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影響台灣半發酵茶生產與品質之因素

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摘　要

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市場的供需是決定台灣茶葉生產的重要因素之一。以往台灣所生產之茶葉主要以供外銷爲主，初期外銷的茶葉是烏龍茶，但後來依次被紅茶、綠茶所取代。近年來由於生產成本劇增，因此失去了很多外銷市場，但專供國內消費的半發酵茶之生產就變得更爲重要了。雖然茶葉栽種面積及茶葉外銷量均已減少，但茶葉總生產量卻能維持的相當好，此乃由於品種及栽種技術的不斷改良進步，促使每單位面積的茶葉產量逐漸增加。目前，在23,000公頃的茶園中可生產23,000噸茶葉。

茶葉的品質受到一些因素的影響，這些因素可歸納分類爲四種，即品種、環境、栽培、耕作及茶葉加工技術。就品種來說，各品種的發酵能力、化學成份及農藝性狀均有不同；半發酵茶的品質比產量更重要。環境因素：土壤與氣候是影響品質的二個主要因素，高海拔被認爲可提高茶葉的品質。栽培技術：包括耕作、除草、肥培管理、灌溉、茶樹保護及收穫管理等，這些均會影響茶葉之產量及品質；在所有影響品質的管理操作中，葉齡和收穫季節最爲重要。加工技術：半發酵茶之加工技術涉及一系列複雜的操作（萎凋、攪拌、烘炒、揉捻、乾燥），這些操作技術亦可視爲一種藝術，每一個操作步驟即使輕微的改變都會影響茶葉的品質，包括外形、茶湯顏色、香氣及滋味，因此在同一批茶菁中由不同人工所製成的茶葉，其品質卻相差很大。

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FACTORS AFFECTING THE PRODUCTION AND QUALITY OF PARTIALLY FERMENTED TEA IN TAIWAN

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Summary

Supply and demand is one of the most important factors determining Taiwan tea production. Historically, production of Taiwan tea was primarily for export. Oolong tea was the most important tea exported initially, but it was replaced by black tea and then by green tea. Recently in Taiwan, due to a sharp increase in production costs of tea, we have lost substantial markets, and the production of partially fermented Chinese tea for domestic consumption has become more important. Both the tea plantation area and tea exports have decreased. However, the amount of total tea production has been fairly well maintained because of a gradual increase in tea yield per unit area as a result of progress in culture technology and variety improvement. Currently, 23,000 m.t. of tea are produced from 23,000 ha of tea plantation.

The quality of tea is affected by a number of factors which can be classified under 4 major items, namely cultivars, environment, cultural practices and tea processing techniques. Cultivars: the fermentation ability, chemical components and agronomic characters vary with cultivars: For partially fermented tea, quality is more important than yield. Environments: Soils and climate are two major factors affecting the quality. High elevations are considered to be the most favourable for production of quality tea. Cultural practices: These, including tillage, weeding, fertility management, irrigation, plant protection and harvesting management may affect the quality though their effect on the yield may be more important. Among the management practices affecting the quality, leaf age and season of harvesting are the most significant. Processing technique: The processing technique of partially fermented tea involves a series of complicated operations (withering, shaking, panning, rolling, and drying) which, indeed, can be regarded as an art. Slight changes in manipulation of every step can affect the final quality including appearance, tea liquor colour, aroma ad taste. It is not surprising to find that the qualities of made teas from the same batch of fresh leaves may vary greatly between individual processors.

Introduction

Due to a large increase in labour wages under rapid development of the industry, the production cost of Taiwan tea has increased. Therefore, the export of green and black teas has decreased greatly under the strong competition of the international tea market. The tastes of partially fermented teas such as Paochung, Oolong and Teh-Kuang-Ing teas are liked by Taiwan

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domestic consumers. The decline of the green and black tea industry has been replaced by a rise in partially fermented Taiwan tea for domestic consumption (Chiu, 1988). The demand for high grade Taiwan teas is great. Factors affecting the production and quality of Taiwan teas have been clarified and solved through tea research. The improvement of tea quality and decrease in production costs have become the main targets for increasing the income of tea farmers.

Production of Taiwan Tea

From the production and export of Taiwan teas over the last 12 years (1977-1988) shown in Table 1, it is seen that the total tea production has gradually decreased from about 27,000 m.t. to 23,000 m.t. Earlier, most Taiwan tea production was primarily for export, however, the export of teas which include black, green, Paochung and Oolong teas decreased from about 20,000 m.t. to 7,800 m.t. during the last 10 years. The reduction in tea export is due to the sharp increase in production costs as a result of an increase in labour wages caused by rapid industrialization. The reduction in tea exports was mainly in black and green teas. On the other hand, Oolong tea export, mostly to Japan, increased rapidly. The production of partially fermented (Paochung and Oolong) teas for domestic consumption has recently become more important than that for export (Chiu, 1988). Thus supply-demand is the most important factor in determination of production of Taiwan teas.

