Adv. Hort. Sci., 2014 28(2): 105-110

Evaluation of local eggplant cultivars in terms of the suitability as materials for "Yakuzen" dishes

S. Tsukagoshi* [(1)], K. Kuroda, M. Hohjo*, F. Ikegami*, N. Kunisaki***, T. Hanamura***, K. Yamada***, T. Hagiwara*****

* *Center for Environment, Health and Field Sciences, Chiba University, 6-2-1 Kashiwanoha, Kashiwa, Chiba 277-0882, Japan.*

** *Faculty of Horticulture, Chiba University, 648 Matsudo, Matsudo, Chiba 271-8510, Japan.*

*** *Research and Development Department, Nichirei Foods Inc., 9 Shinminato, Mihama-ku, Chiba 261-0002, Japan.*

Key words: functionality, local cultivars, property and taste, *Solanum melongena.*

Abstract: "Yakuzen" is a form of medicinal cooking based on the theories of Oriental medicine. To prepare Yakuzen dishes, in-season materials with appropriate properties and tastes, "Sei-Mi," are selected according to the health status and constitution of each person. In this study, the suitability of eggplant (*Solanum melongena* L.) cultivars for Yakuzen was evaluated by sensory tests and by analysis of the functional constituents considered to be closely related to the taste and functionality of Yakuzen dishes. Twenty-two eggplant cultivars including 21 Japanese and 1 Italian cultivar, and a Thai species (*Solanum xanthocarpum* Schrad & Wendl.) were evaluated. Principal component analysis (PCA) was used for comprehensive evaluation among the cultivars. From the PCA, many of the cultivars with round or oval fruit were characterized as juicy and sweet and considered easy to eat; most of the long-fruit cultivars were characterized as having higher specific amino acid contents. The small and round fruit cultivar Dewako and the Thai species (Makhuea pro) were considered to contain many functional ingredients, such as ash, polyphenols, and specific amino acids, and to have higher suitability for Yakuzen dishes.

1. Introduction

In recent years, malignant neoplasm (cancer), cerebrovascular disease and heart disease have become major causes of death among Japanese people, with approximately 75% of deaths in Japan caused by these diseases (Japanese Ministry of Health, Labour and Welfare, 2009 a). Such diseases are generally called lifestyle diseases because they are thought to be strongly related to a lack of exercise and high intake of fat and salt. Therefore, emphasis has shifted from early diagnosis (secondary prevention) to lifestyle improvement (primary prevention) (Japanese Ministry of Health, Labour and Welfare, 2009 b). In this context, research on foods that have pharmacological effects or physiological functions, such as disease prevention and health maintenance, has become more important (Namba, 1999; Tokui *et al*., 2003). Regarding the pharmacological effects of food, there is a form of medicinal cooking called "Yakuzen" which is based on the philosophy of Oriental medicine and is intended to maintain good health and improve physical condition. The preparation of Yakuzen dishes draws from the theory of "Yaku-shoku Dou-gen", which means that the same principle underlies the daily diet and medical treatment, and on the yin-yang theory, the five-phase theory in Oriental medicine. As a result, Yakuzen has attracted considerable attention for the prevention of lifestyle diseases.

To prepare Yakuzen dishes, in-season materials with appropriate properties and tastes are selected according to the health status and constitution of each person (Namba, 1995; Lan *et al*., 2002; Tokui *et al*., 2003). These properties and tastes are called "Sei-Mi" in Yakuzen theory. Sei-Mi consists of four properties (making the human body hot, warm, cool, or cold) and five tastes (salty, bitter, sweet, pungent, and sour), and each is considered to have its own function in the human body (Namba, 1999; Tokui *et al.*, 2003). If the concept of Sei-Mi can be applied to vegetables, a cultivar that has a strong flavor and a high content of functional constituents related to the properties and taste is considered to have strong Sei-Mi and is suitable for Yakuzen dishes.

However, the inherent flavor of vegetable cultivars has been weakened by breeding because priority has been given to ease of consumption for consumers or ease of production for growers. In the case of eggplant (*Solanum melongena* L.), popular cultivars in Japan today are F_1 (first filial generation) cultivars derived from a parental line with oval fruit, a deep purple pericarp, and high yield; these cultivars have improved fruit quality with less unpleasant or harsh taste.

