UV-B dependent and independent vitamin D synthesis in plants

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Introduction

❀ In the skin of vertebrate animals and humans, vitamin D is formed by the processes:
Provitamin D ➪ Previtamin D ➪ Vitamin D.
The conversion of provitamin D to previtamin D is a photochemical reaction requiring ultraviolet-B photons.

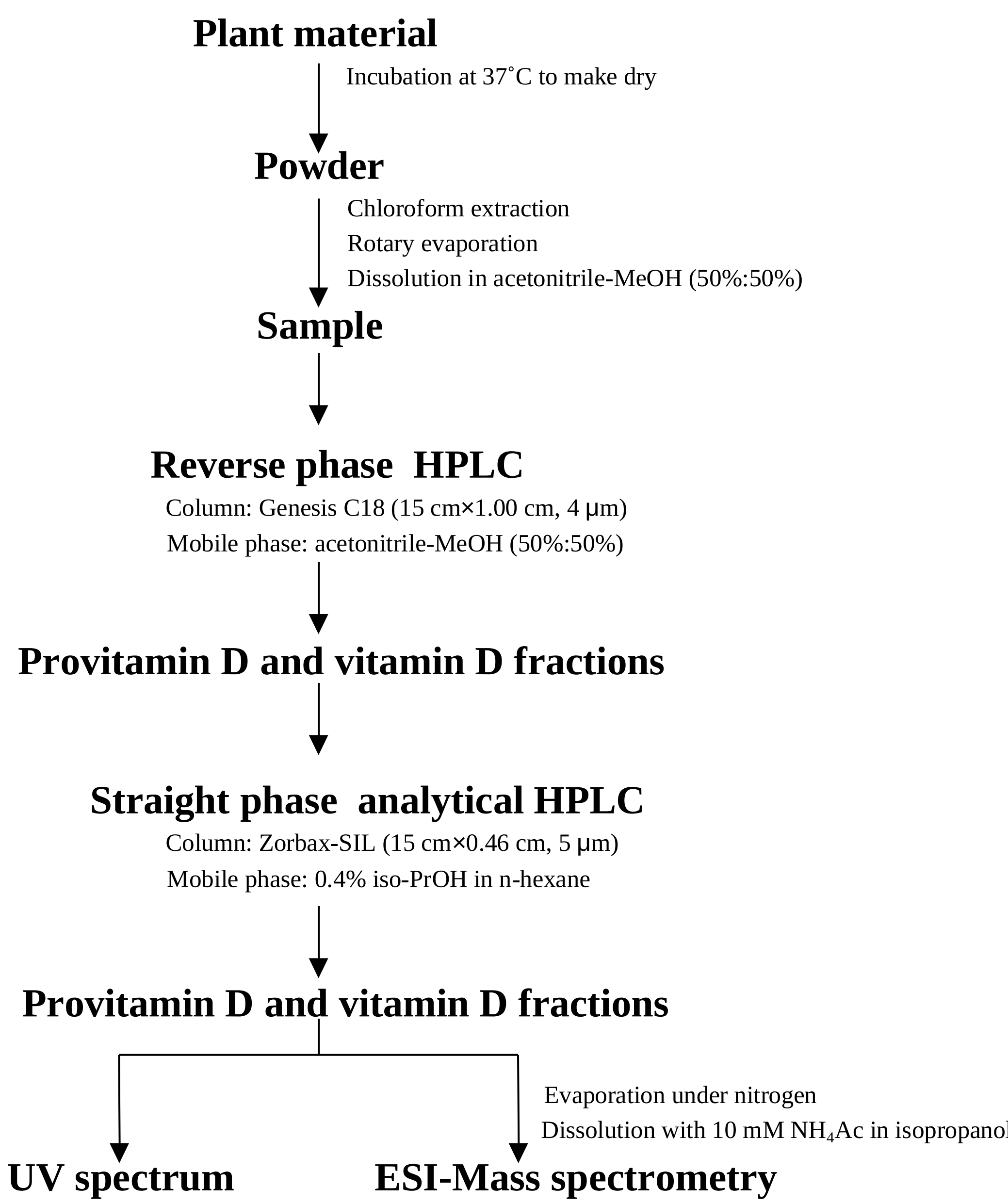
❀ Not only vitamin D_2 but also vitamin D_3 have been found in a variety of plants.

❀ The results of this study demonstrates that both UV-B dependent and independent pathways exist in plants for the biosynthesis of vitamins D.

Materials and Methods

Daucus carota (leaves and roots)

Lycopersicon esculentum (leaves)



Results

❀ Vitamin D_2 and D_3 in the root of carrot (*Daucus carota*) grown in absence of UV-B

Provitamin D_2, provitamin D_3, vitamin D_2 and vitamin D_3 were identified and determined

Chromatograpms of reverse phase HPLC (Fig.1)

Chromatograpms of straight phase HPLC (Fig.2, Fig.3)

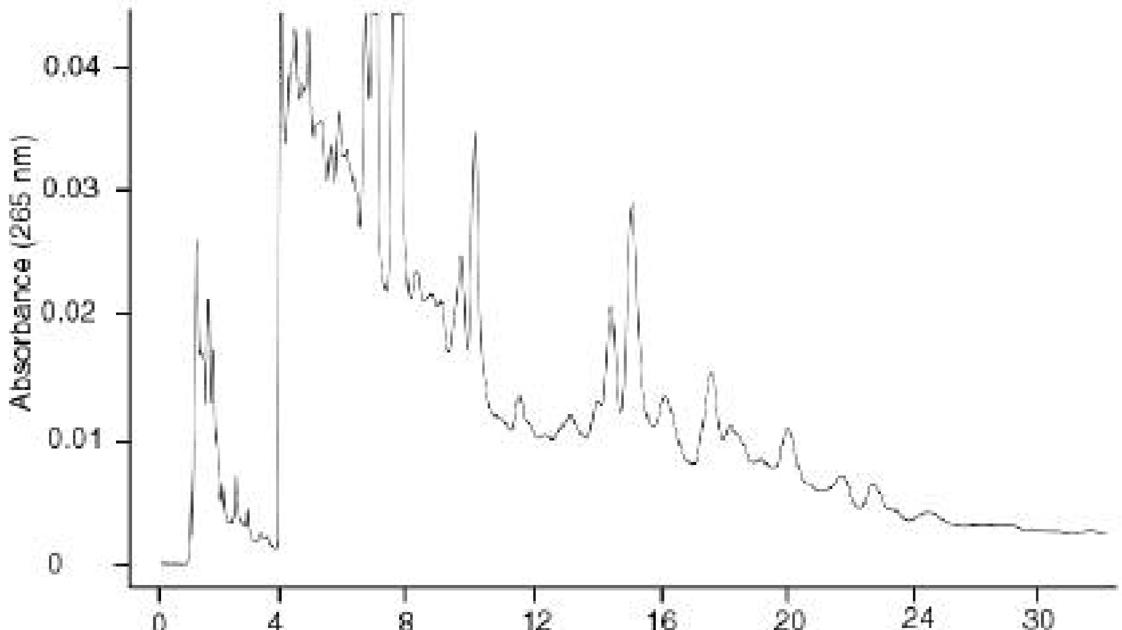
UV-spectrum of the provitamin D_2 (Fig.4)

Electrospray ionisation (ESI) mass spectra (Fig.5, Fig.6)

❀ Contents of provitamins and vitamins D_2 and D_3 in tomato[a] (*Lycopersicon esculentum*) leaves

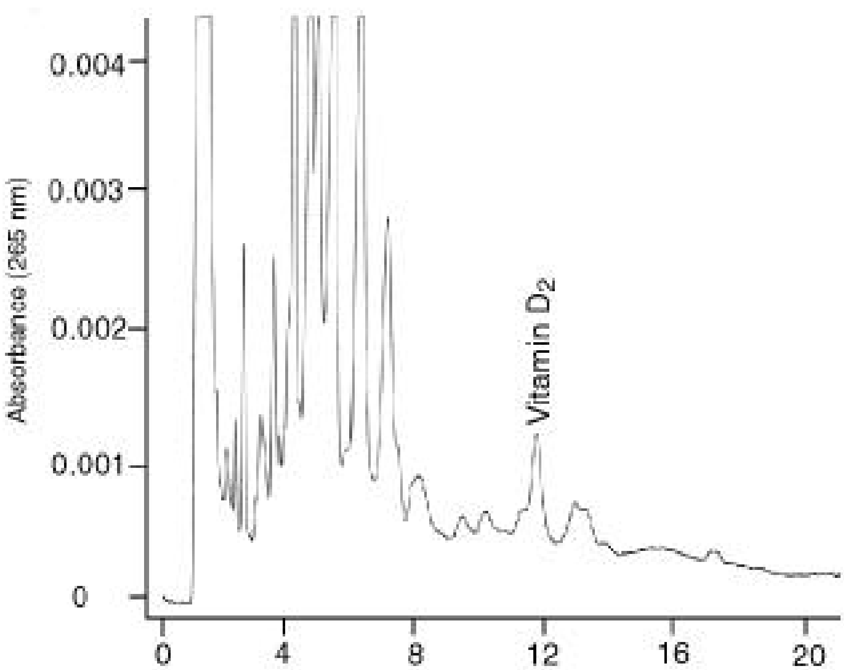
		Micrograms per gram dry weight		
Organism	Provitamin D_2	Provitamin D_3	Vitamin D_2	Vitamin D_3
Tomato (-UV-B)	1.83	0.61	0	0
Tomato (+UV-B)	2.23	0.76	0.087	0.28

[a] Tomato plants were grown in a greenhouse with or without UV-B radiation (0.85 kJ plant weighted UV-B radiation per m^2 and day)



Retention time (min)

Fig. 1. Chromatogram of the first reverse phase HPLC



Retention time (min)

Fig. 2. Chromatogram of the straight phase HPLC

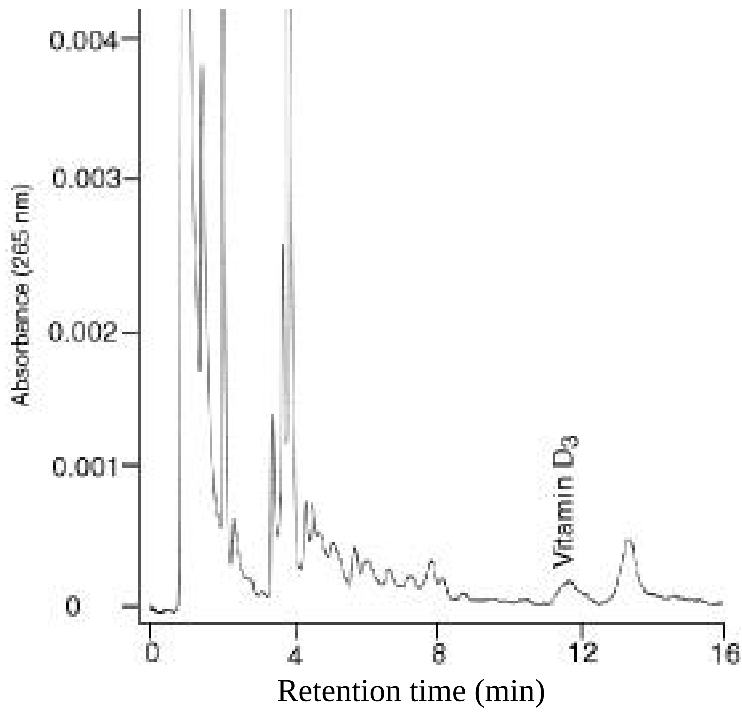


Fig. 3. Chromatogram of the straight phase HPLC

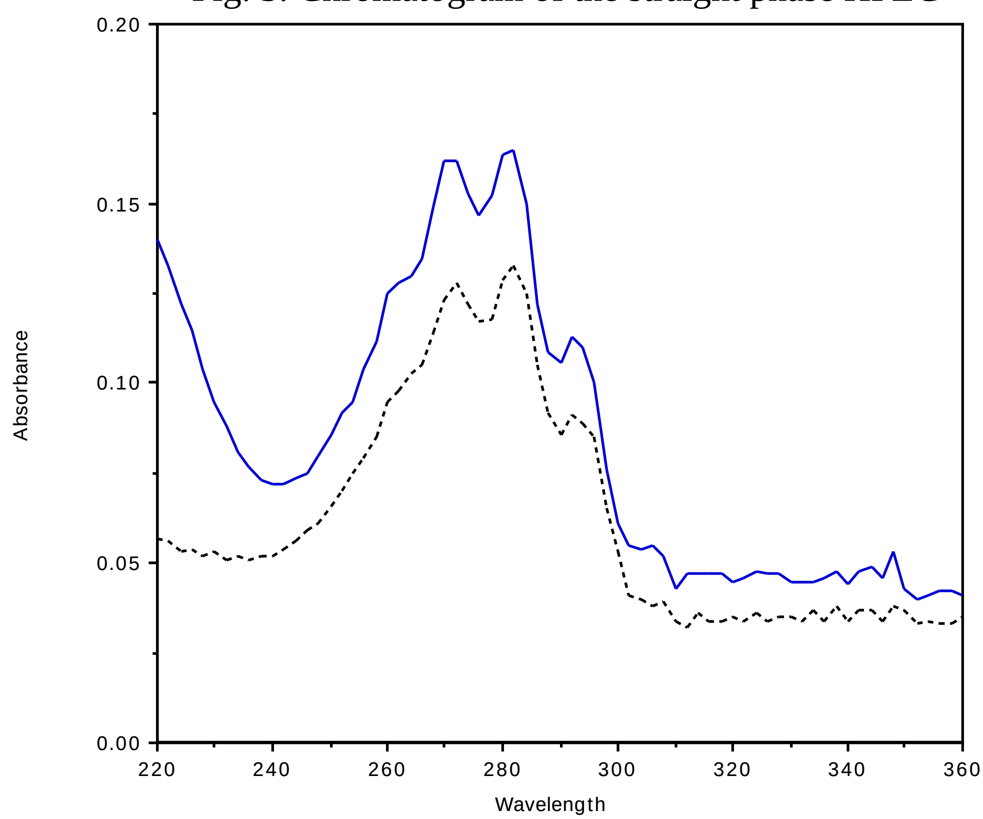


Fig. 4. Ultraviolet spectra of putative provitamin D_2 fraction from carrot purified by two successive steps of HPLC (solid line) and standard provitamin D_2 (dashed line).

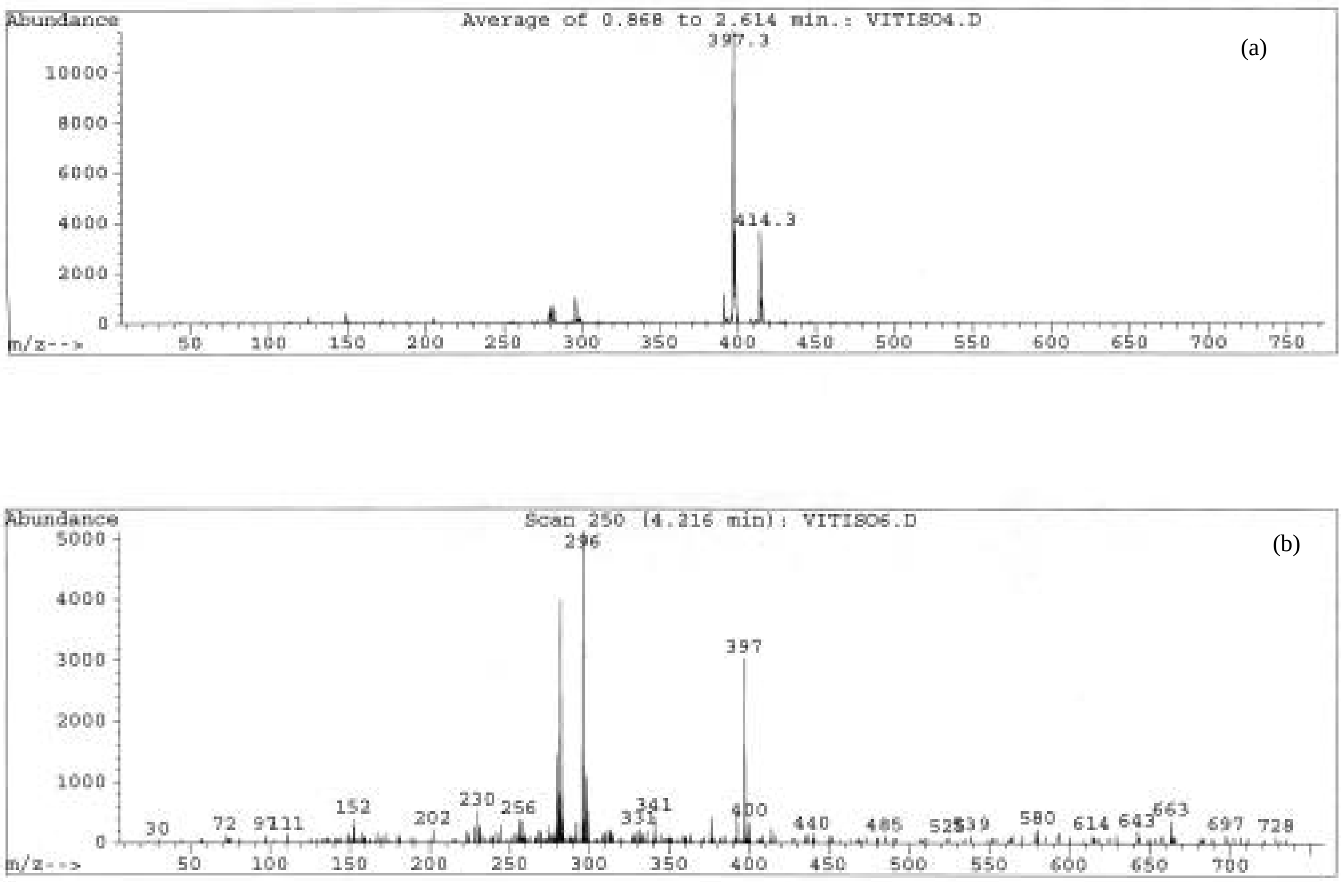


Fig. 5. ESI-MS analyses of standard vitamin D_2 and vitamin D_2 sample prepared from carrot. (a) standard vitamin D_2, peaks at *m/z* 397.3 and *m/z* 414.3 represent $[M\text{-}H]^+$ and $[M\text{-}NH_4]^+$, respectively; (b) vitamin D_2 sample, the peak at *m/z* 397 shows that the sample contains vitamin D_2.

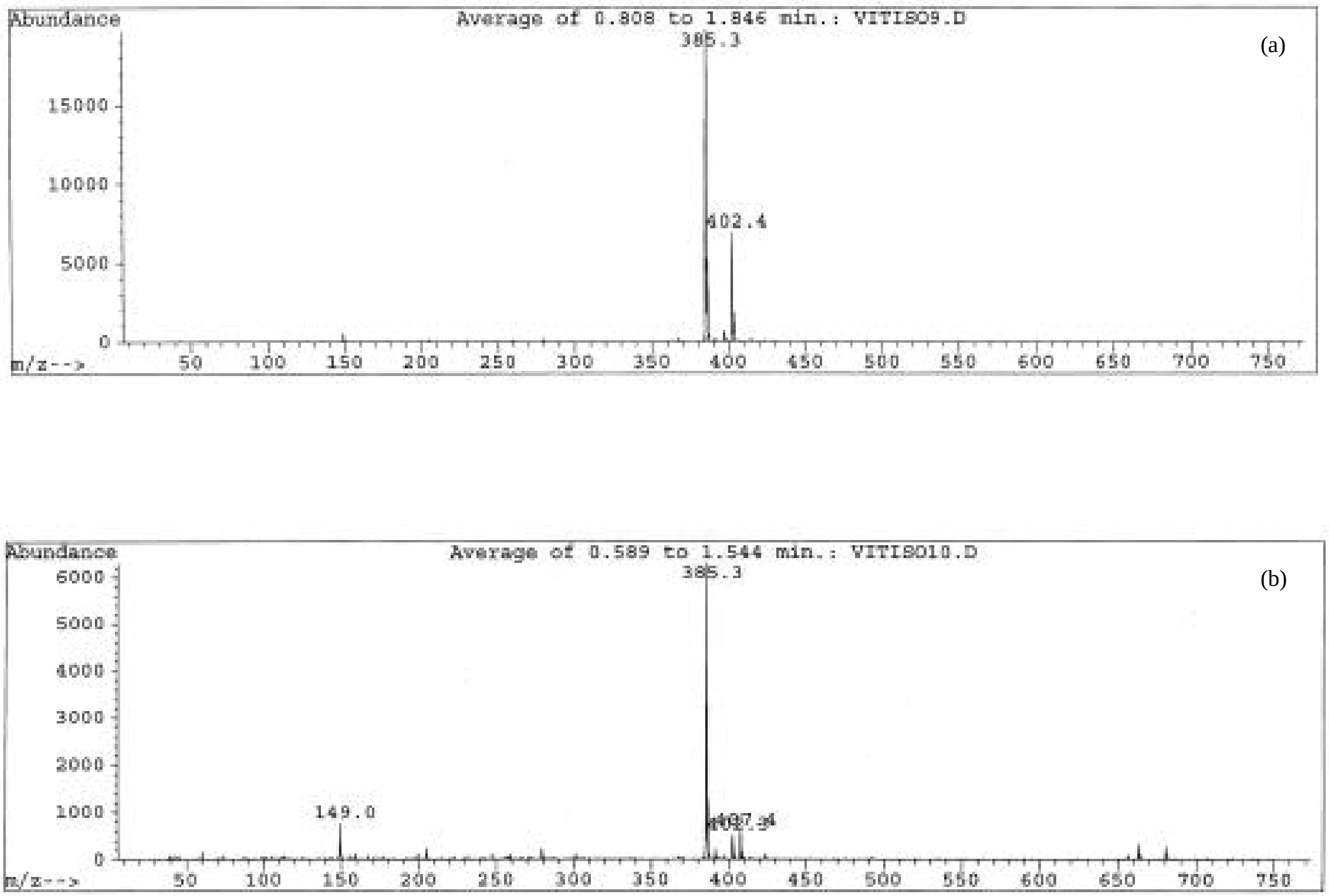


Fig. 6. ESI-MS analyses of standard vitamin D_3 and vitamin D_3 sample prepared from carrot. (a) standard vitamin D_3, peaks at *m/z* 385.3 and *m/z* 402.4 represent $[M\text{-}H]^+$ and $[M\text{-}NH_4]^+$, respectively; (b) vitamin D_3 sample, the peaks at *m/z* 385.3 and 402.3 show that the sample contains vitamin D_3.

❀ Is provitamin D a UV-B receptor?

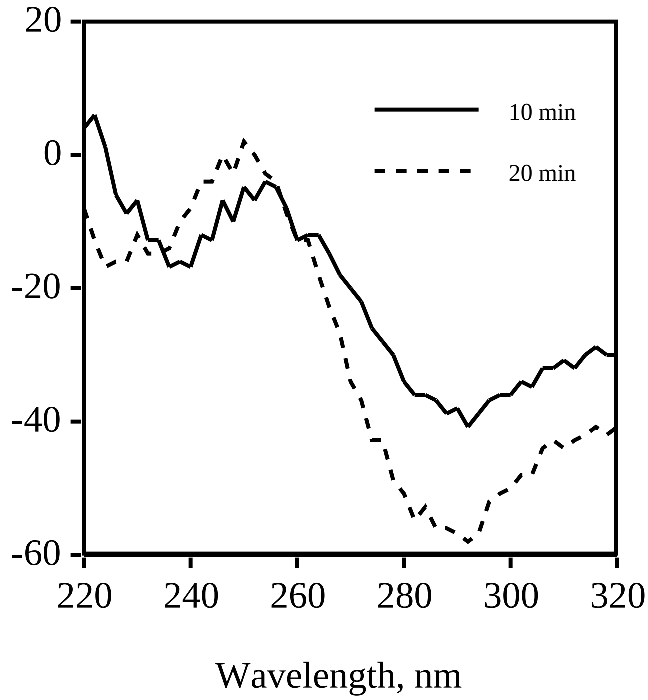


Fig.7. Absorbance change in outer cell membranes from tomato leaf cells irradiated for 10 and 20 minutes with radiation (mainly UV-B radiation, but also UV-C, UV-A and some visible light) from a Philips TL12 lamp. Note that the maximum absorbance decrease occurs where one would expect for a substance that acts as a UV-B receptor and disappears in the process.