Effects of Different Roasting Temperature on Flavor and Quality of Oolong Tea (Tong-Tin Type)

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Abstract

The change of liquor color, aroma and taste of oolong tea after roasting have close relation with the change of nonvolatile and volatile compounds. Oolong tea roasted at 80°C still preserved its original golden liquor color, brothy taste, and floral aroma, The high concentrations of linalool, linalool oxides, β-ionone, and 3.7-dimethyl-1.5.7-octatrien-3-ol, with a proportional concentration of pyrroles, pyrazines, and furans are probably the main contributors to the pleasant roast aroma of oolong tea roasted at 100°C or 120°C. The high concentrations of pyrroles (1-ethyl-2-formyl-pyrrole in major), pyrazines (2.5-dimethyl-3-ethyl-pyrazine in major), and furans (5-methyl-2-furfural in major) are probably the main contributors to the over–roast burnt odor of tea roasted at 140°C or above. Obvious deterioration in the quality of tea, such as turning the color of liquor to red and dull, increasing of sour taste and burnt odor of roasted tea, was found when roasted at 140°C or above. Our results strongly suggest that the roasting temperature of high quality oolong tea should not be higher than 80°C, and that of middle-grade tea should be around 100~120°C.

Keywords: Oolong tea, roast aroma, flavor, roasting

Introduction

Tea flavor is unique among various beverages, and flavor is the most important factor in determining tea quality. Accordingly, the market price of tea is based on its flavor. The term flavor involves both taste (nonvolatile compounds) and aroma (volatile compounds). The characteristic taste of tea is made up of a balanced mixture of astringency, bitterness, brothy taste, and slight sweetness (Haslam, 1988; Yamanishi, 1995). Principal contributors of astringency and bitterness are catechins and caffeine. The brothy taste is due mainly to amino acids.

Very complicated mixtures of volatile compounds, such as terpenoids, alcohols, carbonyl compounds, etc., contribute to characteristic tea aroma (Dai, 1998; Juan, 1981; Kobayashi, 1985; Ni 1997; Takeo, 1981). Aroma is considered the most important factor contributing to the quality of tea. Because the sense of olfaction is much more sensitive than the sense of taste, even minor components occuring in very low concentrations have an effect on the overall quality of tea. (Yamanishi, 1995)

Factors contributing to specific tea aroma are : various manufacturing processes (Juan, 1981; Kobayashi, 1985; Ni, 1997; Takeo, 1983a; Takeo, 1983b; Tokitomo, 1984; Yamanishi, 1970;Yamanishi, 1980), different varieties of tea plants (Chen, 1998; Dai, 1997; Dai, 1998; Takeo, 1983b), maturity of leaves (Tokitomo, 1984; Yano, 1990;Yamanishi, 1995), climatic conditions during tea-flush growth, (Juan, 1981; Dai, 1997; Yamanishi, 1995), roasting of made tea (Anan, 1979; Anan, 1981; Anan, 1984; Hara, 1982; Koehler, 1970; Tanaka, 1984; Yamanishi, 1973), and others. Oolong tea (Tong-Tin Type) are processed through solar withering, indoor withering with shaking, panning, rolling, primary drying, ball–rolling, and drying. Although the aroma and taste of oolong tea are formed in the course of withering and shaking (the undergoing of partial-fermentation), improper control during drying and roasting after panning and rolling will result in the loss of aroma or even scorched taste due

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to high temperature to debase the tea quality. The quality of oolong tea produced in low-land tea plantation is lower than that produced in high-land. Usually roasting is used to improve the aroma and taste of low quality tea. The technique of tea roasting still depends largely on experience of tea makers in Taiwan. In order to get the basic information for setting up a scientific and automatic controlling method for tea roasting, the effects of roasting temperature on taste (nonvolatile compounds), aroma (volatile compounds), and quality of oolong tea were studied.