[(1)] Corresponding author: tsukag@faculty.chiba-u.jp

Received for publication 31 March 2014
Accepted for publication 07 July 2014

However, eggplant was introduced into Japan more than 1,260 years ago, and it is mentioned in Nara-period documents (The Shõsõin documents) edited in 750 A.D. (Yoshida, 2010). Therefore, many cultivars have been developed over the long history of cultivation, and even today there are many cultivars with local origins. The chemical composition, flavor, and texture of the edible parts of plants vary among cultivars. Local cultivars grown for many years may have retained more flavor, and some of them may be more suitable for Yakuzen dishes than the currently popular cultivars.

Regarding the functionality of foods, many studies have focused on certain ingredients and have discussed the relationship between the amounts of those ingredients and the functionality of the food. However, it is important to consider the functionality of foods comprehensively in Yakuzen theory. In previous studies, we used principal component analysis (PCA) to comprehensively evaluate the functionality of local cultivars, and we demonstrated that two local cultivars of Japanese radish (*Raphanus sativus* L.), two of carrot (*Daucus carota* L.), and one of bitter melon (*Momordica charantia* L.) were more suitable for Yakuzen dishes than the widely used F_1 cultivar (Saito *et al.*, 2010; Tsukagoshi, *et al.*, 2011 a, b).

In this study, two F_1 cultivars and 21 local cultivars of eggplant were evaluated for their suitability as materials for Yakuzen dishes according to their taste and content of functional constituents.

2. Materials and Methods

Plant materials and growing condition

Twenty-one Japanese eggplant cultivars with different fruit shapes were selected for this study (Table 1). Most of them were purebred cultivars, but two F_1 cultivars were included. In addition, an Italian cultivar and a Thai species (*Solanum xanthocarpum* Schrad & Wendl.) were used. All cultivars were grown at the Center for Environment, Health and Field Sciences, Chiba University. Seeds of all cultivars were sown in 9-cm plastic pots filled with upland soil on 17 April 2012, and the seedlings were raised in a glasshouse. On 5 June seedlings were transplanted to the open field at a spacing of 50 cm between plants and 100 cm between rows. Fruits were harvested when they reached the regular size for each cultivar. Harvest began on 31 July and ended on 14 September. All other management was carried out according to the conventional methods in Japan (Chino, 2001).

Sensory test

Fruits were harvested on 7 and 9 August and the sensory test was conducted the following day. The fruits were washed, cut to a size of 1.5×1.5×3.0 cm, and steamed at 100°C for 5 min. The characteristics of steamed samples were evaluated by six panelists. The panelists passed recognition tests for five tastes (sweetness, umami, saltiness,

Table 1 - Eggplant cultivars used for the experiment

Fruit shape (country)	Cultivar	Abbreviation	Fruit length, weight and color	Remark
Small, Round (Japan)	Dewako	De	3-8 cm, 10-15 g, deep purple	
	Minden	Min	3-8 cm, 10-15 g, deep purple	
Round (Japan)	Aizu maru	AM	8-10 cm, 200-300g, deep purple	
	Kamo nasu	KN	12-15 cm, 200-350 g, deep purple	
	Tonosama	To	approx. 15 cm, 300-450 g, deep purple	
	Yamatoyo maru	YM	10-12 cm, 250-350g, deep purple	
Money pouch (Japan)	Nagaoka kinchaku	NK	8-10 cm, 300-350g, deep purple	
(swelling toward the bottom)	Saitama ao daimaru	SA	approx. 15 cm, 300-450 g, green	
Oval (Japan)	Heta murasaki	HM	approx. 5 cm, 30 g, deep purple	
	Senryo 2 gou	Se2	10-12 cm, 80-90 g, deep purple	F_1, Control cultivar in this experiment
	Se2 (Control)	SK	10-11 cm, 150-180 g, deep purple	
	Wase shinkuro	WS	10-12cm, 80-120 g, deep purple	
	Yamashina	Ya	10-12cm, 80-120 g, deep purple	
Long (Japan)	Chikuyou	Chi	20-25 cm, 120-150 g, deep purple	F_1
	Hakata naga	Hak	40-45 cm, 200-300 g, deep purple	
	Hhogo naga	Hho	17-18 cm, 85-90 g, deep purple	
	Himo nasu	HN	25-30 cm, 150-200 g, pale purple	
	Kitta chunaga	KC	10-12cm, 80-120 g, deep purple	
	Kurume oh naga	KO	30-35 cm, 250-300 g, deep purple	
	Shikon sendai naga	SS	8-10 cm, 20-30 g, bluish purple	
	Shin nagasaki naga	SN	35-40 cm, approx. 250 g, deep purple	
Big, Oval (Italy)	Zebra	Ze	20-25 cm, 300-400 g, purple and white stripes	
Small, Round (Thailand)	Makhuea pro	MP	4-5 cm, approx.10 g, green	Solanum xanthocarpum

