A Study on the Adaptability of Yunnan Tea Cultivars in Southern Fujian

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Abstract With *Camellia sinensis* (L.) O. Kuntze cv Fuding Dabaicha as the control, an experiment was conducted to study the adaptability of Yunnan tea cultivars Zijuan, Yunkang 10, Yunkang 14, Foxiang 3, Yuncha 1, Jinggu Dabaicha, Xueya 100, in Zhangzhou, south Fujian tea area, during 2012 - 2014. The results show that the tea cultivars (Yunkang 14, Foxiang 3, Jinggu Dabaicha) grow in general conditions; while the cultivars (Zijuan, Yunkang 10, Yuncha 1, Xueya 100) show good adaptability in south Fujian tea area, and they grow in good conditions, and they are as good as the control cultivar Fuding Dabaicha, in terms of bud leaf traits, resistance and chemical quality, *etc*. So these cultivars are suitable for cultivation in southern Fujian tea area.

Key words Zijuan, Tea cultivar, Adaptability

1 Introduction

Fujian is a major tea producing province with the greatest number of tea cultivars in the nation, and currently it produces oolong tea, black tea, green tea, white tea and scented tea. Southern Fujian has a long history in tea production, and is one of the major production and consumption areas of oolong tea; in recent years, the production of black tea and other types of tea is speeding up. Zhangzhou College of Science and Technology has introduced 10 tea cultivars from Yunnan Province since 2008 to conduct researches on cultivars' adaptability and new product development. Zijuan (*Camellia sinensis* var. Assamica), as a special tea cultivar bred from Yunnan large leaf variety by Tea Research Institute of Yunnan Academy of Agricultural Sciences, and was included in the list of National New Plant Variety Protection by State Forestry Administration in 2005, with the variety right No. 20050031[1-2]. This cultivar features purple color in tender buds, leaves and stems, and the color turns into dark green when it gets mature[3-4]. Researches have been published successively in recent years due to the high content of flavones, supernormal amount of anthocyanin, and its distinct depressurization and anti-oxidation properties[5-11]. Yunkang 10 and Yunkang 14 used single plant selected from the Nannuo Mountains, Menghai County and were bred by Tea Research Institute of Yunnan Academy of Agricultural Sciences during 1973 - 1985; they were approved as national varieties by National Crop Variety Appraisal Committee in 1987, with No. of GS13050-1987, GS13051-1987, and were widely cultivated in Yunnan Province. The varieties were introduced to Sichuan, Guizhou, Guangdong, Guangxi, Hunan, Hubei provinces[12-15]. Foxiang 3 was a clone variety bred from the F1 generation, which was pollinated and hybridized from Fuding Dabaicha (female parent) and Changye Baihao (male parent), by Tea Research Institute of Yunnan Academy of Agricultural Sciences in 1980, and it was approved as provincial new tea cultivar by Yunnan Crop Variety Appraisal Committee in 2003[16-19]. Yuncha 1 was bred from Yuanjiang thin leaf Nuocha. This research conducts comparative researches on adaptability of these seven Yunnan tea varieties in southeast tea area, aiming to provide reference for development of new tea product and construction of sightseeing tea gardens.

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2 Materials and methods

2.1 Experimental cultivars Zijuan, Yunkang 10, Yunkang 14, Foxiang 3, Yuncha 1, Jinggu Dabaicha, Xueya 100 are the experimental cultivars and Fuding Dabaicha is the control cultivar.

2.2 Experimental design Zhangzhou College of Science and Technology is responsible for tea cultivar planting, and there were 3 replications, using Fuding Dabaicha as control. Each individual covered 13.5 m2 (with 9 m length and 1.5 m big line spacing), small line spacing and plant distance were 0.33 m, 1 single tea bush was planted in each twin-row.

2.3 Planting time March, 2008.

2.4 Experimental methods Content, qualification standards, methods, tea cultivation and management of the experiments are in accordance with Implementation Rules of National Tea Cultivar's Regional Experiment and Cultivar Regional Experiment Tea Cultivation, Management and Appraisal Content. Items investigated and observed included botany morphological characteristics, phonological phase, tea growth conditions, biochemical component of fresh tea leaves, tea processing quality and stress resistance, *etc*.

