Plant Gene and Trait 2022, Vol.13, No.4, 1-9
http://genbreedpublisher.com/index.php/pgt

Research Article Open Access

Analysis and Evaluation of Excellent Germplasm Resources and Quality of *Camellia oleifera* in Hainan

Wang Hai, Zhou Yang, Deng Yajie, Song Jiaming, Qiu Yue, Lai Hanggui
College of Tropical Crops, Hainan University, Haikou, 570228, China
Corresponding author email: laihanggui8938@163.com
Plant Gene and Trait, 2022, Vol.13, No.4 doi: 10.5376/pgt.2022.13.0004
Received: 21 Sep., 2022
Accepted: 28 Sep., 2022
Published: 05 Oct., 2022

Preferred citation for this article:
Wang H., Zhou Y., Deng Y.J., Song J.M., Qiu Y., and Lai H.G., 2022, Analysis and evaluation of excellent germplasm resources and quality of *Camellia oleifera* in Hainan, Plant Gene and Trait, 13(4): 1-9 (doi: 10.5376/pgt.2022.13.0004)

Abstract In order to cultivate high-yielding and high-quality varieties of *Camellia oleifera* and increase the yield and economic benefits of the local Hainan *Camellia oleifera*, this study conducted a detailed investigation on the excellent *Camellia oleifera* trees in different producing areas in Hainan Province, and carefully selected 30 excellent *Camellia oleifera* trees for systematic analysis. The economic traits, biological characteristics, fatty acid composition and content, correlation of main fatty acids and the quality of camellia oil were analyzed in detail. The results show that the indicators of fruit economic traits are all significantly different (P<0.01); the excellent quality of *Camellia oleifera* with excellent main biological characteristics have better quality of camellia oil, and vice versa; the fatty acid composition and content also show for different differences, the content of linoleic acid varies greatly, while the content of oleic acid is relatively stable; the correlation between oleic acid and linoleic acid and palmitic acid is extremely significantly negatively correlating, while it is significantly positive for stearic acid related.; Hainan *Camellia oleifera* excellent tree the biological characteristics of oleoresin are good, but there are also differences to a certain degree, which affects its quality differences; the impact of different producing areas in Hainan on the quality of camellia seed oil may also be related to factors such as latitude, precipitation, sunshine, and temperature, which in turn caused there are certain differences in the quality of tea oil from different producing areas in Hainan. With the continuous in-depth study of its fruit traits and biological characteristics, it provides a reference for future Hainan Camellia breeding work.
Keywords *Camellia oleifera* breeding; Fruit economic traits; Biological characteristics; Quality

Camellia oleifera Abel, belonging to *Camellia* of Theaceae, is an economic oil crop with a wide planting area in southern China. At present, the area of *Camellia oleifera* planted in China has reached 6 550 hm^2 (Li et al., 2017), mainly distributed in southern provinces of China, such as Guangxi, Yunnan, Hainan and other places. Hainan has a long history of planting *Camellia oleifera*. Because of its unique geographical location, Hainan Island has its own unique *Camellia oleifera* resources. *Camellia oleifera* trees in Hainan has excellent characteristics and *Camellia oleifera* quality, which is deeply loved by consumers, and the price of *Camellia oleifera* is also higher than that in the mainland (Li et al., 2011, Bulletin of Agricultural Science and Technology, (6): 8-11). For a long time, Hainan *Camellia oleifera* has produced a large number of mutated tree species. *Camellia oleifera* trees in various production areas show obvious differences between their advantages and disadvantages, and the germplasm resources are relatively chaotic. The collection, preservation, development and utilization of germplasm resources is an essential process of Hainan *Camellia oleifera* breeding.