bitterness, and sourness) and the discrimination tests for four solutes (sucrose, sodium chloride, tartaric acid, and sodium glutamate). In addition, they had more than one year experience in evaluating vegetables and were classified as expert assessors (Japanese Society for Sensory Evaluation, 2009). The characteristics listed in Table 2 were evaluated on a scale of -5 (weaker) to 5 (stronger) compared to Se2, the control cultivar in this study.

Taste sensor analysis and amino acid content

Approximately 50 g of fresh fruit was homogenized in 100 mL of water in an ice bath, then filtered through cotton cloth. Although filtrates were prepared separately from three or four fruit samples, the filtrates were mixed to obtain the quantity necessary for measurements. Bitterness, astringency, acridity, and pungency of the filtrates were measured using a taste sensor system (SA402B, Intelligent Sensor Technology, Kanagawa, Japan). Each value was expressed relative to the control cultivar (Se2), which was set at zero. A portion of each filtrate was filtered again through a 0.45-µm filter (DISMIC-25CS, Advantec, Tokyo, Japan) and the amino acid content was measured using an amino acid analyzer (JLC-500/V, JEOL, Tokyo, Japan).

Soluble solids content

Fresh fruit was cut into small pieces and pressed in gauze to extract the juice. The soluble solids content of the juice was measured using a refractometer (PAL-1, ATAGO, Tokyo, Japan) and expressed as percent Brix.

Ash and polyphenol contents

The harvested fruit was stored at -30°C until use. Fresh-frozen fruit samples were freeze-dried and ground into a fine powder. Ash content was determined using the dry ashing method. Briefly, 0.3 g of the powder was put in a crucible and ashed at 550°C for 24-48 hr. After cooling, the weight of the residue was measured. Polyphenol content was determined using iron tartrate spectrophotometry. First, 0.2 g of the powder was mixed with 10 mL of distilled water, and shaken for 10 min at 80°C. After cooling, the sample was centrifuged at 3,000 rpm for 15 min. Then, 3.2 mL of the supernatant was mixed with 1.6 mL of iron tartrate reagent (0.1% (w/v) ferrous sulfate and 0.5% (w/v) potassium sodium tartrate) and 3.2 mL of phosphate buffer (0.1 M, pH7.5). The absorbance at 540 nm was then measured using a spectrophotometer (U-2000, Hitachi, Tokyo, Japan). The polyphenol content was calculated from a

Table 2 - Evaluation of the taste of eggplant cultivars by sensory test [z]

Fruit shape	Cultivar	Aroma		Softness		Juiciness	Sweetness	Bitterness	Astringency
		Good	Grassy	Pericarp	Flesh				& Acridity
Small, Round	De [y]	0 [x]	0	-1	0	0	0	1	1
	Min	1	1	0	-1	0	-1	2	1
Round	AM	0	1	0	-1	0	0	0	1
	KN	1	1	0	-1	0	0	0	0
	To	0	0	-1	0	0	0	1	0
	YM	0	0	0	1	1	1	-1	0
Money pouch	NK	0	2	-3	-2	-1	-1	0	0
	SA	0	2	-4	0	-1	0	0	1
Oval	HM	0	0	0	1	0	0	0	0
	Se2 (Control)	0	0	0	0	0	0	0	0
	SK	0	2	0	1	2	1	0	0
	WS	0	0	-1	0	-1	-1	0	0
	Ya	1	0	-1	0	0	0	0	0
Long	Chi	0	0	0	1	0	-1	0	0
	Hak	0	0	1	1	-1	0	-1	0
	Hho	0	0	0	0	0	0	0	0
	HN	0	1	-1	1	-1	-1	0	0
	KC	0	0	-2	1	0	-1	0	1
	KO	0	0	-2	1	-1	-1	0	0
	SS	0	1	-1	0	0	-1	0	1
	SN	0	2	0	1	-2	0	-1	0
Big, Oval	Ze	2	2	0	-2	0	-1	0	2
Small, Round	MP	0	3	0	-1	0	-1	0	1

[z] Eggplant fruit was cut to the size of 1.5 x 1.5 x 3.0 cm, then steamed at 100 degree C for 5 min before the test.
[y] Amino acid which is considered to be important for the functionality of eggplant in Yakuzen theory.
[x] Tastes were evaluated on a scale of -5 (weaker) to 5 (stronger) as compared to Senryo 2 gou (Se2).

standard curve of ethyl gallate.