2.4.1 Tea cultivar's biological characters. (i) Survey on surviving rate. Survey was conducted on individual surviving plant rate and bush surviving rate; the individual surviving rate (%) =

(survived embryo tea individual number/planted embryo tea individuals) × 100%, bush surviving rate (%) = (survived bush number/planted bushes) ×100%. (ii) Observation of shoot phenological phase. From 2012 to 2014, successive observation was taken on early stage one-bud two-leave spring shoots every 2 days. Any bruised or mistakenly plucked tips were replaced with tips of the same growing status. (iii) Characters of bud and leaf. Observation was taken on varieties' color and luster, robustness, fine hair, one-hundred-bud weight of the one-tip three-leaf, *etc*. (iv) Sprout density. Observation was taken on sprout density for 3 successive springs after planting, and in the one-tip two-leaf period, 3 sites were chosen in each cultivar field at random, and the number of sprouting tips within 10 cm leaf layer in each site (33 cm × 33 cm) was calculated, taking average value. (v) Resistance observation. Observation was taken on the effect on tea from cold injury, drought damage and insect attack from 2012 to 2014.

2.4.2 Chemical component analysis on fresh tea leaves. This study processed one-tip two-leaf fresh tea leaves through steaming method, and tested the biochemical components, including water extract (GB/T8305 – 2013), tea polyphenol (GB/T8313 – 2008), amino acid (GB/T8314 – 2013), and caffeine (GB/T8312 – 2013). The anthocyanin content was determined referring to literature[20].

2.5 Data analysis Excel 2010 and DPS were used for analysis.

3 Results and analysis

3.1 Biological characters of tea cultivars

3.1.1 Transplanting survival rate of tea bushes. The transplanting survival rate was investigated on the full age experimental cultivars. As shown in Fig. 1, compared with Fuding Dabaicha, the transplanting survival rate of all 7 experimental cultivars was low. The transplanting survival rate of Zijuan, Yunkang 10, Jinggu Dabaicha was above 90%, and the rate of Yunkang 10 was 94%. The transplanting survival rate of Yuncha 1, Yunkang 14, Foxiang 3 and Xueya 100 were 80 – 90% evidently lower than that of the control, and the rate of Yuncha 1 was lowest. The figure shows significant differences in survival rate between different cultivars, and Zijuan, Yunkang 10 and Jinggu Dabaicha adapted well in Southern Fujian, while Yuncha 1, Yunkang 14, Foxiang 3 and Xueya 100 required great emphasis on tea planting management.

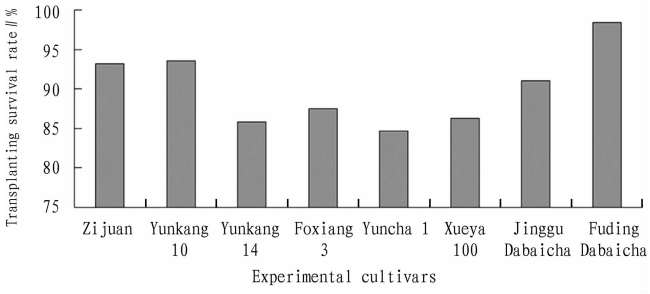

Fig. 1 Transplanting survival rate of different tea cultivars

3.1.2 Observation of shoot phenological phase. Phenological phase observation was compared with the control. The one-tip two-leaf phase and one-tip three-leaf phase of experimental cultivars are shown in Table 1. One-tip two-leaf phases of all 7 cultivars were in middle-to-late March, one-tip three-leaf phases were in late March and early April, which were later than CK's. Phenological phases of Yunkang 10, Foxiang 3 and Yuncha 1 were close to each other, with one-tip two-leaf phase around March 20, one-tip three-leaf phase around March 26; phenological phases of Zijuan, Yunkang 14, Jinggu Dabaicha, Xueya were approximately the same, with one-tip two-leaf phase around March 25 and one-tip three-leaf around April 5.

