

Nitrate and Chlorophyll Contents in Organically Cultivated Chinese Cabbages

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Key words: nitrate, nitrate limit value, ADI, chlorophyll, outer leaf, Chinese cabbage

Abstract

*An average Korean known to ingest 3.4 times of the nitrate ADI level are found to have taken in 97% of nitrates through vegetables. This study analyzed the contents of nitrates and chlorophyll in organic Chinese cabbages, a major favorite vegetable for Koreans, with a view to lowering daily intake of nitrate. Our findings show that, in organically cultivated cabbages, the further outward the leaf was located, the more significantly the contents of nitrates increased, with the midrib and leaf blade showing positive relationship of $r=0.789^{**}$, and $=0.659^{**}$, respectively. In the case of the midrib, the contents increased as high as 79 times ranging from 40ppm for the innermost leaf to 3,177ppm for the outermost one, and when it comes to the leaf blade, the contents rose as high as 87 times, showing a range of 40 ~ 3,481ppm. Our findings also suggest that it is advisable to discard 1/3 of the outermost leaves before eating Chinese cabbages, since the outer leaves with known high contents of chlorophyll also have high contents of nitrates.*

Introduction

Due to the high level of nitrate intake through vegetables, namely, 85% of daily nitrate intake (Food Navigator, 2002; European Food Safety Authority, 2008), an Asian takes in more nitrates than a Western who is predominantly oriented toward meat-based foods. The reported levels of nitrate intake through vegetables from a few selected countries include 72.4% in Germany, 75.0% in the United States, 89.9% in Japan and 97.3% in Korea (Sohn et al. 1999).

Daily nitrate intake of an average Korean exceeds 3.4 times of 219mg, the FAO/WHO ADI (Acceptable Daily Intake), because Koreans are known to predominantly ingest vegetables in daily diet (Sohn, 2000).

This study is aimed to deliver the basic data on contents of nitrate and chlorophyll of certified organic Chinese cabbages, the most favourite vegetable for Koreans, to minimize the daily nitrate intake thorough organic Chinese cabbages.

Materials and methods

Certified organic Chinese cabbages (n=120) were sampled from the organic food sections of 6 different supermarkets in Seoul. Midribs and leaf blades of each 120 leaves sampled were separated and numbers were given starting with inner leaves moving toward outer leaves. Fresh samples were squeezed after grinding, and nitrate

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concentrations were measured by RQflex by Merck. The total chlorophyll was added up to chlorophyll a and chlorophyll b measured by UV Spectrophotometer at 663nm and 645nm, respectively.

Results

As shown in Fig.1, changes of nitrate contents significantly increased as the number of leaf increased, namely, the larger the number of leaf, the higher the level of nitrate contents was. In the case of the midrib and leaf blade, the level of nitrate contents increased depending on the position of the leaf showing a positive relationship of a high level registering $r=0.789^{**}$, $r=0.659^{**}$.

When it comes to the midrib, the innermost leaves, namely, the 1st to the 5th leaves, showed 40 ~ 1,113ppm, the leaves ranging from 21st ~ 25th reached 563 ~ 1,786ppm and those ranging from 45 and over reached a maximum of 1,298 ~ 3,177ppm, showing drastic increases. In the case of the leaf blade, the nitrate contents stood at 40 ~ 97ppm for leaves 1st ~ 5th, 119 ~ 965ppm for those 21st ~ 25th, and 522 ~ 2,887ppm for those 46th up to the outermost leaf. In the case of the midrib, the nitrate contents from the innermost to the outermost leaves ranged from 40ppm at minimum to 3,177ppm at maximum, showing a 79.4-fold difference between the minimum and the maximum values. On the other hand, the nitrate accumulation reached 40 ~ 3,481ppm, showing a difference 87.0 times at maximum between the highest and the lowest values.

Our findings show that when a cabbage leaf was eaten in whole depending on the position of the leaf, the intake of NO_3^- from an inner leaf small in size was significantly lower than that from an outer leaf. To be specific, the total NO_3^- content stood at 2.6 mg in the smallest inner leaf weighing 3g, while the total NO_3^- content stood at 375 mg in the largest outer leaf weighing 132g.

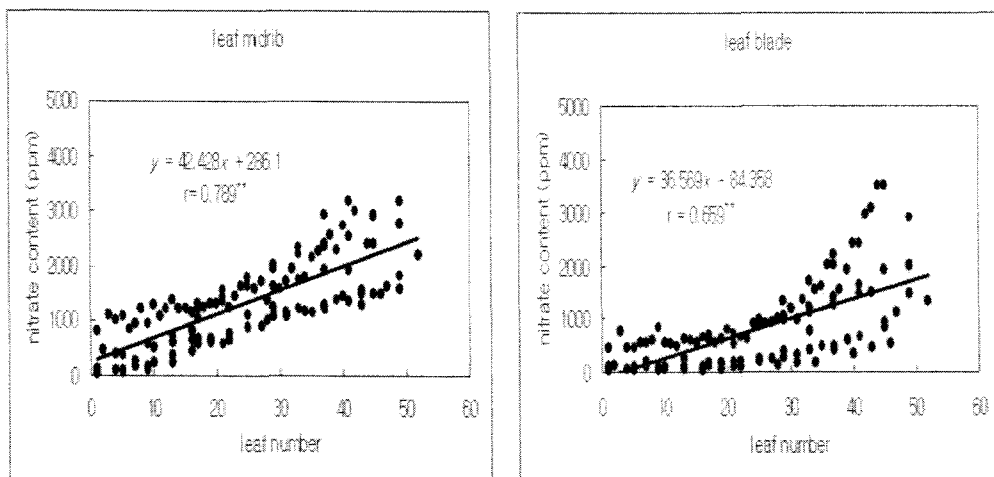


Fig. 1. Differences in nitrate contents in Chinese cabbages by leaf age in 120 samples

The chlorophyll contents depending on the position of the leaf were found to increase according as the age of the leaf increased in both midribs and leaf blades as shown in

Fig. 2. When it comes to the midrib, the chlorophyll contents ranged from 0.21 $\mu\text{g/g}$ at minimum to 1.16 $\mu\text{g/g}$ at maximum. In the case of the leaf blade, the chlorophyll contents ranged from 1.32 $\mu\text{g/g}$ at minimum to 18,72 $\mu\text{g/g}$ at maximum. When it comes to the relationship between the contents of nitrate and chlorophyll, the nitrate contents increased while the chlorophyll contents increased negligibly. In the case of the leaf blade, as the chlorophyll contents increased, the nitrate contents tended to increase noticeably.