Principal component analysis and characterization of cultivars

Data were analyzed by principal component analysis (SPSS for Windows version 13), and the characteristics of cultivars were comprehensively evaluated to determine the suitability of the cultivars as materials for Yakuzen dishes.

3. Results and Discussion

Cultivars NK and SA (with money-pouch fruit shape) tended to have harder fruits, and long-fruit cultivars tended to be less sweet (Table 2). The aroma of the Italian cultivar, Ze was characterized as both "good" and "grassy". However, most cultivars were very similar to Se2 (the control cultivar in this study) in the sensory test.

Taste sensor analysis showed that the local cultivars tended to have a less unpleasant taste than Se2 (Table 3).

Table 3 - Evaluation of the taste of eggplant cultivars by taste sensor [z]

Fruit shape	Cultivar	Bitterness	Astringency	Acridity	Pungency
Small, Round	De [y]	-0.27 [x]	0.06	-1.74	-0.69
	Min	-0.38	0.04	-2.27	-0.96
Round	AM	-0.23	0.20	-1.14	-0.48
	KN	-0.11	0.21	-2.11	-0.94
	To	-0.11	0.13	-2.18	-1.18
	YM	-0.16	-0.02	-1.33	-1.30
Money pouch	NK	-0.26	0.27	-1.78	-0.64
	SA	-0.07	0.30	-2.30	-1.07
Oval	HM	0.22	0.13	-1.83	-0.99
	Se2 (Control)	0.00	0.00	0.00	0.00
	SK	-0.28	0.05	-1.51	-0.76
	WS	-0.06	0.23	-2.26	-1.17
	Ya	-0.09	0.08	-2.57	-1.30
Long	Chi	-0.33	0.12	-1.39	-0.61
	Hak	-0.28	-0.09	-2.55	-1.40
	Hho	-0.15	0.05	-1.61	-0.86
	HN	-0.01	0.15	-2.87	-1.45
	KC	-0.12	0.11	-2.24	-1.28
	KO	-0.43	0.07	-0.52	-0.15
	SS	-0.26	0.04	-2.03	-1.00
	SN	-0.47	-0.05	-2.27	-1.09
Big. Oval	Ze	-0.32	-0.02	-2.73	-1.23
Small. Round	MP	-0.34	0.19	-2.15	-0.75

[z] Taste sensor was prepared to express the value of Se2 was zero.

[y] Amino acid which is considered to be important for the functionality of eggplant in Yakuzen theory.

[x] Positive and negative value means the taste was stronger and weaker than Se2, respectively.

This result did not correspond to the results of the sensory test, and the difference may be due to the heating of samples before the sensory test but not before the taste sensor analysis. Nevertheless, we can conclude that the local cultivars were not unpalatable compared with the commonly used cultivar.

Min, YM and some other cultivars tended to have higher soluble solids contents, but there was no significant difference between cultivars (Table 4). "Mi" (the taste) of eggplant is "Kan" (sweet). In Yakuzen theory, Mi means not only the taste on the tongue but also specific functions in the human body (Tokui *et al.*, 2003). In this study, we could not discern differences of Kan characteristics from the results of sensory test and soluble solids contents among cultivars; therefore, the suitability of cultivars was evaluated on the basis of other characteristics.

Ash content was higher in cultivars De and Min (both of which have small, round fruit) and lower in cultivar WS, and tended to be lower in cultivars with oval fruit. "Sei" (the property) of eggplant is to cool the human body. Potassium accounts for most of the ash of eggplant fruit (USDA, 2013), and the function of this mineral is to release heat inducing diuresis. This function is closely related to the property of eggplant, and higher ash content may be related to greater suitability of cultivars for Yakuzen dishes.

