

Content of lignan, cadmium and some other chemical components in linseed and oil hemp varieties in south-western part of Finland

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Abstract

Lignans are phytoestrogens found ubiquitously throughout the plant kingdom and thus are also present in our diet. After ingestion lignans go through various transformations and in the end they form mammalian lignans by microbial conversion. The amount of these mammalian lignans in human body is linked to the reduced risk of various hormonal dependent cancers such as breast cancer. Flaxseed (*Linum usitatissimum* L.) is one of the richest sources of lignans used in the human diet. Unfortunately, flaxseed also picks up cadmium very efficiently from the soil, which has to be kept in mind when choosing what regions to cultivate it in. SDG-lignan, cadmium and lead contents were studied in linseed, flax and oil hemp variety samples. Oil hemp samples were seeds of the very low THC cannabinoid variety Finola. Linseed varieties were Helmi, Heljä, Laser, Abacus and Sunrise and flax varieties were Martta and Belinka. Both farm and trial samples were studied. SDG lignan contents of linseed and flax variety samples varied 4840-9560 mg kg⁻¹. Helmi linseed variety had higher SDG lignan content than that of Laser. Cadmium contents of linseed and flax variety samples varied from 0.36-1.11 mg kg⁻¹. Cadmium contents of oil hemp samples were 0.017 mg kg⁻¹ and 0.023 mg kg⁻¹. Lead concentrations were rather low in all samples. There was wide variation in the cadmium content of linseed samples cultivated at different locations. It is important to cultivate linseed at high pH soils with low heavy metal content, in order to prevent cadmium accumulation.

Introduction

Linseed (*Linum usitatissimum* L.) and oil hemp (*Cannabis sativa* L.) are oil crops cultivated in small extend in Finland. Some 2000 ha of linseed are cultivated annually in the southern part of Finland but large amounts of linseed are also imported to Finland every year. Oil hemp is cultivated only by some few farmers. Linseed contains nutritional oil with high linolenic acid content, good quality protein and especially high lignan content. Hemp is a highly variable crop

with both fibre and oil hemp varieties. Seed production of high THC cannabinoid content of hemp limits its cultivation. There are, however, varieties with very low THC cannabinoid content. In Finland there exists a Finola variety intended for hemp oil production with no, or very low, THC cannabinoid content.

Flaxseed is one of the richest sources of lignans used in the human diet. The major lignan in flaxseed is secoisolariciresinol, which is present as a diglucoside (SDG) linked to oligomers mainly by 3-hydroxy-3-methyl glutaryl esters (Ford *et al.* 2001, Kamal-Eldin *et al.* 2001). After ingestion lignans, like SDG, undergo transformations and finally form mammalian lignans by the conversion of intestinal microbes. Various health effects have been linked to SDG such as cardiovascular health, control of diabetes and reduction of the risk of certain cancer types (breast, colon and lung) (Adolphe *et al.* 2010). Linseed has, however, tendency to accumulate cadmium from the soil to the seeds. Chronic low-dose exposure, e.g. via food, to cadmium has various negative health effects in humans (Satarug *et al.* 2010). Recently, cadmium has also been found to cause estrogen-like effects *in vitro* and *in vivo* (Johnson *et al.* 2003) thereby causing higher risk to breast cancer in humans (McElroy *et al.* 2006).

Materials and methods

Linseed and oil hemp seed samples were collected from farms in 2005-2008. These included samples from two linseed varieties, Helmi and Laser. A replicated variety trial was established at MTT station in Piikkiö in South-western Finland in 2009. The linseed varieties in the trial were Helmi, Heljä, Laser, Abacus and Sunrise and the fibre flax varieties Martta and Belinka. Oil and protein contents were analysed from the samples. SDG lignan contents were analysed from the crushed seeds after oil removal and basic hydrolysis by liquid chromatography equipped with diode array detector (Muir & Westcott 2000 with slight modifications). Cadmium and lead contents of the samples were analysed by ICP mass spectrometer after wet digestion.

Results and discussion

The chemical quality of linseed and oil hemp samples was good. Both crops are oil crops containing high levels of oil and protein (Table 1). The oil content of linseed varieties varied from 41.3 % to 50.3 % from dry matter. The Helmi variety had a lower oil content than other linseed varieties. Two flax varieties, Martta and Belinka, had the lowest oil contents in 2009. Flax varieties had higher protein contents of 24.8 and 25.0 % compared to the linseed varieties.

In oil crops oil and protein are very often negatively correlated characteristics. The Finola oil hemp had lower oil content and slightly higher protein content than linseed varieties. Linseed absorbed rather a lot of cadmium from the soil, the cadmium content of the seed varying from 0.36-1.11 mg kg⁻¹. A high cadmium content of linseed in Finland has been reported earlier, too (Kymäläinen and Sjöberg 2006). The cadmium contents of Finola oil hemp were very low, 0.017 and 0.023 mg kg⁻¹. It seem that Helmi may take up a little more cadmium but there was more local variation in the cadmium contents of farm samples. Lead contents were rather low in all crops and samples, but the values were higher in farm samples than in the trial samples (Table 1).

Table 1. Oil and protein content of linseed, flax and oil hemp varieties, levels of cadmium and lead, and the SDS lignan contents of linseed in different years and samples

Crop	Sample	Variety	Year	Number	Oil	Protein	Cadmium	Lead	SDG
				of samples n	content % d. m.	content % d. m	content mg kg ¹	content mg kg ¹	lignan mg kg ¹
Linseed	Farm	Helmi	2007	3	41,3		0.73	0.051	7400
		Helmi	2008	3	42.9	22.6	1.11	0.028	7550
			mean		42.1	22.6	0.92	0.040	7470
		Laser	2007	8	44.4		0.43	0.052	4990
		Laser	2008	3	47.2	22.2	0.36	0.055	4840
			mean		45.8	22.2	0.39	0.054	4920
Linseed	Trial	Helmi	2009	1	45.2	22.3	0.61	0.009	9070
		Heljä	2009	1	48.7	21.7	0.61	<0.007	8910
		Laser	2009	1	48.4	18.5	0.48	0.008	5320
		Abacus	2009	1	48.8	19.4	0.46	0.010	7120
		Sunrise	2009	1	50.3	20.8	0.54	0.016	7690
Flax		Martta	2009	1	41.4	24.8	0.57	0.007	9560
		Belinka	2009	1	41.8	25.0	0.42	0.007	8190
Oil hemp	Farm	Finola	2005	1	34.7		0.023	0.011	
			2007	1	35.4		0.017	0.027	
			2009	2	35.8	24.6			

SDS lignan contents were higher in Helmi than in Laser in farm and in trial samples in all years (Table 1). In the trial Laser had the lowest SDS lignan content. Heljä and Helmi linseed varieties and Martta and Belinka flax varieties had the highest SDS lignan contents in the trial. In order to obtain good quality linseed for human consumption it is important to choose right cultivars and cultivate linseed preferably at areas having a high pH and low cadmium concentration

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