Materials and Methods

Materials. Fresh leaves of *Camellia Sinensis* L.var. Chin-`Sin-Oolong were plucked at the Tong-Tin substation, Taiwan Tea Experiment Station. Oolong tea made from the same variety was prepared at the substation. The roasted tea samples were prepared by roasting oolong tea at different temperature (80°C, 100°C, 120°C, 140°C, 160°C) for four hours. The procedure is summarized in fig.1

Determination of the *p*H value and the color of tea liquor

Three grams of tea samples were steeped for 5min. with 150ml of boiling water, then the hot liquor was poured into a beaker and cooled in a cold water bath to about 25°C. The *p*H value of the cool liquor (about 25°C) was determined with a *p*H meter, and the color of the liquor was determined with a color and color difference

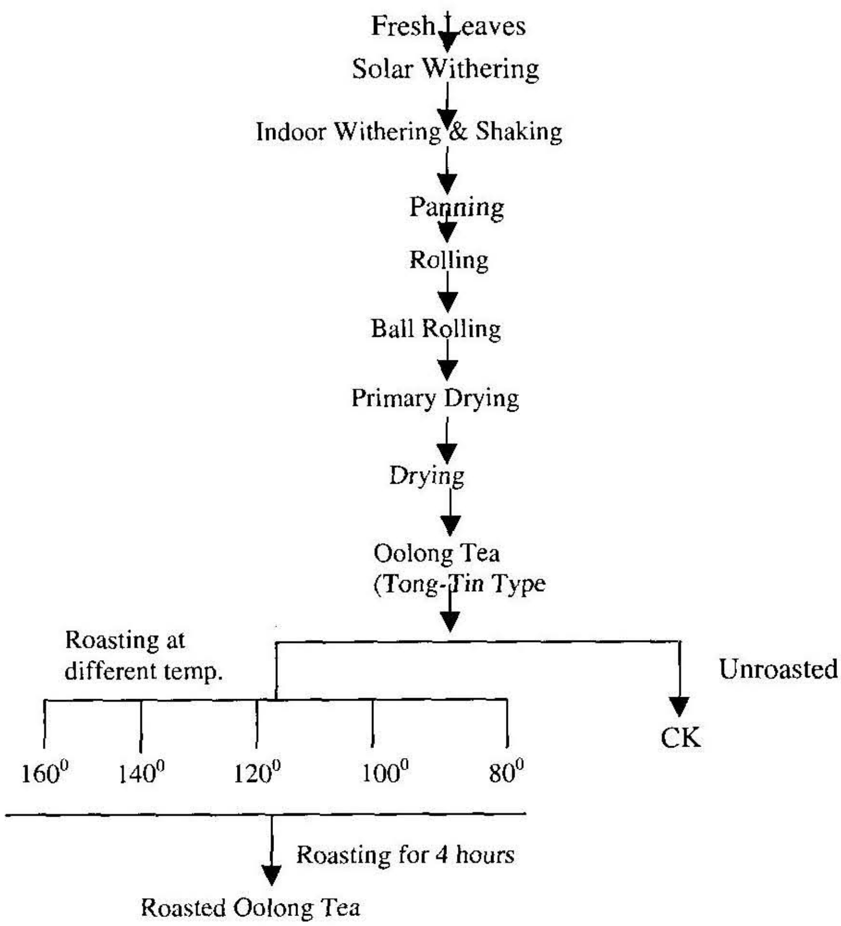

Fig.1. Preparation of the roasted Oolong tea samples

meter (model ND-1001DP; Nippon Denshoku Kogyo Co., Ltd.)

Determination of catechins in tea

The method of Swain and Hillis (1959) with some modification was used for determination of catechins in tea in this study. One gram of tea sample was reflux extracted with 100ml hot water for 1 hour. The tea extract was filtered and made up to 100ml. Five ml of extract was diluted to 100ml with distilled water. A solution of 0.8% vanillin in 40% H_2SO_4 was used as a color developer. One ml of diluted tea extract was mixed with 4 ml of fresh prepared vanillin solution and allowed to stand for 1 hour, then the absorbance of the mixture at 500nm was determined. The content of catechins in tea extract was calculated according to the following equation : Y=66.83X-0.15, where, Y: concentration of catechins in extract (μg/ml), X: absorbance at 500 nm.

Determination of soluble solids in tea

The content of total soluble solids in tea was determined by the AOAC method.

Determination of caffeine in tea

The tea sample was reflux extracted with hot water for one hour and then filtered. PVPP (Polyvinylpolypyrrolidone) was used to adsorb and clear away the polyphenols in tea extract. The caffeine in tea extract was determined by HPLC analysis using a Waters 600E system controller. The Waters 484 turnable absorbance detector was used to detect caffeine at 276nm. The HPLC method used a μ-Bondapack C18 column (3.9mm×300mm). The de-polyhpenol tea extract was filtered through a 0.45μm filter disk, and then 20μl was injected into the column. The mobile phase was acetonitrile/ acetic acid /water (5:1:95, v/v/v) and run at a flow rate of 2.0ml/ min.