Polyphenol content was also higher in De and Min. Eggplant contains polyphenols such as chlorogenic acid and nasunin, which are considered to have antioxidant activity, and to suppress lipid peroxidation, aging, various lifestyle diseases, and cancer (Kimura *et al.*, 1999; Noda *et al.*, 2000; Kitsuda *et al.*, 2005; Singh *et al.* 2009). Das *et al.* (2011) reported that grilled eggplant had a higher polyphenol content, though the cardioprotective ability was not different. The high polyphenol content in De and Min may increase the pharmacological value of these cultivars.

As mentioned above, Mi (the taste) also encompasses specific functions in the human body, and Mi of eggplant is Kan (sweet). Kan is considered to have functions such as supplying nutrition and energy, promoting relaxation, etc. Some amino acids are considered to have Kan functions. For example, glutamine is an energy source for digestion and plays an important role in the maintenance and improvement of immunity and the repair of organs (Ajinomoto Co. Inc., 2003 a, b), and this may correspond to a Kan function. Alanine has a sweet taste and supplies sugars to the body, and it is also considered to have a Kan function. The amino acids strongly related to the Kan of eggplant include alanine, citrulline, glycine, glutamine, proline and serine. Therefore, these amino acid contents were summed to give specific amino acid content (Table 4): it was highest in Se2 and SN and tended to be higher in the long-fruit cultivars and lower in the round-fruit cultivars. Total amino acid content also tended to be higher in the long-fruit cultivars, especially in SN. However, no other trends in amino acid content were observed. The higher content of specific and total amino acids in SN would indicate greater suitability of this cultivar for Yakuzen dishes.

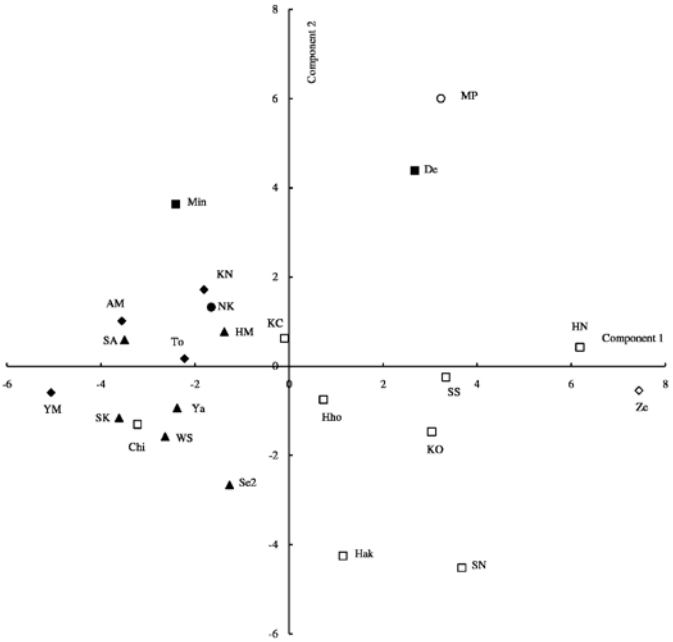

Fig. 1 Two dimensional scatter diagram of the principal component score of eggplant cultivars
■: small, round ◆: round ●: monry pouch ▲: oval □: long ◇: Italy ○: Thailand. Abbreviations as in Table 1.

From the PCA, 23 principal components (PCs) were derived and 14 PCs were considered to be meaningful (contribution rate>1). These 14 meaningful PCs accounted for 96.6% of the total rate (data not shown). Although the first two PCs accounted for only 41.3% of the total rate, a two-dimensional scatter diagram of factor loading was constructed. Specific and total amino acid contents were in the positive direction along the x-axis, and juiciness, sweetness, percent Brix and some unpleasant taste were in the negative direction. Ash, polyphenol content, and bitterness were in the positive direction along the y-axis, and softness was in the negative direction (data not shown). A two-dimensional scatter diagram constructed from the PC1 and PC2 scores of each cultivar enabled classification of the cultivars (Fig. 1). Many of the common F_1 cultivars of eggplant used for commercial production in recent years have been developed to improve ease of consumption and cultivation. Se2 is one of the common cultivars in Japan. It was characterized as juicy and sweet by the PCA and is considered easy to eat. The other cultivars with round or oval fruit were also characterized as juicy and sweet. On the other hand, most of the long-fruit cultivars were distinct from the round-fruit and oval-fruit

Table 4 - Soluble solid, ash, polyphenol and amino acid content of eggplant cultivars

