Improvement of Quality of Green Tea by Deep-Pruning and Root-Pruning

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Introduction

The quality of tea is influenced by physiological and environmental factors, such as age of plants, developmental stages of new shoots, weather conditions before and during the growth of new shoots, soil conditions, fertilization, and so on.

It is said that green tea produced from young plants is superior in quality to that produced from mature plants. Mature plants are usually deep-pruned and root-pruned for improving growth of new shoots. However, effects of deep-pruning and root-pruning on quality of green tea are not clear. In addition, cellular components influencing quality of green tea produced from young plants and mature plants have not been examined in relation to the pruning.

From this point of view, the growth of new shoots in young and mature plants, the quality of green tea produced from young or mature plants, and effects of deep-pruning and root-pruning on the growth of new shoots and the quality of green tea were examined.[1,2]

Methods of experiment

Camellia sinensis (L) O. Kuntze cv. Yabukita (the most prevalent cultivar in Japan) was used. Young plants (2 year-old) and mature plants (10 year-old) were planted in rows (15 m in length) at an intra-row spacing of 40 cm. Three rows were used for each experiment.

Mature plants were pruned to the height of 15 cm (in 1978), 20 cm (in 1979) and 25 cm (in 1980) from the ground surface (deep-pruning). A half of the root system of each mature plants was cut in 1977 and 1978 (root-pruning).

About 20 apical shoots and the second leaves from the base of new shoots of the first flush were sampled to measure the growth of new shoots. Cellular components were determined with the samples obtained from 1979 to 1981.

Hot water extracts of green tea (primary heating tea) were subjected to an organoleptic test.

Content of tannin was measured by the method of Sakai et al.[4] Total nitrogen and free amino acids were measured by the micro Kjeldahl method,[5] and Ninhydrin method,[2] respectively. The amount of flavor in head space vapor was measured with FPD and FID gas-chromatographs.[1]

Growth characteristics of new shoots

Winter buds of young plants were longer and contained more leaves than those of mature plants. After breaking of buds, new shoots of young plants were also longer than those of mature plants (Fig. 1). Although new shoots of mature plants turned banjhi, those of young plants continued to develop (Table 1).

By the deep-pruning of mature plants, their winter buds and new shoots became similar to those of young plants. That is, winter buds of deep-pruned plants were longer and contained more leaves than those of mature plants, and new shoots did not turn banjhi. Moreover, as shown in Fig. 1, new shoots of

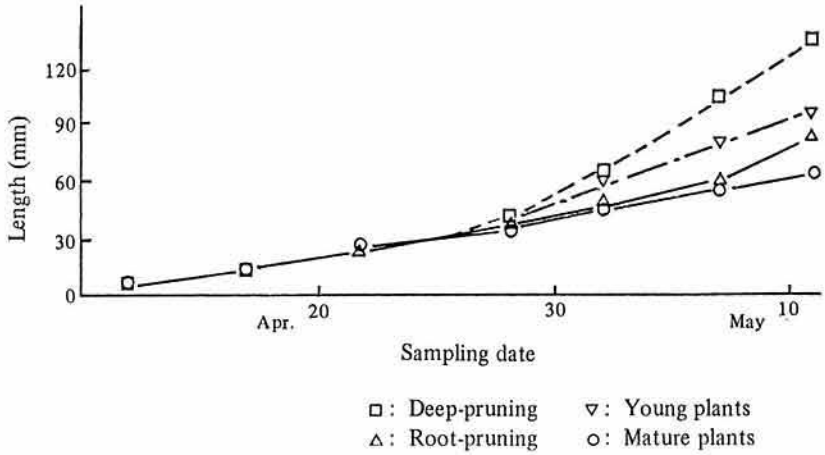

Fig. 1. Changes in the length of new shoots

Table 1. Changes in percent of banjhi shoots

Treatment	May 2	May 7	May 12
Young plants	...	...	0.0
Deep-pruning	...	...	0.0
Root-pruning	41.9	58.3	70.2
Mature plants	46.0	62.2	64.0

deep-pruned plants were even longer than those of young plants.

On the other hand, the root-pruning of mature plants exerted no effect on the growth of winter buds and new shoots, except on the length of new shoots, which were longer than those of mature plants (Fig. 1).

Quality of green tea

As shown in Table 2, the primary heating tea produced from the leaves of young plants was superior in organoleptic quality to that produced from mature plants.

By the deep-pruning and root-pruning of mature plants, the quality of green tea was improved to a level almost equal to that produced from young plants.

The deep-pruning exerted a stronger effect than the root-pruning. The quality improvement induced by root-pruning was recognized for 4 years in taste and 3 years in flavor, whereas deep-pruned plants showed good organoleptic quality even for 4 years after the treatment. Especially, it is interesting that the deep-pruned plants in 1979 was significantly superior in quality to young plants.