At present, because of the output of Hainan *Camellia oleifera* is generally low and the quality of tea oil needs to be improved, the research direction is mainly focused on the output and quality. Chen et al. (2005) investigated, collected and preserved the superior tree character resources of Hainan *Camellia oleifera*, providing a basis for studying the germplasm resources of Hainan *Camellia oleifera* (Refer to the Forestry Industry Standard "Regulations of Selection and Breeding for of Plus Tree and Superior Clone" (LY/T 1730.1-2008)); Yang et al. (2012) conducted a preliminary analysis on the introduction and fine varieties of Hainan *Camellia oleifera*, providing a reference plan for the selection of fine varieties of Hainan *Camellia oleifera*; Xi et al. (2006) made a series of explorations and analyses on excellent clones with high oleic acid content, which provided reasonable reference data for breeding superior tree varieties with high oil content and good quality; Liu et al. (2014) elaborated on fatty acids from different regions, providing basic data for the analysis of fatty acids. However, these studies are all based on *Camellia oleifera* superior trees in a certain area, and there are few studies on the effects of economic and biological characteristics of superior trees in different production areas on their quality.

The comprehensive evaluation and biological characteristics analysis of the fruit economic characteristics of Hainan *Camellia oleifera* superior trees (Refer to the Forestry Industry Standard "Regulations of Selection and Breeding for of Plus Tree and Superior Clone" (LY/T 1730.1-2008)) is an important link in Hainan *Camellia oleifera* breeding. In order to breed high-yield and high-quality *Camellia oleifera* varieties and evaluate Hainan *Camellia oleifera* superior trees more objectively, this study visited and investigated the main production areas of *Camellia oleifera* in Hainan Province. After repeated screening, the superior trees with better fruits, especially fruit characteristics, were selected, and the effects on their quality were analyzed respectively, so as to provide a reference for the breeding and comprehensive development and utilization of *Camellia oleifera* in Hainan.

1 Results and Analysis

1.1 Analysis and evaluation of economic characteristics of superior trees

There were significant differences in the economic characters of the fruits of *Camellia oleifera* superior trees (P<0.01), and there were very significant differences in some economic characters of the fruits. The excellent trees in different production areas of Hainan (including Tunchang, Ding'an, Qionghai, Chengmai and Wuzhishan) investigated in this experiment are representative, and basically cover the main production areas and main planting varieties of *Camellia oleifera* in Hainan. The main reason for the significant difference in economic characteristics of fruits in this study is the difference in fruit characteristics and the impact of different biological characteristics. In addition, it may be limited by local climatic environment, cultivation technology and other factors (Yang et al., 2018), which also affects the quality of *Camellia oleifera.* (Table 1; Figure 1).

Table 1 Difference analysis of fruit economic characters

Project	Dry seed yield (%)	Kernel (%)	Single fruit weight (g)	100 grain weight(g)	Spiral (%)	Oil production rate of fresh fruit (%)
F value	70.66	119	44.69	188	168.11	6.99
P value	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01

A B

Figure 1 Partial outstanding single fruit
Note: A: The region of Tunchang; B: The region of Dingan

1.2 Analysis and evaluation of growth characteristics of *Camellia oleifera* superior trees

The growth characteristics of the selected superior tree varieties showed different degrees of difference. TCTZ-4 has the highest plant height of 9.4 m; QHSK-1 was the smallest, 2.0 m in height; There are four types of superior trees: cluster, vertical, weeping and cross type; The leaf shape of superior trees is long oval, wide lanceolate and oval, showing certain polymorphism; The largest leaf is 8.3~12.8 cm long and 3.1~6.8 cm wide (CMFS-1), and the smallest is 5.6~9.5 cm long and 3.4~5.8 cm wide (DAST-3); There are three types of branch positions of superior trees: low, medium and high. After a series of data analysis and comparison, the growth characteristics of the superior trees are different, resulting in differences in their yield and tea oil quality (Table 2).