Determination of free amino acids in tea

The preparation of tea extract was the same as the determination of caffeine. Free amino acids in tea extract were determined with an automatic amino acid analyzer.

Determination of sugars in tea

The preparation of tea extract was the same as the determination of caffeine. The HPLC method used a Sugar-Pak 1 column (6.5mm×300mm). The Waters 410 RI detector was used to detect sugars in tea extract. The tea extract was filtered through a SEP-PAK C_{18} disk, and then 20μl was injected into the column. The mobile phase was deionized water (50mg EDTA/1000ml H_2O) and run at a flow rate of 0.4ml/min. The column was incubated at 90°C.

Extraction and analysis of aroma

Tea aroma was extracted by simultaneous distillation and extraction (SDE) method with methylene chloride, dried over anhydrous sodium sulfate, concentrated *in vacuo*, and then analysed by GC and GC-MS. A Shimadzu GC-7A gas chromatograph with a flame ionization detector (FID) was used. The GC conditions were as follows: column, 0.25 mm i.d.×50m fused silica WCOT coated with PEG 20M; N_2 carrier gas flow rate, 1.2ml/min; split ratio, 30:1; column temperature, held at 70°C for 4 min and raised to 200°C at a rate of 20/min; and injection temperature, 200°C. A Hewlett-Packard–5790 gas chromatograph coupled with a JEOL–JMS –DX –300 mass spectrometer was used, The mass data were analysed by a JEOL–DA –5000 data processing system. The GC conditions were the same as those in GC analysis. Mass spectra were obtained by electron ionization at 70 eV.

Results and Discussion

Effect on the quality of tea

Oolong tea were roasted at different temperature (80-160°C) for 4 hours, the quality of roasted tea was assayed by sensory evaluation. The made tea color roasted at 80°C or 100°C still preserved the original greenish color. As the roasting temperature increased over 120°C, the color of made tea changed from green into yellow–brown at 120°C, red-brown at 140°C, and even dark-brown at 160°C.

The effect on liquor color of tea was similar to that on appearance of made tea color. The change of liquor color was very little, when the roasting temperature was not higher than 100°C. However, when the roasting temperature was higher than 120°C, the liquor color changed and lost the color that quality oolong tea should have. An obvious change was observed in the liquor color, that showed a color of yellow-red at 120°C, further, it was turned to the orange-red color at 140°C and dark-red at 160°C.

The aroma of tea roasted at 80°C still preserved the characteristically elegant floral aroma of Tong-Tin oolong tea. A pleasant roast aroma was obtained after roasting at 100°C for 4 hours . The tea roasted at 120°C had a strong roast aroma with weak burnt odor, while roasted at 140°C or at 160°C presented on obvious burnt odor, and the taste was sour and bitter. The quality of tea was markedly degraded when it was roasted at over 120°C.

Effect on the *p*H value and the color of tea liquor

Upon roasting, even at 80°C, the *p*H value of tea liquor decreased significantly when compared with that of the original tea (table 1). From this, we know that the *p*H value of tea liquor is easy to be changed during roasting, the comments made by the sensory evaluaters also showed that the sour taste of tea liquor has been increased gradually during roasting.

When tea was roasted at temperature lower than 100°C, the difference among the value of a, b and E of tea liquor was not obvious (shown in table 1), the result was in accordance with the tea taster's comments that the change of liquor color was very little when the roasting temperature was not higher than 100°C. At roasting temperature higher than 120°C, the value of a and b showed an obvious change (largely increased) compared to the original tea, which means a roasting temperature higher than 120°C has an obvious effect on changing the liquor color to yellow-red.

Effect on major nonvolatile compounds and taste of tea

The change of the content of soluble solids, catechins, polyphenols, caffeine, sugars and free amino acids are shown in table 2 and table 3. As shown in table 2, soluble solids content in tea was decreasing with the rising of roasting temperature, particularly at the high temperature of 160°C. This is probably owing to the heat oxidative polymerization and carbonization of the components of tea roasted at high temperature.