Table 1 Phenological phase of experimental tea cultivars

Item	Zijuan	Yunkang 10	Yunkang 14	Foxiang 3	Yuncha 1	Xueya 100	Jinggu Dabaicha	Fuding Dabaicha(CK)
One-tip two-leaf phase	Mar. –26	Mar. –20	Mar. –28	Mar. –18	Mar. –16	Mar. –26	Mar. –24	Mar. –16
One-tip three-leaf phase	Apr. –04	Apr. –28	Apr. –10	Apr. –26	Apr. –26	Apr. –08	Apr. –02	Apr. –24

Table 2 Bud leaf traits of experimental tea cultivars

Cultivars	Shape	Color	Hair	Robustness	One-hundred-bud weight of one-tip three-leaf(g)
Zijuan	Willow-leaf-alike	Purplish red with green	Much	Stout and strong	116
Yunkang 10	Long elliptical	Yellowish green	Excessive	Stout and strong	120
Yunkang 14	Long elliptical	Dark green	Excessive	Stout and strong	156
Foxiang 3	Long elliptical	Green	Excessive	Stout and strong	148
Yuncha 1	Elliptical	Green	Much	Stout and strong	140
Xueya 100	Long elliptical	Dark green	Excessive	Stout and strong	165
Jinggu Dabaicha	Elliptical	Yellowish green	Excessive	Stout and strong	172
Fuding Dabaicha(CK)	Elliptical	Green	Excessive	Average	61

3.1.3 Bud leaf traits. For different tea cultivars, their bud leaf traits vary from each other from shape, color, hair, robustness, one-hundred-bud weight of one-tip three-leaf (g); the bud leaf traits of fresh tea leaves affect the shape of finished tea to a large extent. Bud leaf traits of experiential cultivars are shown in Table 2. Except Zijuan, other cultivars had elliptical or long elliptical

shape leaves. For colors, Zijuan was purplish red with green, different from the purple and black or purplish red of Zijuan from country of origin in Yunnan[1-2]. The emergence of green color and reduction of purple might be affected by environment. Other cultivars were yellowish green, green, or dark green. For hair, Zijuan and Yuncha 1 had much hair, while other cultivars had excessive hair. All cultivars were stout and strong, compared with CK. One-hundred-bud weight of one-tip three-leaf was great compared with CK, and it was over 150 g for Yunkang 14, Jinggu Dabaicha and Xueya 100, followed by Foxiang 3, Yuncha 1 and Yunkang 10. Zijuan had lowest robustness, with 116 g of one-hundred-bud weight.

3.1.4 Bud density. The bud density determined tea output, the more the buds were, the higher the output was. Successive observation from 2012 to 2014 showed that bud density of experimental cultivars was lower than that of Fuding Dabaicha, and the bud density of 7 experimental cultivars varied from each other. Zijuan, Yunkang 10 and Yunkang 14 were of high bud density, while Foxiang 3, Yuncha 1, Jinggu Dabaicha and Xueya 100 were of low density.

Table 3 Bud density of experimental tea cultivars during 2012 to 2014

Cultivar/Year	2012	2013	2014	Average	Compared with CK
Zijuan	46	54	50	50	-21
Yunkang 10	50	56	55	54	-17
Yunkang 14	51	52	62	55	-16
Foxiang 3	41	45	42	43	-28
Yuncha 1	42	43	41	42	-29
Xueya 100	46	40	41	42	-29
Jinggu Dabaicha	41	48	46	45	-26
Fuding Dabaicha(CK)	64	70	78	71	0

3.1.5 Resistance investigation. Resistance of tea bush refers to the ability to resist cold, drought, disease and insect. Tea cultivars have shown their adaptability under different environment. A fine cultivar should be of high quality and output, as well as strong resistance, whereas it would be short of guarantee. The cold-resistance and drought-resistance ability was tested through natural identification method. Ever since being planted, all 7 experimental cultivars had never been injured by chillness or drought under the proper humid climate of southern Fujian tea area. Observation and investigation in recent 3 years showed that major insect attacks were from tea lesser leafhopper, tea geometrid while diseases were from tea gall, tea anthracnose, tea rot, *etc*. The light degree of both insect attack and disease indicated the strong disease-and-insect-resistant ability of experimental cultivars.