Table 1. Total amounts of Taiwan tea produced and exported in the last 12 years

Year	(A) Total Produced m.t.	(B)/(A) Ratio	Amounts exported				
			(B) Total Exports m.t.(%)	Black tea m.t.(%)	Green tea m.t.(%)	Paochung tea m.t.(%)	Oolong tea m.t.(%)
1977	26 303	80/100	21 034(100)	6 489(31)	12 641(60)	1 237(6)	667(3)
1978	25 854	79/100	20 406(100)	2 162(11)	16 618(81)	1 193(6)	432(2)
1979	27 055	71/100	19 233(100)	1 701(9)	15 901(83)	1 190(6)	442(2)
1980	24 479	75/100	18 348(100)	3 083(17)	11 948(65)	2 433(13)	833(5)
1981	25 223	59/100	14 957(100)	3 067(21)	9 323(62)	1 549(10)	1 017(7)
1982	24 051	42/100	9 983(100)	3 097(31)	4 735(47)	1 384(14)	766(8)
1983	24 308	50/100	12 102(100)	4 143(34)	5 373(44)	1 516(13)	1 063(9)
1984	24 365	48/100	11 709(100)	5 628(48)	3 022(26)	1 362(12)	1 698(15)
1985	23 202	43/100	10 024(100)	1 682(17)	3 202(32)	1 363(14)	3 788(38)
1986	23 890	42/100	10 095(100)	1 092(11)	2 575(26)	1 222(12)	5 207(52)
1987	25 578	30/100	7 819(100)	744(9)	1 894(24)	833(10)	4 348(55)
1988	23 577	32/100	7 631(100)	799(10)	1 792(24)	721(10)	4 319(56)

Source: Monthly Tea Newsletter, 1978-1989, The Taiwan Tea Manufacturers' Association.

Partially fermented Taiwan teas have unique qualities (appearance, flavour, taste and colour) which have been developed in response to consumers' demand. The quality of teas is affected by a number of factors which can be classified into four major items, namely tea cultivars, tea growing environment, tea cultural practices, and tea processing techniques.

Factors Affecting Tea Quality

Tea cultivars

Genetic factors greatly influence the yield and qualities of tea. Cultivar differences in the yield of fresh leaf are reflected by some agronomic characteristics of tea cultivars. Generally, the yield of *cultivar assamica* is much higher than that of *cultivar sinensis*, which has greater differences in yield and in agronomic characteristics. Significant correlations between yields and leaf area (Wu, 1974), length of leaf and length of internodes (Fong, 1988) have been observed.

Tea cultivars suitable for manufacture of fully fermented (black) tea generally have stronger polyphenol oxidase activity while cultivars suitable for manufacture of partially fermented (Paochung and Oolong) teas or nonfermented (green) tea have weaker activities as shown in Table 2 (Chen, 1989).

Table 2. Polyphenol oxidase activities of cultivars suitable for manufacture of different kinds of teas (Chen, 1989)

Cultivars suitable for	Polyphenol oxidase activities μl O_2/min/g dry wt	% of TTES No.8
Manufacture of black tea		
TTES No.8	66.0	100
TTES No.1	48.1	73
TTES No.3	44.5	67
Manufacture of Oolong and Paochung teas		
Chin-Shin Da Pang	27.4	42
Hwan-Shin Oolong	34.0	52
TTES No.5	32.8	50
Manufacture of Paochung tea		
TTES No.12	26.5	40
Chin-Shin Oolong	26.8	41
Wu-Yi	27.0	41

The tea growing environment

Environmental factors which greatly affect the quality and yield of tea, include climate and soils. Under lower temperatures, tannin and caffein contents in tea leaves are decreased and amino acids and nitrogen contents (Juan and Lee, 1977; Wu, 1977) as well as thickness of leaves and cell numbers are increased (Chen et al., 1989). Accordingly, the quality of tea grown under lower temperatures is better than that under higher temperatures. Consequently the teas produced at high altitudes are found to be high in grade as well as in price, and those produced above an elevation of 1000 m are very popular among local tea consumers. The conditions of cooler temperatures, greater temperature differences between day and night, high humidity with mist and shorter sunshine hours at high elevations, are regarded as the major contributing factors to the high tea quality. Table 3 shows the relationship between the quality of Paochung tea and its selling price. Based on an investigation of 36 samples collected from the different grades of Paochung teas, Tsai and Chang (1986) reported a significant exponential relation between tea quality and tea price. Of the 4 characters scored for tea quality, the ''appearance'' and ''aroma and taste'' correlated well with the price, respectively.

Table 3. Sensory tasting scores of tea quality and price of spring Paochung tea samples produced from Chin-Hsing Oolong cultivar*

Sample No.	Tasting scores of tea quality					Price NT$/600g
	Appearance (30%)	Water colour (20%)	Aroma & taste (60%)	Infused leaves (10%)	Total	
1	24.5	15.0	29.3	7.0	75.8	1 300
2	24.0	15.5	27.3	7.0	73.8	1 200
3	22.5	14.5	29.3	7.2	73.5	1 000
5	23.0	16.0	30.0	8.0	77.0	800
8	22.5	15.8	29.3	8.0	75.6	600
11	22.8	15.3	28.7	7.5	76.4	500

* Part of data extracted from Tsai and Chang (1986).