The content of catchins and polyphenols in tea just changed a little as the roasting temperature was not higher than 100°C. But when the roasting temperature was over 120°C, the content of catechins would significantly decrease. At that time the content of polyphenols would increase with decreased content of catechins. The fact indicated that catechins at such high temperature (over 120°C) would be oxidized and condensed to form polymers in yellow-orange color (Tanaka, 1984), causing the values of b (positive value means the tendency toward yellow color) and the values of a (positive value means the

Table 1. The effects of roasting temperature on the pH value andcolor of tea liquor.

Treatment	*p*H	ΔL	Δa	Δb	ΔE
CK	6.14	-8.70	-2.57	13.67	16.47
80°	6.05	-9.47	-2.39	16.27	19.07
100°	6.02	-9.40	-2.10	15.53	18.37
120°	5.85	-9.00	0.37	19.40	21.63
140°	5.66	-14.27	2.70	30.17	33.37
160°	5.54	-25.27	6.77	30.77	40.37

CK: The original oolong tea used for roasting
Each roasting treatment comprised roasting for 4 fours at the set temperature.

Table 2. The change of the contents of nonvolatile compounds in tea roasted at different temperature. (Unit: % DW)

Treatment	Solube Solids	Catechins	Polyphenols	Caffeine	Glucose	Sucrose	Fructose
CK	41.2	8.52	18.83	1.58	2.12	2.52	0.93
80^0	40.7	8.22	18.34	1.63	2.12	2.57	0.87
100^0	40.1	7.83	18.83	1.64	2.01	2.71	0.72
120^0	39.8	7.27	19.68	1.58	1.45	2.40	0.57
140^0	39.6	6.23	21.77	1.60	1.27	1.92	0.36
160^0	37.3	4.57	20.18	1.69	0.91	0.38	0.27

CK: The original oolong tea used for roasting
Each roasting treatment comprised roasting for 4 hours at the set temperature.

Table 3. The change of free amino acids in tea roasted at different temperatures. (Unit: n mole /150μl)

Treatment	Lys	Thr	Ala	Glu	Asp	Theanine
CK	1.08(100)	3.27(100)	5.61(100)	19.51(100)	16.32(100)	37.65(100)
80^0	1.23(114)	2.82(86)	5.45(97)	18.96(97)	16.69(102)	38.01(101)
100^0	0.94(87)	2.80(86)	4.70(84)	14.01(72)	13.23(81)	30.47(81)
120^0	0.98(90)	1.96(60)	4.41(79)	8.03(41)	8.23(50)	15.67(42)
140^0	0.52(48)	1.28(39)	2.22(39)	3.69(19)	5.97(37)	5.66(15)
160^0	--	--	1.82(32)	1.43(7)	2.89(18)	1.02(3)

Figures in parenthesis are percent of residue compare with the unroasted tea (CK).
Each roasting treatment comprised roasting for 4 hours at the set temperature.

tendency toward red color) increased positively during roasting (table 1), and the oxidative polymer may have some interaction with oral mucoprotein to induce astringency (Haslam & Lilley, 1988). This may explain the reason why tea tasters comment the tea roasted at higher temperature (120-140°C) tasted astringent. But the speculation need further experiment to confirm. The HPLC analysis of caffeine in tea showed the tendency that the caffeine content increased with the increasing of roasting temperature. This is probably because some caffeine bonded in the tissue would be sublimated and tends to be extracted more easily by hot water. The inference may explain one of the reasons why the more the tea is roasted, the more bitter it tastes. However, the assumption of bound caffeine existing in tea, needs verification.

The contents of free amino acids, particularly theanine (table 3, fig. 2) and reducing sugars such as glucose and fructose began to decrease (table 2, fig. 2), when the tea was roasted to induce a pleasant roast aroma at 100°C or at 120°C. This showed the Maillard reaction was one of the causes that produced roast aroma of tea and made the color of tea liquor brown (Anan, 1979; Anan & Kato, 1984; Hara, 1981; Kato, 1972; Koehler, 1969; Shigematsu, 1972). Besides, the sucrose in tea may decrease its content due to caramelization when being roasted at high temperature (over 120°C). The flavor substance and brown product produced by the caramelization would influence the taste and the browning of tea liquor, and would also have an effect on the formation of roast aroma of tea.