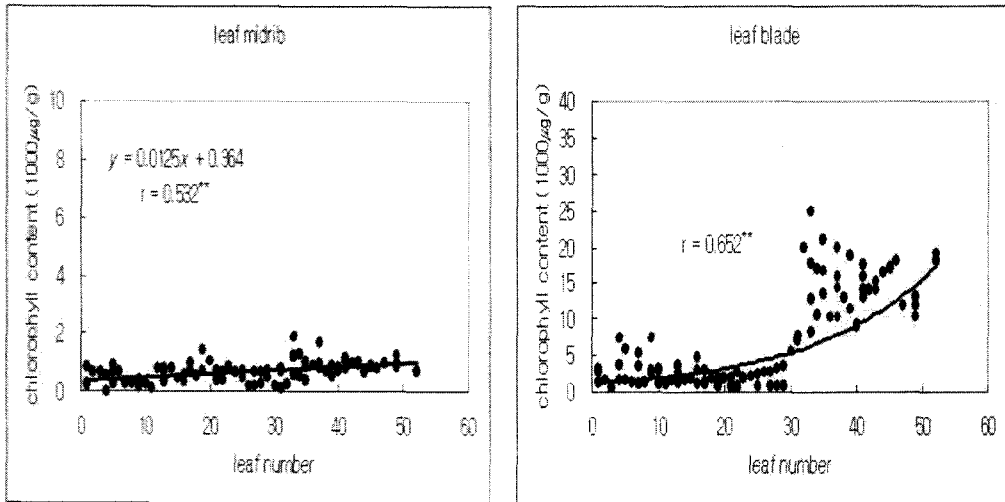


Fig. 2. Differences in chlorophyll contents in Chinese cabbages by leaf age in 120 samples

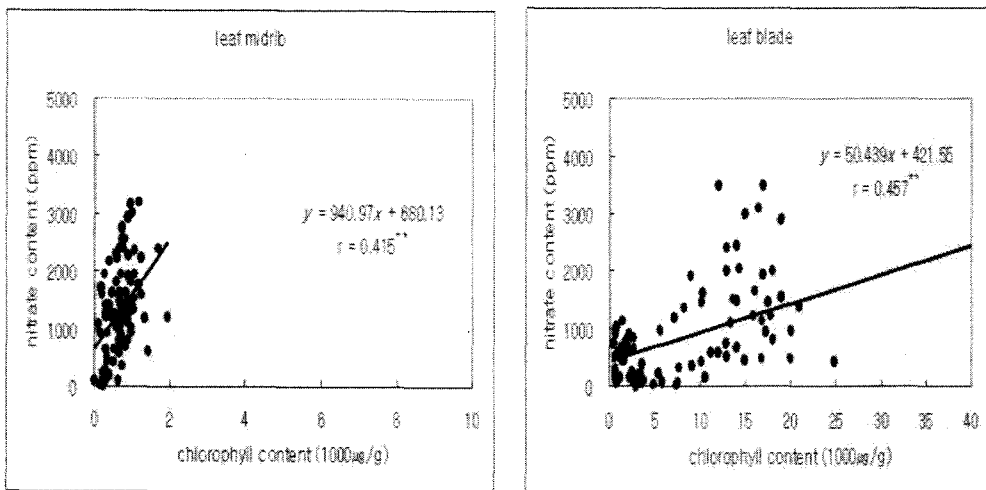


Fig 3. Relationships between nitrate and chlorophyll content in Chinese cabbage in 120 samples.

Discussion

Our findings show that the further outward a leaf was located, the higher the nitrate contents it represented, which was consistent with the reports by Sohn & Kim (1996), Sohn & Yoneyama (1996), Sohn et al. (1999), Sohn and Alley (1997) which found that an outer leaf contained a higher level of nitrate contents. It seems that the more outward the leaf is located, the higher the nitrate content is, since, as a cell grows, a small fluid pouch where nitrate is accumulated is enlarged, and, the older the nitrate reduction enzyme is, the more its vitality generally declines, and the more outward the leaf is located, the higher the nitrate contents are.

When it comes to the relationships between the contents of nitrate and chlorophyll, the nitrate contents significantly increased while the chlorophyll contents increased negligibly in the case of the midrib. In the case of the leaf blade, the more the chlorophyll contents increased, the more noticeably the nitrate contents tended to increase.

Conclusions

It is advisable to eat inner leaves of Chinese cabbages rather than outer leaves to minimize the daily intake of nitrate. It is also recommended that 1/3 of Chinese cabbage leaves with high concentrations of nitrate be discarded before consumption. Our findings also show that the lower the content of chlorophyll was, the lower the content of nitrate was. Therefore, it is strongly recommended that green leaves be discarded in order to lower daily intake of nitrates. By the same token, it is essential to check dried outer leaves of Chinese cabbages for their nitrate contents before eating them as the primary base for vegetable soups, a favourite local delicacy in the wintertime.

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