Table 2 Analysis of growth characteristics of superior trees

Variety number	Plant height (m)	The tree form	Leaf shape	Leaf size (cm)	Position
DAST-1	7.5	The cluster type	Long oval	Long 7.6~11.2, wide 3.8~5.1	Low
DAST-2	6.5	Vertical type	Wide lanceolate	Long 8.1~10.2, wide 2.6~3.3	Center
DAST-3	6.3	Vertical type	Ovoid	Long 5.6~9.5, wide 3.4~5.8	Center
DAST-4	5.7	Cross type	Wide lanceolate	Long 6.6~8.1, wide 3.8~6.1	Low
DAJC-1	6.0	Weeping type	Ovoid	Long 7.7~12.2, wide 3.2~5.1	High
DAJC-2	6.4	Weeping type	Wide lanceolate	Long 8.8~12.6, wide 3.3~4.9	Low
CMFS-1	4.1	Weeping type	Long oval	Long 8.3~12.8, wide 3.1~6.8	High
CMFS-2	3.4	Weeping type	Wide oval	Long 6.6~11.5, wide 2.6~4.1	High
CMFS-3	3.4	Weeping type	Wide lanceolate	Long 8.6~11. 2, wide 3.6~6.0	Center
CMFS-4	4.5	Vertical type	Long oval	Long 8.8~11.8, wide 4.6~5.1	Low
QHSK-1	2.0	Vertical type	Ovoid	Long 7.6~11.8, wide 3.6~5.2	High
QHSK-2	2.5	Vertical type	Wide lanceolate	Long 7.8~12.1, wide 4.6~6.1	High
QHSK-3	2.5	Vertical type	Long oval	Long 8.9~9.8, wide 3.1~5.5	Low
QHSK-4	3.2	Vertical type	Wide oval	Long 8.1~11.2, wide 4 6~5.3	Center
QHSK-5	2.5	Weeping type	Wide lanceolate	Long 7.1~10.8, wide 2.6~5.1	High
WZSHS-1	2.9	Cross type	Ovoid	Long 7.6~11.1, wide 3.8~6.0	Low
WZSHS-2	5.4	Cross type	Wide oval	Long 6.6~11.5, wide 4.6~6.1	High
WZSHS-3	4.8	Weeping type	Long oval	Long 8.9~12.5, wide 4.1~62	Low
WZSFS-1	3.1	Vertical type	Ovoid	Long 8.1~10.5, wide 3.3~5.1	Center
WZSFS-2	2.9	Cross type	Wide lanceolate	Long 8.3~11.2, wide 4.6~6.3	High
WZSFS-3	2.2	Weeping type	Ovoid	Long 6.5~10.5, wide 3.9~5.8	Low
WZSFS-4	6.5	Vertical type	Long oval	Long 6.6~11.5, wide 3.3~5.1	Center
WZSND-1	3.6	Cross type	Wide oval	Long 8.1~11.5, wide 3.1~4.3	High
WZSND-2	3.6	Weeping type	Wide lanceolate	Long 8.2~12.3, wide 3.4~4.8	Low
TCTZ-1	7.0	Cross type	Ovoid	Long 8.1~11.6, wide 3.1~4.6	High
TCTZ-2	7.1	Vertical type	Long oval	Long 7.6~10.5, wide 3.1~4.5	Center
TCTZ-3	7.1	Cross type	Ovoid	Long 8.1~11.6, wide 3.6~4.9	Low
TCTZ-4	9.4	Weeping type	Wide lanceolate	Long 8.2~12.2, wide 3.1~4.6	Center
TCTZ-5	7.6	Vertical type	Long oval	Long 8.1~12.5, wide 3.6~4.4	Low
TCTZ-6	6.9	Vertical type	Wide lanceolate	Long 6.6~9.9, wide 3.1~4.3	High

1.3 Analysis and evaluation of flower buds of *Camellia oleifera* superior trees

The flower buds of *Camellia oleifera* superior trees are all apical; The number of flower buds per plant of DAST-1 is 14 at most, and the number of flower buds per plant of superior trees QHSK-1 and TCTZ-4 is 5 at least; The number of flower buds per plant of each superior tree variety showed different degrees of difference, which affected its total yield. The flower bud differentiation and growth of each excellent tree need to consume more nutrients, so it is necessary to pay attention to supplementing the fertilizer in the critical period of its fertilizer requirement, so as to increase the number of flower buds, improve the fruit yield and increase economic benefits (Tian et al., 2019). The investigated superior tree varieties are basically free of diseases and pests, which also creates good conditions for them to obtain high yield and high quality (Table 3).