Effect on the aroma of tea

Oolong tea (Tong-Tin type) produced in Taiwan is well known as a partial-fermented tea, which has a characteristically elegant floral and fruity aroma. The main contributions to the aroma characteristics come from the high concentration of nerolidol, jasmine lactone, methyl jasmonate, and indole (Juan, 1981;

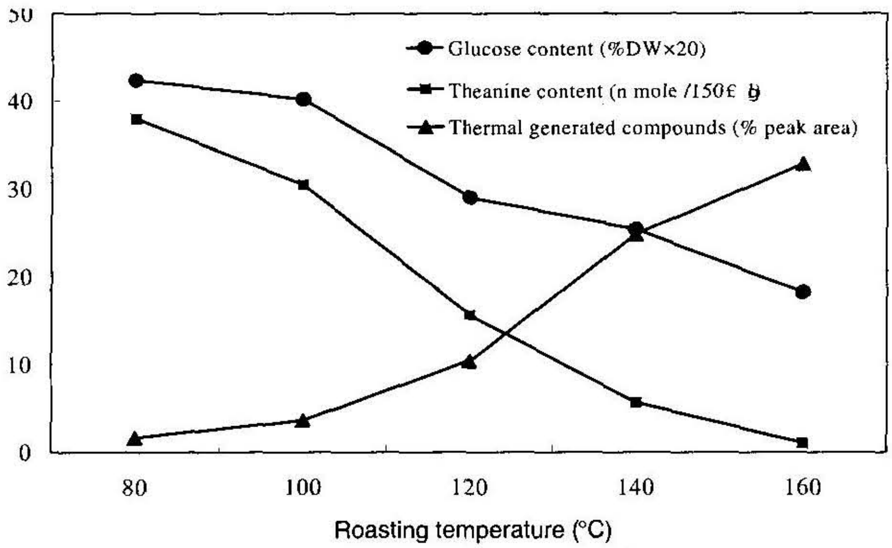

Fig 2. Effect of different roasting temperature on glucose, theanine, and thermal generated compounds content in roasted teas.

Tokitomo, 1984;Kobayashi, 1985). A special processing of partial-fermented tea includes solar withering followed by indoor withering with shaking treatment. Partial-fermented tea is processed while the tea leaves are intact and alive even though they are under water-stress conditions; this is in contrast to the production of black tea, where fermentation takes place when the cells are broken, injured and dead. The leaves are shattered during the rolling process in making black tea. The contents of the cells are mixed with oxygen in making black tea but not in the production of partial-fermented tea (Pouchong tea or oolong tea). The boichemical reactions undergoing in the withering process with shaking several times in making pouchong tea or oolong tea are defined as partial-fermentation, which is quite different from the fermentation process in making black tea.

A report on the formation of aroma compounds during solar withering and indoor withering (the undergoing of partial-fermentation) said that those compounds, which contribute to the floral note, are jasmine lactone, methyl jasmonate, benzyl alcohol, α-farnesence, phenylethyl alcohol, benzyl cyanide, nerolidol, esters of (Z)-3-hexenol, and indole, etc. (Kobayashi, 1985). In this study, we also found that these compounds contribute to floral aroma had a amount of about 50% (in peak area) of the total amount of the aroma of oolong tea roasted at 80°C or at 100°C, and decreased sharply at high roasting temperature such as 140°C and 160°C (refer to table 4, fig 3). The result means that oolong tea roasted at 80°C still has its floral aroma, and loses its floral note as the roasting temperature is higher than 120°C. That is in accordance with the experience of tea makers to roast a high quality oolong tea with a roasting temperature around 70-80°C.

The number and amount of thermally generated aroma compounds increased along with the increasing of roasting temperature. We found 1 pyrrole, 1 pyrazine, 3 furans and 4 ionone-related compounds at 80°C; 5 pyrroles, 4 pyrazines, 4 furans and 4 ionone-related compounds at 100°C; 7 pyrroles 9 pyrazines, 6 furans and 6 ionone-related compounds at 120°C; 6 pyrroles, 9 pyrazines, 7 furans and 5 ionone-related compounds at 140°C; 7 pyrroles, 10 pyrazines, 7 furans and 4 ionone-related compounds at 160°C. The total amount of pyrroles, pyrazines and furans in tea roasted at 80°C, 100°C, 120°C, 140°C, and 160°C were

Table 4. Comparison of aroma compositions of the tea roasted at different temperature.