Table 2. Scores of organoleptic test

Sampling date	Experimental plot	Organoleptic quality[a]	
		Flavor	Taste
Apr. 27 1979 (2)[b]	Young plants	+2.0*	+3.0*
	Deep-pruning	+6.0*	+5.0*
	Root-pruning	+0.5*	+1.0*
	Mature plants	0	0
Apr. 26 1980 (3)	Young plants	+1.5	+2.0
	Deep-pruning	...	...
	Root-pruning	+1.5	+2.5
	Mature plants	0	0
May 10 1980 (3)	Young plants	+2.5**	+3.0**
	Deep-pruning	+2.0**	+2.0**
	Root-pruning	+1.0**	+2.5**
	Mature plants	0	0
Apr. 24 1981 (4)	Young plants	+4.0 +4.5	+3.5 +5.0
	Deep-pruning	+3.0 +3.5	+3.0 +4.5
	Root-pruning	0 +0.5	+1.5 +2.0
	Mature plants	0 +1.0	0 +1.0

a: Hot water extracts were used. The score of tea produced from mature plants was taken as zero. Plus signs indicate higher scores than zero.

b: Figures in parenthesis indicate the number of years after the pruning treatments.

* Significant at 5% level, and ** at 1%level.

Cellular components

Tannin content in new shoots was lower in young plants than in mature plants (Fig. 2). On the other hand, contents of free amino acids (Fig. 3) and total nitrogen were higher in young plants than in mature plants.

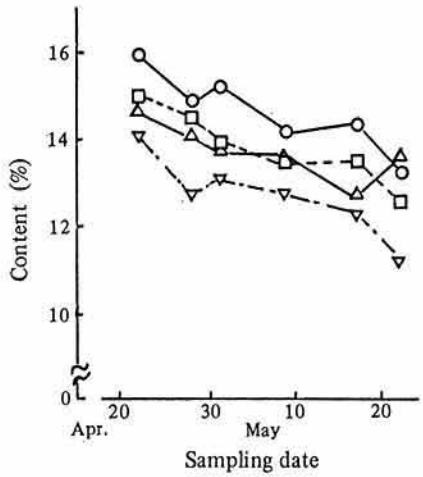

Fig. 2. Changes in tannin content of new shoots
Symbols are the same as Fig. 1.

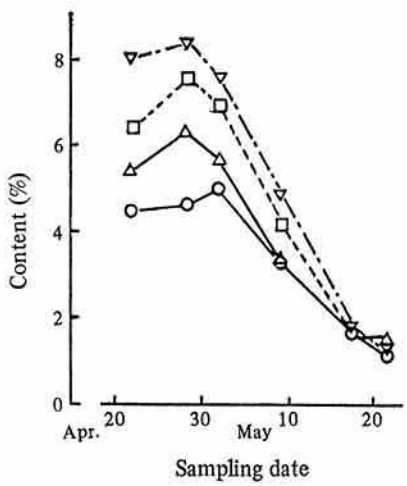

Fig. 3. Changes in content of free amino acids of new shoots
Symbols are the same as Fig. 1.

By deep-pruning and root-pruning, the content of tannin was lowered while the contents of free amino acids and total nitrogen were increased in mature plants.

It is generally said that green tea of good quality contains more amount of free amino acids and total nitrogen and less amount of tannin.[3] Therefore, the cellular changes induced by deep-pruning and root-pruning were regarded as responsible for the improvement of organoleptic quality.

Flavor

Compounds of head space vapor of primary heating tea are shown in Table 3. The head space vapor of young plants contained more dimethylsulfide, a laver-like odor, than that of mature plants. The amount of dimethylsulfide was apparently increased by deep-pruning, while it was only slightly increased by root-pruning.

From the facts that new shoots of young plants and deep-pruned mature plants did not turn banjhi, the analysis of dimethylsulfide content in head space vapor seems to be useful

Table 3. Compounds of head space vapor

Compounds	Experimental plot			
	Young plants	Deep-pruning	Root-pruning	Mature plants
Dimethylsulfide	27.6 a	32.8	15.4	15.3
	20.8b	33.6	13.2	16.6
2-Methylpropanal	2.8	2.4	2.4	3.3
	6.4	7.2	7.0	6.2
Unknown	4.5	3.9	3.7	3.4
	2.6	3.6	3.4	3.2
2-Methylbutanal	0.5	0.4	0.5	0.5
	5.6	7.8	7.8	5.4
n-Valeraldehyde	3.5	3.1	4.2	4.2
	5.0	7.6	6.2	5.0
Unknown	9.7	7.9	9.0	9.0
	11.8	10.0	11.8	12.6
Capronaldehyde	1.0	1.2	1.4	1.4
	7.2	4.8	3.6	5.6
Unknown	0.5	0.5	0.5	0.6
	4.6	3.8	3.0	2.4

Upper numbers (a) and lower numbers (b) are peak height (cm) of primary heating tea prepared on May 10, 1980 and Apr. 24, 1981, respectively.

for judging the maturity of new shoots.

Other components of head space vapor were not different among young plants, mature plants, deep-pruned and root-pruned plants (Table 3).

Conclusion

Green tea produced from leaves of young plants was superior in quality to that produced from mature plants. The deep-pruning or root-pruning treatment of mature plants induced an improvement of tea quality. The improvement in taste was recognized for a period of at least 4 years and that in flavor for 3 years after the treatment. The improvement of quality corresponded to increased amounts of free amino acids and total nitrogen, and a decreased amount of tannin in new shoots. Growth of new shoots was also increased by these treatments. Therefore, the deep-pruning and root-pruning of mature plants are useful in improving quality of green tea.

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