Plant biofortification with iodine
Iodine in plants

High

Low
Iodine in algae
First iodine fortified crops in supermarkets
Spinach biofortification

1 μM IO3-, 10 μM I- is taken up and reaches a concentration in leaves up to 300 μg/100g p.f. (Zhu et al., 2003)
Spinach biofortification

...but reduction of biomass due to phytotoxicity
(Zhu et al., 2003)
Iodine biofortification in rice

5% potassium iodate solution for 12 or 24 days, increased soil iodine 3-fold, and crop and animal iodine 2-fold

“IODINATION OF IRRIGATION WATER AS A METHOD OF SUPPLYING IODINE TO A SEVERELY IODINE-DEFICIENT POPULATION IN XINJIANG, CHINA” (Lancet, 1994, 344: 107-110)
None of the treatments provided sufficient I in the seed to meet human dietary requirements: lack of transport through the phloem?

Xilematic or phloematic transport of iodine?

...both

but preferential xilematic transport

Iodine physiology in plants?
Iodine uptake in the thyroid cell

TSH, TNFα, IFN-γ, IL-6, IL-1α, IL-1β, ceramide, sphingomyelinase, iodide, estradiol, T3, dexamethasone, Tg

TSH, cAMP, forskolin, adenosine

TPO, Pendrin

Iodine uptake in the thyroid cell

Thyroid Follicular Cell

basolateral

apical

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Metabolic engineering: hNIS in Arabidopsis

Increased radioactive iodine content in the hNIS plants
Metabolic engineering: hNIS in Arabidopsis

*hNIS* plants do not accumulate more iodine when fed with discrete amounts of non-radioactive iodine.
Iodine uptake and volatilization?

Methyltransferases capable of catalyzing the S-adenosyl-L-methionine (SAM)-dependent methylation of iodide (I\(^{-}\)) to produce methyl halides

HARMLESS TO OZONE LAYER (HOL)
HARMLESS TO OZONE LAYER (HOL) mutant in Arabidopsis

Increased iodine content in the hol-1 mutant plants
HARMLESS TO OZONE LAYER (HOL) mutant in Arabidopsis

More efficient iodine distribution in the hol-1 mutant plants
HARMLESS TO OZONE LAYER (HOL) mutant in Arabidopsis

The hol-1 mutant displays higher iodine content
HARMLESS TO OZONE LAYER (HOL) gene is induced by the increased iodine uptake in NIS transgenic Arabidopsis

Induction of HOL1 counteracts the increased iodine uptake in NIS plants.
Increased iodine uptake in *NISxhol1* plants

The cross between hNIS and hol-1 plants is more efficient in iodine uptake.
Increased iodine uptake in *NISxhol1* plants

The cross between hNIS and hol-1 plants is more efficient in iodine uptake.
Iodine physiology in plants

Iodine

CH₃I

VOLATILIZATION

UPTAKE

Iodine
Iodine physiology in plants

Emissions of Methyl Halides and Methane from Rice Paddies

K. R. Redeker,¹ N.-Y. Wang,¹ J. C. Low,² A. McMillan,¹ S. C. Tyler,¹ R. J. Cicerone¹,2*

...about 1 percent of atmospheric methyl bromide and 5 percent of methyl iodide arise from rice fields worldwide.
Iodine biofortification in plants

Iodine volatilization as CH$_3$I plays a major role in reducing iodine content in plants.

Selection of crops with low HOL-1 like activities can provide an effective method for iodine biofortification programmes.
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