Fruit shape	Cultivar	Soluble solids (% Brix)	Ash (g 100 g^{-1} FW)	Polyphenol [z] (mg 100 g^{-1} FW)	Specific amino acid [y] (mg 100 g^{-1} FW)	Total amino acid (mg 100 g^{-1} FW)
Small. Round	De [x]	5.1 a [w]	0.60 a [w]	673.4 a [w]	120.6	284.9
	Min	5.2 a	0.60 a	434.0 a	71.1	186.0
Round	AM	4.8 a	0.45 ab	169.0 b	37.2	151.2
	KN	5.4[v]	0.53 [v]	150.0[v]	48.8	203.1
	To	4.8 a	0.39 b	253.7 ab	52.5	196.6
	YM	5.3 a	0.50 ab	255.0 ab	36.3	144.3
Money pouch	NK	5.0 a	0.45 ab	172.9 b	63.1	197.8
	SA	4.6 a	0.50 ab	247.3 ab	39.5	167.3
Oval	HM	4.7 a	0.50 ab	300.6 ab	64.5	203.1
	Se2 (Control)	4.6 a	0.44 ab	129.1 b	145.6	302.0
	SK	4.3 a	0.39 b	158.4 b	48.0	170.6
	WS	5.1 a	0.37 b	181.9 b	52.8	199.1
	Ya	4.3 a	0.40 b	248.5 ab	58.1	185.4
Long	Chi	4.5 a	0.42 ab	188.1 b	34.1	161.2
	Hak	4.3 a	0.38 b	127.9 b	116.3	286.5
	Hho	4.8 a	0.52 ab	166.2 b	76.8	253.3
	HN	4.5 a	0.52 ab	144.1 b	83.6	288.6
	KC	4.4 a	0.48 ab	236.6 ab	50.8	211.0
	KO	5.1 a	0.45 ab	135.1 b	93.6	314.2
	SS	4.1 a	0.38 b	250.6 ab	106.1	281.8
	SN	4.5 a	0.41 ab	119.2 b	139.2	342.0
Big. Oval	Ze	3.8 a	0.46 ab	124.0 b	95.1	308.9
Small. Round	MP	5.1 a	0.56 ab	245.9 ab	63.9	196.7

[z] Polyphenol content was expressed as ethyl gallate equivalent.
[y] Amino acid strongly related to Kan of eggplant.
[x] Abbreviations as in Table 1.
[w] Different letter within the row indicates significant difference by Tukey's multiple range test at 5% level (n=5).
[v] Number of harvested fruit was not enough for statistical analysis.

cultivars. They were characterized as having higher specific amino acid contents and little unpleasant taste or sweetness. The small and round fruit cultivar De and the Thai species (MP) were considered to contain many functional ingredients, such as ash, polyphenols, and specific amino acids, and to have greater suitability for Yakuzen dishes.

4. Conclusions

Among the local Japanese cultivars used in this study, cv. De is highly suitable for Yakuzen dishes because it contains many ingredients associated with the properties and taste (Sei-Mi) of eggplant in Yakuzen theory. In addition, the Italian cultivar (Ze) and the Thai species were highly distinct. Different results may have been obtained had we grown the cultivars in another area or under different conditions. Nevertheless, we have demonstrated that some local eggplant cultivars have stronger Sei-Mi than current F_1 cultivars. These characteristics could add value to the local cultivars and lead to regional development.

References

AJINOMOTO CO. INC., 2003 a - *Amino san no hataraki (Function of amino acid). Amino acid handbook*. - AJINOMOTO Co. Inc., Kogyo Chousa-kai Publishing, Tokyo, Japan, pp. 20-63.

AJINOMOTO CO. INC., 2003 b - *Hinmoku betsu kakuron (Detailed explanation of each amino acid). Amino acid handbook*. - AJINOMOTO Co. Inc., Kogyo Chousa-kai Publishing, Tokyo, Japan, pp. 147-174.

CHINO K., 2001 - *Nasu no roji saibai (Cultivation method of eggplant in open field). Yasai tsukuri no jissai -Ka Sai 1- (Practical method of vegetable cultivation - fruit vegetables 1)*. Rural Culture Association Japan, Tokyo, Japan, pp. 80-90.

DAS S., RAYCHAUDHURI U., FALCHI M., BERTELLI A., BRAGA P.C., DAS D.K., 2011 - *Cardioprotective properties of raw and cooked eggplant*. - Food Funct., 2: 395-399.

