Allyl Isothiocyanate and its Contribution to Pungency in Cabbage (*Brassica oleracea* L.)

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A close correlation was demonstrated between the pungency of fresh cabbage evaluated by sensory tests and the concentration of allyl isothiocyanate (AITC) formed in macerated cabbage with 39 cultivars commonly grown in Japan. Most of the cultivars tested contained AITC lower than 0.5 mg/100 g, and had no pungency. Only 3 cultivars containing AITC higher than 2.0 mg/100 g showed a pungency. It was concluded that there is virtually no problem as far as the pungency is concerned, when cabbages grown in Japan are consumed raw.

Pungency is one of the most important factors affecting the taste of fresh cabbage. The characteristic flavor of the Cruciferae family, including cabbage, is due to isothiocyanates which are produced enzymatically from glucosinolates when the tissue is injured^{1)~4)}.

In a survey of past literature, compositional differences in glucosinolates and in their breakdown products in cabbage were reported in many kinds of cultivars⁵⁾, portions of cabbage⁶⁾, and in commercial sauerkraut⁷⁾.

The aim of the study was to demonstrate the correlation between the pungency of fresh cabbage heads evaluated by sensory test and the concentration of allyl isothiocyanate (AITC), the major volatile isothiocyanate, formed in cabbage.

1. Materials and Methods

Materials

Cabbage was cultivated in the field of the Vegetable and Ornamental Crops Research Station and harvested on proper days in June, 1984 and in March, 1985. The heads were stored at 5°C for several days until use for experiments.

Five heads from each cultivar were used, and each one was vertically cut into two portions. One portion was organoleptically evaluated and the other was used to determine AITC.

Evaluation of pungency by sensory test

The heads were shredded in 3 mm width. They were presented to 20 panellers of the Research Station for tasting within 1 hour after shredding. After tasting, panellers were asked to rate the samples for pungency with the following rating scores: not pungent, 0; slightly pungent, 1; pungent, 2. Evaluation of pungency was expressed as the means of the panellers' scoring.

Quantitative determination of AITC formed after maceration

AITC was analyzed by gas chromatography as described in a previous paper⁴⁾. Shredded cabbage, ca. 3 cm × 3 cm, was macerated into homogenate with a homogenizer. The homogenate, 15 ml, and 50 µg of phenyl isothiocyanate as an inner standard were put into a 20 ml bottle with a rubber cap, and then saturated with sodium chloride. The bottle was kept in boiling water for 2 minutes and 1 ml of the headspace vapor was injected into a gas chromatograph. The gas chromatographic conditions were as follows: column, 3 mm × 3 m glass column packed with 5% PEG-HP on Uniport HT; carrier gas, N₂ at a flow rate of 40 ml/min; detector, FID; column temperature, programmed from 80°C to 190°C at a rate of 4°C/min; retention time of AITC, 9.4 min on the condition.

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Table 1 Relationship between the evaluations of pungency and the formed AITC concentrations in several kinds of cabbages

Cultivar	Part of head*	Harvest	Evaluation of pungency**	Formed AITC conc. (mg/100g)
Kinkei 201	Whole	June '84	0	0.05
Nanpu	Whole	June '84	0	0.05
Akimakichuwase	Whole	June '84	0.5	0.55
Masago sankidori	Whole	June '84	0.5	0.78
Orora 1	Whole	June '84	0.6	1.45
Fuyudori miyako	Whole	June '84	1.2	3.98
Shikidori	Whole	June '84	1.2	4.27
Harunagi	Exterior	March '85	0	0.12
Harunagi	Interior	March '85	0	0.22
Kinshun	Exterior	March '85	0	0.32
Kinshun	Interior	March '85	0	0.51
Kogetsu	Exterior	March '85	0.7	1.08
Kogetsu	Interior	March '85	1.3	1.97
Taikan ogosho	Exterior	March '85	0.8	1.12
Taikan ogosho	Interior	March '85	1.5	2.81

*Whole, edible whole head; Exterior, outer half from the 1st leaf to the 15th; Interior, inner half from the 16th to the pith.

