7.19 - Flax sprouts from commercial and wild species as functional food

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Background

Flaxseed has regained popularity as food ingredient and has been recognized as functional food source owing to its bioactive components: omega-3 fatty acids, high quality proteins, lignans and dietary fiber [1]. Germination was demonstrated to improve nutritional value of seeds by increasing **phenolic** and **lignans** content and by decreasing **antinutritional factors**.

In this work:

1. some ***Linum usitatissimum* (*L.u.*)** varieties and **wild *Linum* species** were sprouted
2. sprouts **nutritional characterization** was performed: oil, protein and phenol content, antioxidant activity (AA), and antinutritional factors.

Results

1) Sprout development:

- *L.u.* var. Sideral
- *L.u.* var. Solal
- *Linum dolomiticum*

2) Seeds, sprouts and coats nutritional characterization:

Specie/var.	Tissues	Phenols µg GAE/mg DW	Flavonoids µg QE/mg DW	AA % inhib DPPH/mg DW	µg Isoorientin/ mg DW	µg Isovitexin/ mg DW	µg SDG/ mg DW
L.u. var. Sideral	Seeds	3.0 ± 0.1	8.6 ± 0.6	17.9 ± 1.3	n.d.	n.d.	15.0 ± 0.4
	Sprouts	**10.6 ± 0.7**	8.0 ± 0.1	30.0 ± 1.7	n.d.	n.d.	0.0
	Coats	9.1 ± 0.7	**13.3 ± 0.6**	**45.4 ± 0.9**	n.d.	n.d.	**62,3 ± 0.3**
L.u. var. Solal	Seeds	3.5 ± 0.2	7.3 ± 0.6	20.5 ± 0.7	n.d.	n.d.	21.7 ± 0.7
	Sprouts	**10.7 ± 0.5**	7.4 ± 0.6	41.2 ± 2.5	n.d.	n.d.	0.0
	Coats	9.3 ± 0.5	**20.3 ± 1.4**	**53.2 ± 1.1**	n.d.	n.d.	**82.1** ± 3.2
Linum dolomiticum	Seeds	4.6 ± 0.4	23.0 ± 1.1	26.8 ± 1.0	**2.67 ± 0.17**	0.06 ± 0.02	0.0
	Sprouts	**7.0 ± 0.4**	24.9 ± 1	13.6 ± 1.1	0.46 ± 0.04	**1.89 ± 0.12**	0.0
	Coats	6.7 ± 0.1	**30.4 ± 1.4**	**32.8 ± 1.5**	0.15 ± 0.01	0.07 ± 0.03	0.0

1. Total **phenol content** and **antioxidant activity** are higher in sprouts than in seeds.
2. Secoisolariciresinol diglucoside (**SDG**), the **most** representative lignan found in *L.u.*, is only present in **seed-coat** of *L. usitatissimum* varieties only.
3. The wild species, ***Linum dolomiticum***, shows a higher flavonoid content than *L.u.* and the main representative ones are **isoorientin** and **isovitexin**.

Specie/var.	Tissues	g proteins/100g DW	% oil	% ω3	% ω6
L.u. var. Sideral	Seeds	15.9 ± 0.3	**25**	**55.7**	16.2
	Sprouts	**26.1** ± 1.0	23.8	**54**	17.7
	Coats	12.9 ± 0.7	6.1	**48.3**	18
L.u. var. Solal	Seeds	18.6 ± 0.7	**37**	1.6	**71.2**
	Sprouts	**22.5** ± 0.2	30	2.3	**71.4**
	Coats	14.5 ± 1.0	15.9	1.3	**65.5**
Linum dolomiticum	Seeds	**27.5** ± 0.2	**24.9**	**58.6**	18.8
	Sprouts	19.0 ± 0.3	22.8	55.0	15.05
	Coats	7.1 ± 0.3	9.8	n.d.	n.d.

1. In *L.u.* varieties **protein content** was higher in sprouts than in seeds. The opposite was observed in *L. dolomiticum*, probably due to the longer time of sprouting.
2. The **oil content** slightly decreased after germination. However, the quality is maintained. The two *L.u.* varieties showed **ω3 and ω6** opposite percentage.

Anti Nutritional factors:

A reduction in the content of anti-nutritional factors was observed after sprouting. In particular:

1. **Phytic acid**: lowered after sprouting, seed-coats exhibited the lowest content.
2. **Tannins**: mainly present in seed-coats. *L. dolomiticum* showed a higher content than *L.u.* varieties in seeds and sprouts.

Specie/var.	Tissues	Phytic acid (g/100 g)	ug TA /mg DW
L.u. var. Sideral	Seeds	1.36 ± 0.06	1.6 ± 0.6
	Sprouts	0.85 ± 0.09	**0.3 ± 0.1**
	Coats	**0.18 ± 0.02**	6.7± 0.9
L.u. var. Solal	Seeds	3.52 ± 0.25	1.9± 0.3
	Sprouts	2.95 ± 0.16	**0.5 ± 0.3**
	Coats	**0.23 ± 0.04**	6.3 ± 1.0
Linum dolomiticum	Seeds	2.39 ± 0.06	2.6 ± 0.6
	Sprouts	1.36 ± 0.16	**1.2 ± 0.7**
	Coats	**0.09± 0.01**	5.9 ± 0.8

Materials and Methods

The seeds were germinated for five days or more depending on the species. Seed coats were separated from the shoots during harvesting, were freeze-dried and defatted. All the analyses were performed on these samples.

Conclusions

1. Germination represents a very good strategy to improve nutritional value of numerous seed species [2]. In flax sprouts an increase in **phenols** and **antioxidant activity** together with a decrease in **antinutritional factors** was observed compared to the seed counterparts.
2. Commercial and wild flax species showed different abundance of specific metabolite classes.
3. Interestingly, **SDG** was present only in *L.u.* varieties. **SDG** has a strong AA and phytoestrogenic effects through its derived mammalian metabolites, enterodiol and enterolactone [3].

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