JAPANESE MINISTRY OF HEALTH, LABOUR AND WELFARE, 2009 a - *Annual changes in death rate for leading causes of death. Health, labour and welfare report 2008-2009 Part 1*. - Japanese Ministry of Health, Labour and Welfare, No. 10.

JAPANESE MINISTRY OF HEALTH, LABOUR AND WELFARE, 2009 b - *Changes in national health promotion measures, Health, labour and welfare report 2008-2009 Part 2*. - Japanese Ministry of Health, Labour and Welfare, No. 62.

JAPANESE SOCIETY FOR SENSORY EVALUATION, 2009 - *Panel. Kannou hyouka shi text (Textbook for sensory evaluator)*. Japanese Society for Sensory Evaluation, Kenpakush, Tokyo, Japan, pp. 49-53.

KIMURA Y., ARAKI Y., TAKENAKA A., IGARASHI K., 1999 - *Protective effects of dietary nasunin on paraquat-induced oxidative stress in rats*. - Biosci. Biotechnol. Biochem., 63: 799-804.

KITSUDA K., NAKAMURA T., MORITA N., IMAHORI Y., SUZUKI T., IKEDA H., 2005 - *Antioxidative activity in eggplant 'Mizu-nasu' fruit and its enhancement after injury*. - Hort. Res. (Japan), 4: 229-232.

LAN S., SAKAI E., TANAKA T., 2002 - *The role of "Ishoku-dougen" in Japan. A study of "Yaku-zen" which is both old and new meal science*. - A. Proc. Gifu Pharm. Univ., 51: 47-53.

NAMBA T., 1995 - *Yakuzen to Kampo (Yakuzen and Oriental medicine)*. - Farumashia, 31: 19-21.

NAMBA T., 1999 - *Yakuzen no genri to shoku/yaku zai no kouyou (1) [Principes of Yakuzen, and the effect of food and medicine (1)]*. - J. Cookery Sci. Japan, 32: 374-379.

NODA Y., KANEYUKI T., IGARASHI K., MORI A., PACKER L., 2000 - *Antioxidant activity of nasunin, an anthocyanin in eggplant peels*. - Toxicology, 148: 119-123.

SAITO Y., HOHJO M., TSUKAGOSHI S., IKEGAMI F., NAKAO C., HANAMURA T., YAMADA K., HAGIWARA T., 2010 - *Study on the adequacy of vegetables as materials for medicinal foods. 5. Comprehensive evaluation of pre-selected* Momordica charantia *L. cultivars by principal component analysis.* - Hort. Res., 10 (Suppl.1): 481.

SINGH A.P., LUTHRIA D., WILSON T., VORSA N., SINGH V., BANUELOS G.S., PASAKDEE S., 2009 - *Polyphenols content and antioxidant capacity of eggplant pulp*. - Food Chemistry, 114: 955-961.

TOKUI N., MINARI Y., ZHANG Z.L., GUO X., 2003 - *Yakuzen no gaiyou (Outline of Yakuzen). Yakuzen to Chu-Igaku (Yakuzen and Chinese medicine)*. - Kenpakusha, Tokyo, Japam, pp. 2-32.

TSUKAGOSHI S., INUZUKA S., HOHJO M., IKEGAMI F., TAKENAGA S., NAKAO C., URYU N., HAGIWARA T., AOKI H., HANAMURA T., 2011 a - *Evaluation of Japanese radish cultivars in terms of medicinal properties for "Yakuzen" dishes.* - Hortresearch, 65: 81-86.

TSUKAGOSHI S., TAKANO A., HOHJO M., IKEGAMI F., HAGIWARA T., NAKAO C., YAMADA K, HANAMURA T., TAKENAGA S., AOKI H., 2011 b - *Evaluation of some local cultivars of carrot in terms of the suitability as materials for "Yakuzen" dishes*. - J. Trad. Med., 28: 106-114.

UNITED STATES DEPARTMENT OF AGRICULTURE, 2013 - *National nutrient database for standard reference, Release 26.* - United States Department of Agriculture, http://ndb.nal.usda.gov/ndb/search/list.

YOSHIDA T., 2010 - *Gensan to raireki (Origin and history of eggplant). Nougyo gijutsu taikei yasai hen (Compendium of agriculture, vegetables edition).* Vol. 5. Kisohen (Basis). - Rural Culture Association Japan, Tokyo, Japan, pp. 3-7.