Tea quality is profoundly affected by seasons. For Paochung tea, spring tea has the best quality followed by winter tea then by autumn tea. Summer tea is the worst because of high temperatures and strong sunshine which apparently produces higher tannin, caffeine and catechin levels, causing a reduction in quality. This is characterized by greater bitterness and astringency (Wu and Kao, 1954; Juan and Lee, 1977; Wu, 1977). Soils are not as important in affecting tea quality although remarkable effects on tea yield have been observed (Wang and Chang, 1988).

Cultural practices

Cultural practices for tea plants, including fertility management and mulching (Chang and Chu, 1987), shading (Fong and Shyu, 1988), plant protection (Chen, 1983), pruning (Fong, 1982; Tsai, 1985), irrigation (Huang, 1988), and harvesting management, may affect the tea quality, though their affect on the yield may be more obvious. Among the management practices affecting the quality, harvesting at the proper leaf age is the most important. For manufacture of partially fermented teas, harvesting of banji bud is suitable for light-fermented Paochung tea, and harvesting of one bud and two leaves with an unopened and needle-shaped leaf is suitable for heavy-fermented Formosan Oolong tea. Paochung tea, which has a fresh aroma and a degree of fermentation of 12%, is better made from banji buds because of their leaf chemical characteristics, that is, lower activity of polyphenol oxidase (Chen, 1989) and lower contents of caffeine and catechins (Juan and Lee, 1977; Wu, 1977). On the other hand, Formosan Oolong tea, which has a specific flavour and taste and a degree of fermentation of 60%, is made from unopened leaves with a white pubescence and high activity of polyphenol oxidase.

Mechanical harvesting is conducted in most Taiwan tea gardens except in the high grade tea areas where hand plucking is conducted in order to obtain high tea quality. After a few years of experiments and demonstrations, hand-plucking has been successfully changed to mechanical-plucking, resulting in high incomes in the high grade tea area (Huang et al., 1986).

The effect of irrigation is evident in tea plantations especially during the dry season in central Taiwan. Irrigation can not only maintain the vigor of tea plants but also increase the tea yield and quality thereby greatly increasing the income of tea farmers (Huang, 1988).

A number of diseases and insects are found to damage tea plants in Taiwan (Chen, 1983). Generally, both yield and quality are reduced when the tea plant suffers from disease and insect damage. However, there is an exception in which so-called Fromosan Oolong tea or Oriental beauty of White-Tip Oolong tea is produced from the leaves attacked by small green leaf hoppers. Such Oolong tea is found to have a unique aroma but the yield is greatly reduced by 10 to 20% of that of tea without hopper damage.

The processing technique

The processing technique of partially fermented tea involves a series of sophisticated operations comprising withering, shaking, panning, rolling, and drying, which indeed can be regarded as an art. Solar withering, indoor withering and shaking are considered to be especially important. Withering is the operation of inducing aroma production, while shaking is the operation generating the driving forces of chemical and physical reactions (Fermentation) involved in prouction of taste, aroma and colour of tea liquor.

It has been found that the aromatic content does not change much during solar withering but does so significantly during indoor withering and shaking (Tokitomo et al., 1984; Kobayashi et al., 1985). This finding may well explain the observation of traditional Paochung tea processing experts that the aroma and taste of Paochung tea are closely associated with the technique

of withering and shaking. The conditions of solar withering and shaking needed to produce the elegant floral aroma of Paochung tea have been studied. (Kobabyashi et al., 1985). During the fermentation induced by withering and shaking, theaflavins and thearubigins are formed and catechins are reduced resulting in a reduction of bitterness and astringency. Most free amino acids except theanine, glutamic and aspartic acids are increased which may increase the brothy taste. Caffeines are reduced or may react with theaflavins and other polyphenol compounds and the bitter taste may be reduced (Wu and Yeh, 1977; Wu and Yeh, 1978; Wu and Yeh, 1979). Several methods of drying, the last step of the Paochung tea process, have been studied which shows that the tea quality is significantly affected by different drying methods (Juan and Chang, 1988). The final taste of made tea is the result of the aforementioned reactions and quality tea is assumed to be formed by combination of each component in certain and specific rates (Wu and Yeh, 1977; Wu and Yeh. 1978; Wu and Yeh, 1979). In Oolong tea, sensory taste scores are found to correlate with total N, theobromine, caffeine, catechins, soluble solids and amino acids (Tsai and Chang, 1986). Slight changes in manipulation of each step of the aforementioned operations can affect the quality of teas which are composed of appearance, tea liquor colour, aroma and taste. Therefore, it is not surprising to find that the quality of made tea from the same batch of fresh leaves may vary greatly between different processors.

Conclusion

Tea growing environment and tea processing techniques are the most important factors affecting the quality of partially fermented tea, while cultivars and cultural practices are the most important factors affecting the yield of tea.

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