Compound	Peak area %				
	80°C	**100°C**	**120°C**	**140°C**	**160°C**
Green note:					
Hexanal	2.55	1.39	0.95	0.95	1.11
E-2-Hexenal	0.53	0.31	0.24	0.25	0.22
Z-3-Hexenol	0.50	0.59	0.86	1.40	1.75
E-3-Hexenyl butyrate	0.13	0.15	0.11	0	0
α-Terpineol	0.41	0.12	0.15	0.13	0
Z-3-Hexenyl-2-methyl-butyrate	0.48	0.38	0.36	0	0
	4.60	**2.94**	**2.67**	**2.73**	**3.08**
Floral note:					
α-Farnesene	14.99	14.20	9.67	4.20	1.32
Benzyl alcohol	0.88	0.82	0.87	0.53	0.46
Phenylethyl alcohol	1.41	1.29	1.11	0.82	0.53
Benzyl cyanide	1.79	1.72	1.77	2.0	1.38
Nerolidol	10.35	8.70	6.09	3.26	1.30
Z-3-Hexenyl benzoate	1.29	0.97	0.99	0.27	0.29
Jasmine lactone	1.89	1.67	1.65	1.15	0.93
Cis-Methyl jasmonate	0.54	0.34	0.46	0.09	0
Indole	16.10	14.31	9.40	3.30	0.92
Z-3-Hexenyl hexanoate	1.82	1.90	1.75	1.67	1.33
	51.06	**45.92**	**33.76**	**17.29**	**8.46**
Thermally generated:					
1-Ethyl pyrrole	0	0.23	0.61	1.18	0.58
1-Ethyl-2-formyl-pyrrole	0.18	1.03	2.22	5.82	4.58
2.4-Dimethyl-3-acetyl-pyrrole	0	0.21	0.42	1.55	1.11
N-Methyl-2-acetyl-pyrrole	0	0	0.08	0.12	0.06
N-Furfuryl pyrrole	0	0.06	0.14	0.16	0.17
2-Acetyl-pyrrole	0	0.24	0.89	0.69	0.51
1-Methyl-2-pyrrolecarboxy aldehyde	0	0	0.20	0	0.97
Methyl pyrazine	0	0.07	0.37	0.81	0.93
2.5-Dimethyl-pyrazine	0.62	0.16	0.66	1.45	1.78
2.6-Dimethyl-pyrazine	0	0.40	0.49	0.83	0.87
2-Ethyl-pyrazine	0	0.12	0.31	0.59	0.70
2.3-Dimethyl-pyrazine	0	0	0.08	0.21	0.26
2-Ethyl-6-methyl-pyrazine	0	0	0.29	0.24	0.33
2-Ethyl-5-methyl-pyrazine	0	0	0.05	0.09	0.76
Trimethyl pyrazine	0	0	0.07	0.09	0.30
2.5-Dimethyl-3-ethyl-pyrazine	0	0	1.10	5.13	9.97
2-Ethyl-3.5-dimethyl-pyrazine	0	0	0	0	0.30
2-Amylfuran	0.34	0.27	0.18	0.16	0.20
Furfural	0.29	0.39	0.54	0.97	0.76
2-Acetyl-furan	0	0.13	0.42	1.01	1.11
5-Methyl-2-furfural	*0*	*0*	*0.73*	*2.96*	*4.70*
Furancarboxylic acid, methyl ester	0	0	0	0.29	1.45
Furfuryl alcohol	0	0	0.17	0.12	0.08
5-Butyldihyro-2(3H)-furanone	0.23	0.31	0.39	0.36	0.33
	1.66	**3.62**	**10.41**	**24.83**	**32.81**

