out the difference between sesame (*Jusheng*) and flax: the square stem is *Jusheng*, while the round one is *Huma* (Yang 1991). Therefore, “Huma” is oil flax due to its round stem that differs from sesame. Sesame was easily mistaken for “Huma” in ancient Chinese writing because both have the character *Ma* (fibre).

Flax was also popular in the Gansu Corridor during the Tang Dynasty (A.D. 618–907), since quite a few roads lead directly to Turpan, Xinjiang from the Gansu Corridor through the Qiliang mountains. According to the third book of *Turpan's Document* (reprinted in 1981), many records of “Huma” and “Juehumasuo” were found in Tang Dynasty documents that were unearthed from Tang graves in the north of the village Asitana, Huoyanshan Town, Turpan, Xinjiang Autonomous Region (Yang 1995).

The natural conditions in Turpan, Xinjiang are suitable for cultivating oil flax, but not sesame. Therefore, “Huma” in the above documents should specify oil flax, and “Juehumasuo” the ropes made of the bast of oil flax.

An oil crop planted widely in Dunhuang Region, Gansu Province in the Tang Dynasty, the Five Dynasties (A.D. 907–960) and the early Song Dynasty (A.D. 960–1279) was called “Huangma” (Xu 2004). According to the similarity in phonology of “Huang” and “Hu”, and the morphological characters of “Huangma” recorded in the literature, “Huangma” planted in Dunhuang Region is thought to be “Huma”, oil flax today. Moreover, Su mentioned in his book *Tu Jing Ben Cao* of A.D. 1061 that there was wild “Huma” visible everywhere in Shaanxi Province. This “wild Huma” could have been naturalized from “Huma” (Hu and Wang 1987).

After the Song Dynasty, “Huma” (oil flax) is frequently found in Chinese agricultural texts.

Ben Cao Gang Mu (Li 1999) recorded that the Shaanxi people also planted oil flax and called it “Bishi (tick, an arachnid) Huma”. This showed that Shaanxi Province was also one of the places where oil flax was grown in ancient China. *Zhi Wu Ming Shi Tu Kao* (Wu 1848) noted that “Huma” (oil flax) was planted in Shaanxi and Yunnan provinces under the name of Shanxi “Huma” in this famous literature. Therefore, cultivated oil flax was not only grown in northern China, but also in southern China by the 19th century. Oil flax had already been cultivated

widely in China by the middle of the Qing Dynasty (A.D. 1644–1911).

Presently, in China oil flax is mainly grown in the provinces and autonomous regions such as Hebei, Shaanxi, Inner Mongolia, Gansu, Ningxia and Xinjiang. From 2001 to 2007, the annual acreage and total output of oil flax seed (linseed) in China was 401,200 ha and 362,400 tons, of which the above six provinces and autonomous regions contributed 97.31 and 97.30%, respectively (Zhang et al. 2009).

Fibre flax and oil-fibre flax have a very short cultivation history in China. Fibre flax was introduced from Japan in 1906, while oil-fibre flax was planted much later. Fibre flax is mainly planted in Heilongjiang, Jilin, Xinjiang and Inner Mongolia. Fibre flax was also introduced successfully to southern China in the early 1990s. Now it is planted on a large scale in the winter season in Yunnan and Hunan provinces (Li et al. 2006).

Use of flax in China

Flax was firstly used as medicine in ancient China and then as oil and fibre. Diversified medicinal uses of flax were recorded from ancient China, by which ancient Chinese people contributed much to the development of flax uses.

Medicines

The earliest records of flax as medicine appeared in *Tu Jing Ben Cao* in A.D. 1061 (Hu and Wang 1987). The book said that “Huma”, produced in Yanzhou Prefecture (the border areas among Hebei, Henan and Shandong provinces today) and Weishengjun (Qingxian County, Shanxi Province today), also named as “Yama”, is sweet, slightly warm, non-poisonous, having green leaves and stems and white flowers. The seeds were collected in early August and were used to cure some serious diseases caused by pathogenic wind, showing the functions to dispel pathogenic wind, replenish blood and nourish both the liver and kidneys. *Dian Nan Ben Cao* in 1436 (Lan 1978) reported that flax roots could supplement vigour and darken the hair; the stems could relieve rheumatic pains; the leaves could cure a disease that made people unable to speak due to infection of the mouth. So far, people know that the root, stem and leaf could all be used as medicine in ancient China. People in southern Yunnan Province cook the flax root with chicken and eat it as a tonic food today. *Ben Cao Gang Mu* in 1590 (Li 1999) introduced the medicinal functions of flax as tonifying the five inner organs (heart, liver, spleen, lung and kidney), increasing vigour, good for muscle growth and brain health, moistening dryness and dispelling pathogenic

wind. He suggested using flax to treat skin pruritis, leprosy, vertigo and constipation.