**Sensory score 0 (not pungent) ~2 (pungent)

Table 2 Classification of main cabbage cultivars grown in Japan by the strength of pungency

AITC concentration	Type*	Cultivar
Lower than 0.5mg/100g Not pungent	Savar**	Kinshun, Kosui, Ryokushun, Harunagi
	Akimaki gokuwase***	Kinkei 201, Akimaki wase, Haruhikari 7, Nanpu, Chuwase 2, YR seishun, Akimaki chuwase 2, Ryokushin chuwase
	Savoy	Savoy king, Kern
	Copenhagen market	Ball head, Asuka sankidori
	Succession	Delicious, YR kenzan, Shuki, Shin A go, Shinkashu, Shoshu, Shunkamaki
	Kandama****	Shutoku, Yayoi, YR hamayu
	Akimaki gokuwase	Akimaki chuwase
0.5 mg/100 g- 2.0 mg/100 g Slightly pungent	Savoy	Savoy ace
	Copenhagen market	Green ball, Orora 1
	Succession	Masago sanki, Koshinohikari, Hayadori
	Kandama	Kandori 1, Taikan ogosho, Kogetsu
Higher than 2.0 mg/ 100 g Pungent	Succession	Ginryoku
	Kandama	Shikidori, Fuyudori miyako

* According to Vegetable Cultivar List (Japan Seed Trade Association)

** Hybrid between Akimaki gokuwase or Savoy and Kandama

*** Extremely early cultivars for spring harvesting

**** Cultivars for winter harvesting

2. Results and Discussion

Correlation of pungency with formed AITC concentrations

Whole heads from 7 cultivars, and the exterior and interior leaves of the heads from 4 cultivars were used for the sensory evaluation of pungency and for the quantitative determination of formed AITC concentrations. Table 1 shows that no pungency was detected in 4 cultivars, i.e., 'Kinkei 201', 'Nanpu', 'Harunagi', and 'Kinshun', and that the formed AITC concentrations of those cultivars were as low as 0.05 to 0.51 mg/100 g.

In 4 samples, 'Fuyudorimiyako' (whole head), 'Shikidori' (whole head), 'Kogetsu' (interior) and 'Taikan ogosho' (interior), the evaluations of pungency were 1.2 to 1.5, indicating that most panellers recognized pungency in those samples. The formed AITC concentrations were 1.97 to 4.27 mg/100 g.

The other heads gave the evaluation between 0.5 and 0.8, indicating that the samples had a slight pungency. It is apparent from those results that evaluations of pungency by sensory tests are closely related to the formed AITC concentrations.

AITC is a major volatile isothiocyanate present in cabbage⁵⁾, and therefore the quantitative determination of the compound is likely to make it possible to evaluate the strength of pungency without using the sensory test.

Formed AITC concentrations of various kinds of cultivars

In order to estimate the strength of pungency of cabbage cultivars commonly grown in Japan, AITC concentrations of 39 cultivars were determined, and from the results those cultivars were classified into 3 groups as shown in Table 2.

The cultivars containing AITC lower than 0.5 mg/100 g, which revealed no pungency, accounted for two thirds, or 26 cultivars of those tested in this experiment. Most cultivars belonging to Sawar and Akimaki gokuwase types that are generally recognized as being tasty were included in the group. Ten cultivars, about one fourth of those tested, contained

from 0.5 to 2.0 mg/100 g of AITC and showed a slight pungency.

Only 3 cultivars containing AITC higher than 2.0 mg/100 g showed a pungency.

Moderate pungency is necessary for cabbage flavor, but cabbages with strong pungency are not to Japanese consumer's taste when they are consumed raw⁸⁾. The results in this experiment demonstrate that most cabbage cultivars commercially produced in Japan have no or slight pungency, and therefore there is virtually no problem as far as pungency is concerned.

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キャベツのアリルイソチオシアネート 含量と辛味の関係

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生食キャベツの辛味とホモジェネート中に生成したアリルイソチオシアネート (AITC) 含量との間に密接な

関係のあることを、国内の主要 39 品種を用いて確認した。供試した大多数の品種は AITC 生成量 0.5 mg/100 g 以下で、辛味はなかった。たった 3 品種のみが、2.0 mg/

100 g 以上の AITC を生成し、辛味を示した。この結果から、国産キャベツは、生食時の辛味が問題となることは少ないと判断した。

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H.R. MOSKOWITZ 編

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- I テクスチャーの物理的測定
- II 物理的測定と主観的測定との関係
- III テクスチャーの主観的測定

(合計 12 章) からなっている。内容は、食品物性の基礎的な面から始まり、消費者による官能評価まで幅広い。図、表をふんだんに含み、わかり易く書かれている。

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Seafoods and Fish Oils in Human Health and Disease

KINSELLA, J.E. 編

Dekker 社から出版している Food Science and Technology シリーズの 23 巻である。現在、話題になっている魚に含まれる高度不飽和脂肪酸と疾病との関連を総説した書である。内容は、食事中脂質と心臓疾患との関係、エイコサ酸の代謝、オメガ-3-酸が脂質代謝に及ぼす影響、米国におけるオメガ-3-酸の摂取、脂質中のコレステロールとビタミン、魚油の安全性、魚油の加工等である。米国で漁獲される魚種の特徴と、脂肪酸組成が巻末にまとめられている。この方面の研究者にとって、多くの情報が得られる。

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