Contd

table 4 contd

Compound	Peak area %				
	80°C	100°C	120°C	140°C	160°C
Ionone derivatives					
6-Methyl-ionone	0	0	0.05	0	0.28
2.6.6-Trimethyl-2-hydroxycyclohexanone	0.66	0.46	0.52	0	0
1-Methyl-1-cyclohexen-3-one	0	0	0.23	0.47	0
α-Ionone	0	0	0	0.29	0.18
β-Ionone	2.48	2.55	2.67	2.39	1.84
5.6-Epoxy-β-ionone	0.31	0.21	0.33	0.22	0
Theaspirone	0.38	0.22	0.42	0.13	0.19
	3.83	**3.44**	**4.22**	**3.5**	**2.49**
Other major compounds					
Linalool oxide I	0.81	1.13	1.64	3.40	3.99
Linalool oxide II	0.63	0.55	0.66	1.50	1.88
(E·E)2.4-Heptadienal	1.24	1.52	1.76	2.37	2.31
Linalool	1.99	2.20	1.81	1.33	0.68
3.7-dimethyl-1.5.7-octatrien-3-ol	1.80	7.97	8.96	3.39	0.71
Linalool oxide III	1.11	1.27	1.75	2.42	0.86
Methyl salicylate	0.33	0.31	0.33	2.06	3.35
Hexanoic acid	0.29	0.23	0.45	0.34	0.31
Geraniol	7.34	6.84	5.30	2.58	0.92
	15.54	**22.02**	**22.66**	**19.39**	**15.01**
Total	**76.69**	**77.94**	**73.72**	**67.74**	**61.85**

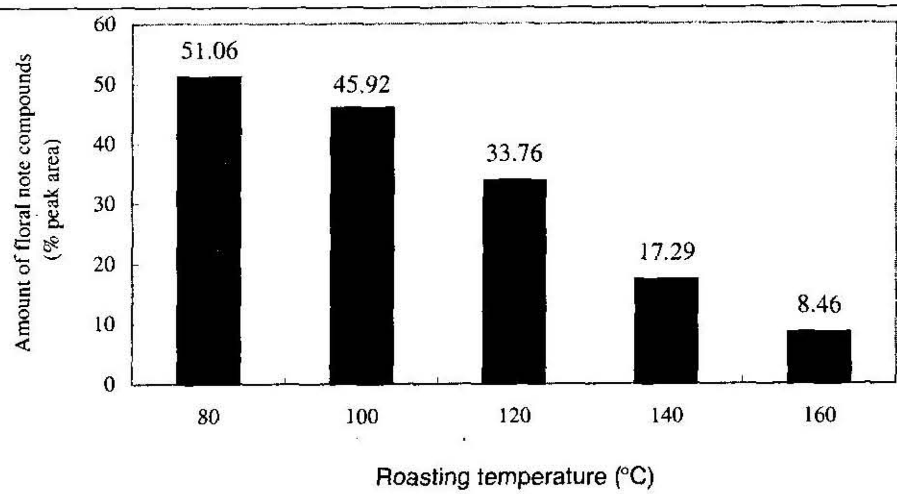

Fig 3. Effect of different roasting temperature on the amountof floral note compounds in roasted tea

1.66, 3.62, 10.41, 24.83, and 32.81% peak raea, respectively, (table 4, fig. 2; fig. 4).

Heating of amino acids and sugars produces furans, pyrroles, and pyrazines (Anan, 1981; Hara, 1982; Kato, 1972; Yamaanishi, 1989). This is the basis for roasting a lower-quality green tea, ban-cha, at a temperature of about 180°C for a few minutes to produce a roast aroma with weak burnt smell of Hojicha. (Yamanishi, 1973) The taste of Hojicha, roasted green tea, becomes more brisk and light from the loss of amino acid and soluble catechins (Anan, 1984). The characteristic aroma of

