**Cadmium in sunflower seeds: different contents in hulls and kernels and consequences for food and feed industry**

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**Abstract:**

**Context:** Contamination of sunflower seeds by soil-derived cadmium is an important issue for food and feed because this crop strongly accumulates this toxic metal. Diffuse contamination of agricultural soils by Cd, derived from soil pedogenesis or agricultural inputs and atmospheric fallouts, is a concern because it may result in harvests that do not comply with the regulation for contaminants in food products. The Cd content of sunflower seeds for direct human consumption (excluding seed for oil production) is regulated at 0.5 mg/kg (EC 2023/915). In the crushing process, Cd is concentrated in the meal, while little Cd is found in oil. For animal feed, raw materials like sunflower meal should not contain more than 1mg/kg (Directive 2022/32/EC). De-hulling the seeds before crushing results in meals having a higher protein content, but if Cd is more concentrated in kernels or hulls, it can increase the risk of non-conformity of the meal. There are also some prospects to valorize sunflower meals as proteins for humans, but this may be hampered by the Cd concentration in pressed kernels.

**Objectives:** The goals of this work were (1) to study the repartition of Cd between seed hulls and kernels and to evaluate the consequences for the Cd content in meals and (2) to evaluate the genetic variability for Cd repartition between hulls and kernels as a perspective for breeding.

**Materials and methods:** Sunflower seeds were collected in a field trial comparing 3 cultivars: ES Biba, Extrasol, Vellox, cultivated on a calcareous loam in Charente-Maritime County in France, this soil having a moderately high Cd content (1 mg Cd/kg). Half of the samples was washed with distilled water. Samples were dehulled on a pilot dehulling equipment. The Cd contents in hulls and kernels were determined by atomic absorption spectroscopy after digestion in a HNO3-HCl mixture.

**Results:** The seeds from the three sunflower varieties ES Biba, Extrasol and Vellox had Cd contents of 0.84, 0.88 and 0.76 mg Cd/kg, respectively, all exceeding the EU regulation limit of 0.5 mg Cd/kg seeds for human food. Kernels were more concentrated in Cd compared to hulls and the ratio depended on the varieties: × 2.6 for ES Biba, × 1.3 for Extrasol and × 1.5 for Vellox. On average, for the three varieties, washing seeds did not affect their total Cd contents. Despite the Cd contents of the whole seeds did not differ between the varieties, their Cd fraction in the edible kernels differed significantly, from 78% (Extrasol) to 87% (ES Biba) of the total seed Cd.

**Conclusion:** The results of this study showed that kernels were richer in Cd than the hulls. They also suggest that (i) the size of the kernel, relative to that of the hull, may affect the dilution of Cd in kernel tissues and (ii) there might be genetic variability for the capacity of transfer of Cd from the hull to the kernel. This opens the perspective of breeding sunflower genotypes that accumulate less Cd in kernels to increase food/feed safety.

**Keywords:** cadmium, agricultural soil contamination, sunflower seed, hull, genetic variability

**Funding:** This work was supported by an internal funding of Terres Inovia.