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Iodine biofortification of *Eschscholzia californica* Cham. plants with the use of various iodine compounds and its effect on the biosynthesis of selected alkaloids

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INTRODUCTION & AIM

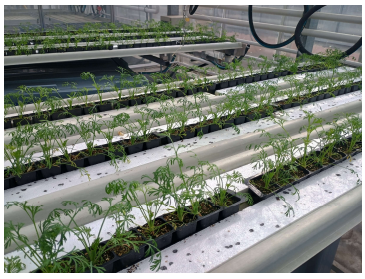
The biofortification of medicinal plants has been proposed as a novel method of introducing essential mineral nutrients into the human diet. Yet, its increased levels may affect the synthesis of secondary metabolites and health-promoting properties of these plants.

California poppy (*Eschscholzia californica* Cham.) has been widely used in traditional medicine for analgesic and sedative purposes due to the presence of various alkaloids.

The study evaluated the effect of inorganic and organic iodine compounds on the growth and the accumulation of iodine and selected alkaloids in the leaves of California poppy grown in hydroponic system.

METHODS

Cultivation: *Eschscholzia californica* Cham. plants were grown in the autumn season in the hydroponic NFT system. Seeds were sown into propagation trays filled with vermiculite; seedlings with 4-5 true leaves were then transplanted into the NFT system.



The experimental design: four combinations with the application of 0.25 mg I·dm^{-3} of iodine compounds: 1.) control 2.) KI (potassium iodide); 3.) 2-ISA (3-iodosalicylic acid; 4.) 3,5-diISA (3,5-diiodosalicylic acid). Iodine compounds were introduced into the nutrient solution 2 weeks after seedling transplantation.

Plant harvest was conducted at the stage of intensive vegetative growth of plants, before flowering, and was followed by plant biomass estimation. Iodine content in plants was analysed using ICP-MS technique [Ledwożyw-Smoleń et al. (2025)].

The levels of selected alkaloids in leaves were determined by LC-MS/MS technique (Tao et al. 2020, Zielińska et al. 2020).

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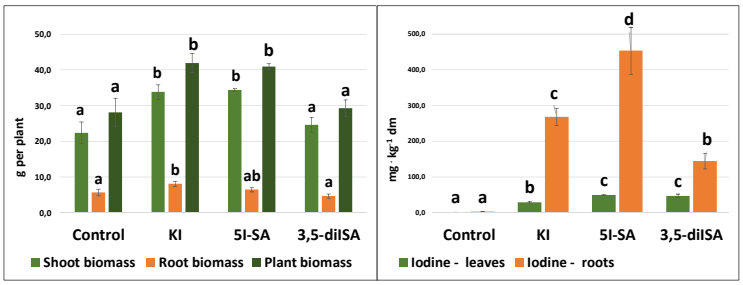
RESULTS & DISCUSSION

Fig. 1 Biomass and iodine content in *E. californica* plants



(means ± SE; n=4, the same letters for bars within individual series denote means not statisticaly different at p<0.05)

- Plant iodine content increased in all I combinations, with the highest levels noted for 5-iodosalicylic acid (5-ISA).
- The improved growth of plants was noted for KI and 5-ISA applications.

Table 1 The content of selected alkaloids in the leaves of *E. californica* plants

	Allocryptopine	Berberine	Californidine	Chelerythrine	Coptisine	Corydaline
	mg · kg-1 dm					
Control	201.6 ± 40.02 a	0.62 ± 0.055 a	482.6 ± 70.99 a	3.3 ± 0.27 a	4.1 ± 0.89 a	225.3 ± 49.00 a
KI	338.6 ± 75.19 a	0.74 ± 0.064 a	614.9 ± 58.26 a	5.4 ± 0.96 a	7.4 ± 1.83 a	383.9 ± 83.45 a
5I-SA	257.1 ± 23.39 a	1.80 ± 0.146 b	596.3 ± 67.07 a	6.1 ± 1.38 a	5.5 ± 0.49 a	291.5 ± 29.94 a
3,5-diISA	245.4 ± 33.50 a	0.67 ± 0.022 a	505.6 ± 63.06 a	5.2 ± 0.59 a	5.2 ± 0.72 a	282.1 ± 39.65 a
	Protopine	Reticuline	Sanguinirine	Scoulerine	Dehydro-corydaline	Papaverine
	mg · kg-1 dm				*µg · kg-1 dm*	
Control	418.0 ± 83.15 a	2.9 ± 0.62 a	4.8 ± 0.96 a	0.40 ± 0.138 a	13.7 ± 0.84 a	380.2 ± 5.42 a
KI	710.9 ± 111.51 b	3.4 ± 0.66 a	8.0 ± 1.22 b	0.39 ± 0.079 a	22.5 ± 4.02 a	416.5 ± 5.73 b
5I-SA	541.3 ± 50.78 ab	3.2 ± 0.64 a	11.3 ± 0.13 c	0.42 ± 0.163 a	12.5 ± 5.89 a	409.0 ± 3.89 b
3,5-diISA	546.6 ± 80.87 ab	2.6 ± 0.58 a	8.4 ± 0.53 b	0.27 ± 0.062 a	14.2 ± 3.04 a	389.7 ±5.80 a

(means ± SE; n=4, means denoted with the same letters are not statisticaly different at p<0.05)

- The leaf level of *sanguinarine* increased in all iodine combinations, with the highest level noted for 5-ISA.
- *Berberine* content increased only after 5-ISA application, while protopine content - after KI treatment. *Papaverine* level increased similarly in plants treated with KI and 5-ISA.
- The leaf levels of: *allocryptopine, californidine, coptisine, corydaline, dehydrocorydaline* and *reticuline* tended to be higher in KI combination, yet the observed changes were not significant.

CONCLUSION & FUTURE WORK

- An increase of whole plant biomass after the application of KI and 5-ISA indicates its possible growth-promoting effect on *Eschscholzia* plants.
- The observed modifications of alkaloid profile suggest iodine involvement in the regulation of its biosynthesis.
- Further studies are required to monitor the changes of alkaloid levels in roots in order to fully evaluate the effect of iodine in the production and distribution of these metabolites in *Eschscholzia* plants.

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