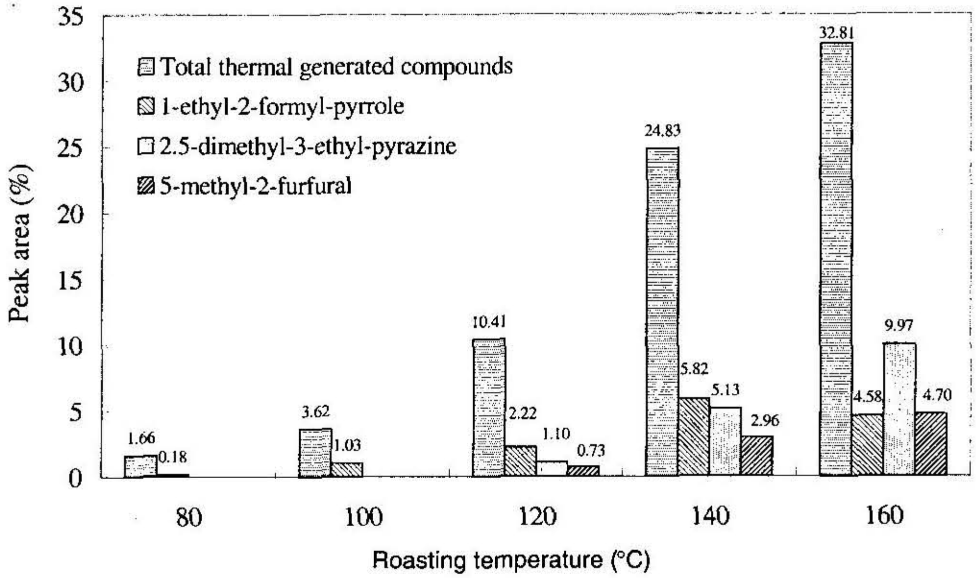

Fig 4. Comparison of the amount of thermal generated compounds in roasted tea.

Hojicha is due to the large amount of pyrazines, furans, pyrroles and ionone-related compounds (Yamanishi, 1973). In this study we found that the formation of thermal generated aroma (pyrroles, pyrazines, and furans) was higher with the decreasing of sugars and free amino acids (fig. 2). The results indicate that the formation of roast aroma and burnt odor are due to the Maillard reaction of free amino acids (Theanine in major) and reducing sugars, and also the caramelization of sucrose, depend on the roasting temperature. When roasting at high temperature (over 140°C), the roasted tea had a over-roast burnt odor. The high concentrations of pyrroles (1-ethyl-2-formyl-pyrrole in major), pyrazines (2.5-dimethyl-3-ethyl-pyzazine in major), and furans (5-methyl-2-furfural in major) are probably the main contributors to the over-roast and burnt odor of tea roasted at the temperature of 140°C and above. (fig. 4)

Longzing tea is one of the famous Chinese green teas because of its attractive flavor. The high concentrations of linalool, linalool oxides, geraniol, 2-phenylethanol, lactones, β-ionone, 3.7-dimethyl-1.5.7-octatrien-3-ol, and pyrazines are the contributors to the characteristic floral sweet note and pleasant roast aroma of Longzing tea (Yamanishi, 1995), For roasted oolong tea, we also found the high concentrations of linalool, linalool oxides, β-ionone, and 3.7-dimethyl-1.5.7-octatrien-3-ol in the tea with pleasant roast aroma (table. 4). The results strongly suggested that the high concentrations of linalool, linalool oxides, β-ionone and 3.7-dimethyl-1.5.7-octatrien -3-ol, with a proportional concentration of pyrroles, pyrazines and furans were the contributors to the characteristic pleasant roast aroma of roasted oolong tea.

Conclusions

The change of liquor color, aroma and taste of tea after roasting have close relations with the change of chemical components, both of nonvalatile and volatile compounds, in tea. Oolong tea roasted at 80°C still preserved its original golden liquor color, brothy taste, and floral aroma, showed just a little change of chemical components compare to that of unroasted original tea. The volatile compounds, α-farnesene, benzyl alcohol, phenylethyl alcohol, benzyl cyanide, nerolidol, esters of 3-hexenol, jasmine lactone, methyl jasmonate, and indole contribute to the floral note of high quality oolong tea. These compounds had a high concentration and showed just a little change after roasting at 80°C or 100°C, and decreased sharply after roasting at 120°C and above.

The high concentrations of linalool, linalool oxides, β-ionone, and 3.7-dimethyl-1.5.7-octatrien-3-ol, with a proportional concentration of pyrroles, pyrazines, and furans probably contribute to the pleasant roast aroma of roasted oolong tea. The high concentrations of pyrroles (1-ethyl-2-formyl-pyrrole in major), pyrazines (2.5-dimethyl-3-ethyl-pyarzine in major), and furans (5-methyl-2-furfrual in major) are probably the main contributors to the over-roast burnt odor of tea roasted at 140°C or above.

In order to keep its original superior flavor (taste and aroma), it is suggest to roast the high-grade oolong tea at 80°C or less. As to the middle-grade or low-grade tea, owing to inadequacy of aroma, the roasting temperature will be enhanced to 100-120°C to make tea have roast aroma and improve the quality of its flavor. As the roasting temperature reaches 140°C or above, the quality of tea deteriorates quickly, the liquor color turns dark red, tastes sour and has heavy burnt odor. From the results of this study, we suggest that the roasting temperature of high quality oolong tea should not be higher than 80°C, and that of middle-grade tea should be around 100-120°C.

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