1.4 Analysis and evaluation of diseases and insect pests of *Camellia oleifera* superior trees

The pests and diseases of superior trees DAST-3, DAJC-1, DAJC-2, CMFS-2, CMFS-4, QHSK-1, QHSK-2, QHSK-3, QHSK-5, WZSHS-1, WZSFS-1, WZSFS-3, WZSND-1, TCTZ-1, TCTZ-3, TCTZ-4, TCTZ-5 and TCTZ-6 perform well. Basically, there is no damage to the leaves and a small number of leaves are disturbed by pests and diseases. The leaves of other superior tree varieties were damaged to varying degrees. QHSK-4 leaves were severely damaged, about 20% of which were damaged. The leaves of other superior tree varieties are damaged to a lesser extent or not. The leaves of superior trees are damaged, which affects the vegetative growth and reproductive growth of plants, thus affecting the yield and economic characteristics of superior trees and further affecting the quality of *Camellia oleifera* (Table 4).

Table 3 Statistics of flower buds of excellent trees

Variety number	The birth place	Number of flower buds per branch	Development situation	Disease/Insect pests
DAST-1	Apical	14	Well	Nothing
DAST-2	Apical	6	Best	Nothing
DAST-3	Apical	8	Well	Nothing
DAST-4	Apical	9	Well	Nothing
DAJC-1	Apical	11	Well	Nothing
DAJC-2	Apical	8	Well	Nothing
CMFS-1	Apical	9	Well	Nothing
CMFS-2	Apical	12	Well	Nothing
CMFS-3	Apical	12	Well	Nothing
CMFS-4	Apical	6	Well	Nothing
QHSK-1	Apical	5	Well	Nothing
QHSK-2	Apical	6	Well	Nothing
QHSK-3	Apical	9	Well	Nothing
QHSK-4	Apical	10	Well	Nothing
QHSK-5	Apical	11	Well	Nothing
WZSHS-1	Apical	12	Well	Nothing
WZSHS-2	Apical	11	Well	Nothing
WZSHS-3	Apical	6	Well	Nothing
WZSFS-1	Apical	8	Well	Nothing
WZSFS-2	Apical	6	Well	Nothing
WZSFS-3	Apical	6	Well	Nothing
WZSFS-4	Apical	7	Well	Nothing
WZSND-1	Apical	8	Well	Nothing
WZSND-2	Apical	6	Well	Nothing
TCTZ-1	Apical	9	Well	Nothing
TCTZ-2	Apical	6	Well	Nothing
TCTZ-3	Apical	6	Well	Nothing
TCTZ-4	Apical	5	Well	Nothing
TCTZ-5	Apical	9	Well	Nothing
TCTZ-6	Apical	6	Well	Nothing

1.5 Fatty acid composition and content of *Camellia oleifera* seed oil

The coefficient of variation of fatty acids of Hainan *Camellia oleifera* seed oil ranges from 6.39% to 46.12%. Linoleic acid (46.12%) has the largest coefficient of variation and oleic acid (6.39) has the smallest coefficient of variation. The degree of variation of palmitic acid, stearic acid and linolenic acid also shows obvious differences, which indirectly reflects the rich genetic variation characteristics of Hainan *Camellia oleifera* superior trees and has great selection potential (Liu et al., 2014). Other contents showed a moderate degree of variation (Figure 2).

1.6 Correlation comparison of main fatty acids

This study focuses on the evaluation of the quality of tea oil from the biological characteristics. Although there is a large difference in its biological characteristics and a close correlation between the content of fatty acids in *Camellia oleifera* seed oil, the correlation varies slightly. Oleic acid has a very significant negative correlation with linoleic acid and palmitic acid. During the formation of fatty acids, linoleic acid has a large degree of variation and is constantly transformed into oleic acid, which is consistent with the research results of Xu et al. (2018), while oleic acid has a significant positive correlation with stearic acid (Figure 3). