

# How fine bubbles change germination and initial plant growth of spinach and Japanese mustard spinach

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## Abstract

Fine bubbles, FBs, attract keen attention because of the benefit of enhancing the function of water with less or no use of chemicals. Areas of application rapidly spread to industrial cleaning, pharmaceuticals, material processing, and fishery or plants farming. Among the successful results, the authors paid a special interest on the growth enhancement of plants grown with hydroponic cultivation.

In recent years, the number of fundamental research on working mechanism of FB is growing. Liu et al.[1] reported that enhancement of germination and plant growth in the initial period. They reported that both positive and negative effects appear on various plants. There was an adequate amount of FB depending of the plant species. In this study, we investigated the influence of FB on germination and initial plant growth of spinach and Japanese mustard spinach using oxygen and air UFB in water.

Tap water was chosen as a medium and oxygen or air was dispersed as FBs through a generator that was developed by Goshima, a co-author of this work. The bubble diameter distribution and the number density of UFB were analyzed with Nanosight, LM-10 (Malvern). With and without O<sub>2</sub> and air UFB, germination and subsequent initial growth was examined with fifty seeds of spinach or Japanese mustard spinach. Germination ratio and stem length and root length were observed for comparison. Also, dissolved oxygen concentration in water was measured by DO meter.

The water containing air or O<sub>2</sub> UFB clearly increased the length of the stem length of Japanese mustard spinach by 1.2~1.3 times of that was observed in tap water. Also, the distribution of the stem length was changed by the presence of UFB. Even if the water containing air UFB had low dissolved oxygen, the use clearly promoted the elongation of Japanese mustard stem length. This fact demonstrates that the presence of bubbles improved the plant growth.

[1] S.Liu, et al.;Langmuir, 32(2016)11295-11302

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