3.2 Chemical component analysis on fresh tea leaves

3.2.1 Conventional chemical component comparison. The experiment processed one-tip two-leaf fresh leaves into fixed samples by steaming, and measured the main chemical components of 7 experimental cultivars. As shown in Table 4, TP content of experimental cultivars were higher than CK's, of which Zijian's was highest with 39.58%, Yunkang 10, Foxiang 3 and Yunkang 14's second to it, while Yuncha 1, Xueya 100 and Jinggu Dbaicha's content was lowest. With 3.20% amino acid content, Yuncha 1 was ranked first among all 7 experimental cultivars, Jinggu Dabaicha second to it with 3.12%. Polyphenols and amino acids ratio of Zijuan, Yunkang 10, Yunkang 14 and Foxiang 3 was lower than that of Fuding Dabaicha. Caffeine content of all experimental cultivars was higher than that of Fuding Dabaicha, of which Yunkang 14's caffeine content was as high as 4.18%, Zijuan 4.07%, Yunkang 10 and Jinggu Dabaicha were next to them.

Table 4 Main biochemical components in fixed sample of experimental tea cultivars

Cultivar	TP//%	Amino acid//%	Caffeine//%	Water extract//%	TP/Amino Acid
Zijuan	39.58	2.53	4.07	48.46	15.64
Yunkang 10	34.82	2.45	3.75	47.23	14.21
Yunkang 14	32.85	2.57	4.18	46.74	12.78
Foxiang 3	33.93	2.69	3.53	45.55	12.61
Yuncha 1	29.34	3.20	3.48	46.51	9.17
Xueya 100	29.45	2.71	3.22	46.28	10.87
Jinggu Dabaicha	32.13	3.12	3.82	45.25	10.30
Fuding Dabaicha(CK)	28.67	2.52	3.21	45.17	11.38

3.2.2 Anthocyanin content comparison. Anthocyanin is a water-soluble glycosidic pigment and widely exists in plants; it is of certain nutritional and pharmacologic function and it has huge utilization potentiality in food, cosmetics, medicine and other aspects. In this research, for anthocyanin content in one-tip two-leaf sprouts from different cultivars, Zijuan was ranked first with 2.2%, while other cultivars' content was lower than 1%, of which Yunkang 10, Yunkang 14 and Foxiang 3's was lower than the CK's, while Yuncha 1, Xueya 100, and Jinggu Dabaicha's was close to the CK's. The anthocyanin content of Zijuan in this research was lower than in other researches (2.7%-3.6%)[10], which might be related to the climate in southern Fujian tea area.

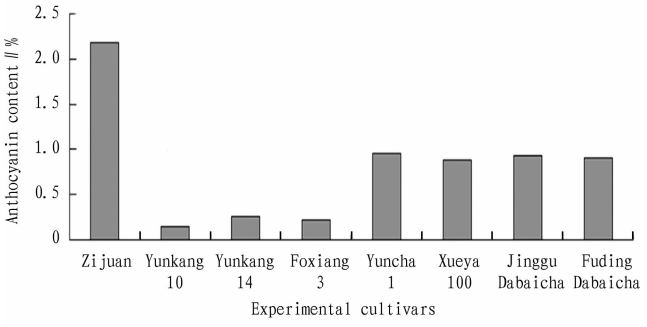

Fig. 2 Anthocyanin content of experimental tea cultivars

4 Conclusions and discussions

With Fuding Dabaicha as the control, this research investigated 7 fine Yunnan tea cultivars' adaptability in southern Fujian tea area successively for 3 years. The results showed ordinary growth situations of Foxiang 3, Yunkang 14, Jinggu Dabaicha with low output, and good growth conditions of Zijuan, Yunkang 10, Yuncha 1 and Xueya 100 with considerable good or even better bud leaf traits, resistance, chemical quality compared with CK, which indicated their favorable adaptability in southern Fujian tea area. In recent years, sightseeing tea plantations have received higher attention than before, and application of tea bushes in gardens is the organic combination of tea culture and garden culture. Zijuan and other special germplasm resources have endowed tea bushes with rich ornamental value, adding new connotation for tea bushes garden culture. This research detected that anthocyanin content in Zijuan was 2.2%, lower than in other researches (2.7% -3.6%), and it might be influenced by the climate in southern Fujian and tip luster turned from purplish red to purplish green. Further researches could be conducted for its mechanism. In the course of researching Zijuan tea, the influence of climate and environment on Zijuan's bud and leaf luster should be also taken into consideration.

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