Oil use records

Kou, in his book of A.D. 1116 *Ben Cao Yan Yi* (K'o Fêng-shih 1905), under the article of “Huma” in volume 20, described the methods of making and eating “Huma” oil: heat and press the “Huma” seed into fresh oil that is used only for lighting at first; the fresh oil should be heated again before it turns into edible, matured oil. However, according to modern knowledge, it is certainly not reasonable to heat linseed oil because it destroys the properties of the oil. Li (1999) mentioned that flax seed could be pressed for lamp oil, in his book *Ben Cao Gang Mu* (Li 1999). *Fang Tu Ji*, a book edited in the 16th century, summarized the uses of flax: the seeds produce linseed oil, the oil is good for lighting and smells pleasant for cooking, the stems are used as fuel, and the pressed seed cake fertilizes farmland (Li and Liu 1982). Two books, *Se Xie Cong Tan* of 1830 (Shen 1983) and *Zhi Wu Ming Shi Tu Kao* (Wu 1848) separated sesame from flax by describing morphological features, as well as the uses of flax. *Se Xie Cong Tan* said that “Huma” (oil flax) has slender and short stems, with blue flowers blooming on the top. “Huma” oil is used for lamp oil and makes smells and smoke; it would cause vomiting, tight chest and red face after eating. Although people in far northern China usually use linseed oil for cooking, this oil is produced in remote areas and has a bad smell; it is not good to eat too much of it (Shen 1983). *Zhi Wu Ming Shi Tu Kao* (Wu 1848) described how Shanxi “Huma” has round, yellowish brown thick roots without veins; capsules looked like cardamom (*Amomum compactum* Soland. ex Maton) fruits, and seeds were similar to sesame. People in Yunnan mill it and eat it with noodles. This book also cited from Datong Prefectural Records, Shanxi Province: “Huma” looked like *Dianthus* plants with small bright blue flowers, the seed can be used to produce oil. The oil mills appeared until the middle of the Qing Dynasty (Li and Liu 1982).

Folk uses of Chinese flax

Chinese people often use flax roots, stems and leaves for curing chronic hepatitis, diseases of the testicles, hernia, headaches caused by internal stirring and constipation. Flax seeds were used to get rid of foreign objects dropped into eyes: “rinse and drench the flax seed, insert the seed underneath eyelid, close eyes for a few moments, and take out the flax seed to which the foreign objects stick”. The fresh flax straw is mashed and then externally applied to treat rheumatoid arthritis and soften tumours (Wang 2002). The flax seed alone or mixed with seeds of *Capsella bursa-*

pastoris (shepherd’s purse) and *Lobelia* plants such as *L. sessilifolia* or *L. melliana* is crushed into a mash and used to treat boils. Flax seed tea is used to treat colds, coughs and urinary system ailments. Flax oil, as a relaxation agent mixed with lime water, can treat burns from fire and hot water. When mixed with honey, flax oil is a good cosmetic to remove facial freckles. As an animal medicine, flax oil can treat diarrhoea in sheep and horses. Flax also functions as a natural pesticide to repel insects when planted near potatoes.

Flax bast was also sometimes used to make ropes in ancient China, as shown by quite a few records of flax rope, discovered in ancient documents in excavated tombs from the Tang Dynasty in the north of Asitana village, Huoyanshan Town, Turpan, Xinjiang Autonomous Region (Yang 1995). However, more recently flax fibre has been used for making clothes, bedding, car cushions and art wares in China (Liu and Liu 2006).

Concluding remarks

Linum usitatissimum L. (flax) was named “Huma” in ancient China and has been cultivated there for more than 2,000 years according to written sources. There are at least nine *Linum* species distributed in China, but more studies of archaeobotanical finds from well dated excavations are needed to spell out which species are native. Although many uses are known from books and local peoples, flax was mainly used as a medicine and for its oil in ancient China. It was not until the last 100 years that fibre flax began to be cultivated and used.

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