水耕葉菜中硝酸/亞硝酸態氮素蓄積之探討

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摘　要

利用無土設施栽培之水耕蔬菜是近年來生鮮超市消費族之寵兒，然其葉片中含NO_3-N是否過量卻常爲國內學者議論之焦點。由於無機的NO_3-N乃爲水耕養液配方之主要氮素源，栽培過程一旦施用過多之NO_3-N是否會蓄積于蔬菜葉片中，進而影響到食用者之健康，卻也是水耕技術研發者不可忽視的重要課題。因之，從民國77年起本場即開始針對NO_3-N在水耕葉菜之分佈，代謝和外在環境限制因子例如氣溫、水溫、入射日照量、遮蔭、施氮量及方式；烹調方式、溫度及時間；收穫後貯藏方式、時間及溫度等作系列之試驗研究，茲將成果條述如下：

1. 根據民國79～81年間，從28家水耕農戶之定期取樣分析得知，夏季時各種葉菜之NO_3-N含量在800～1300 ppm間，NO_2-N含量在1.4～1.9 ppm間，農家養液中NO_3-N含量在138～141 ppm間。冬季時各種葉菜之NO_3- N含量則在614～1,451 ppm間，NO_2-N含量在1.0～1.5 ppm間，養液中NO_3-N含量在125～171 ppm間。
2. 小白菜及葉萵苣植體內NO_3-N大部份蓄積於葉柄中(57～63%)，其次爲葉片中(31～26%)及根部(12%～11%)；NO_2-N則大部份蓄積於根部。隨氮素濃度之增加，增量之NO_3-N均蓄積于葉片及葉柄中，而增量之NO_2-N則蓄積于葉片中。
3. 小白葉及葉萵苣體內NRase及NiRase均存在於葉片中，根部及葉柄中諸酵素活性極低。
4. 隨著入射光照量、氣溫、養液溫度、氮肥濃度之增加均會促成葉片中NO_3-N及NO_2-N之變化：在高氣溫(35℃)，低光照(5 KLux)及高氮量(NO_3-N 198 ppm)處理下，NRase活性低下，而導致NO_3-N大量蓄積于葉片中，但NiRase活性不受影響。
5. 葉面噴施0.5%之尿素或硝酸鈣並不會增加葉片中NO_3-N或NO_2-N之含量，且有助於葉綠素含量之增加。
6. 水煮及油炒處理可減少葉片中NO_3-N及NO_2-N之含量，然而釋放出之NO_3-N及NO_2-N則殘留於湯中。
7. 經5℃低溫貯藏1天以上之水耕葉菜，可降低其NO_3-N含量。

關鍵字：水耕、葉菜、硝酸態氣、亞硝酸態氮、蓄積。

Studies on the Status of Nitrate/Nitrite Nitrogen Accumulation in Hydroponic Leafy Vegetable

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ABSTRACT

Hydroponic leafy vegetable sounded on its hygienic superiority becomes more popular in the supermarket. Due to the inorganic nitrate nitrogen is the major nitrogen sources in the hydroponic fertilization, it is suspected to be harzard as if the over dosage of nitrate/nitrite was accumulated in the hydroponic vegetable. A series of experiments conducted in Taichung DAIS since 1988 were designed to evaluate the metabolic process and partition of nitrate/nitrite nitrogen in the hydroponic vegetable, and to clearify the exterior limiting factors i.e. air/nurient temperature, radiation, shading, dosage and application method of nitrate fertilization, postharvesting and cooking process. The results were summarized as followed:

1. According to a two-year experiments, nutrient and vegetable were sampled monthly from 28 hydroponic farms. The NO_3-N and NO_2-N content of leafy vegetables in summer season were 800-1300 ppm and 1.4-1.9 ppm respectively and those in winter season were respectively 614-1451 ppm and 1.0-1.5 ppm. As in respect to the NO_3-N content in the nutrient, it was 138-141 ppm in summer season and that in winter season was 125-171 ppm.
2. The 57-63 % of absorbed NO_3-N was accumulated in the leaf stalk of hydroponic grown Pai-Tsai and leafy lettuce, the other 31-26% was in the leaf blade and another 12-11% was in the root. However, the majority of coverted NO_2-N was lefted in the root. With the increase dosage of NO_3-N fertilization, more NO_3-N was accumulated in the leaf blade and leaf stalk. Besides, more converted NO_2-N was also found in the leaf blade.
3. Significant enzyme activities of NRase and NiRase were detected in leaf blade of Pai-Tai and Leafy lettuce, but inactive in the leaf stalk and root.
4. The NO_3-N and NO_2-N content in leaf blade were variated as with increase of radiation, air/nutrient temperature and chemical nitrogen fertilization. In the treatment of high air temperature(35℃), low light intensity(5 Klux) and high nitrogen fertilization (NO_3-N, 198 ppm), the NRase activity was inhibited to result in higher NO_3-N accumulation in the leaf blade. However, NiRase activity seemed no effects in such treatment.
5. Foliage spraying treatment with 0.5% of urea and calcium nitrate showed no effects on the accumulation of NO_3-N and NO_2-N in the leaf blade, but incerease in chloroplyll content.
6. Both NO_3-N and NO_2-N in the leaf blade were reduced in boiling and frying treatments, but those were released to the soup residue.
7. The NO_3-N content in the leaf blade was decreased as it was stored in 5℃ one day after harvest.

Key words: hydroponic vegetable, nitrate/nitrite nitrogen, accumulation.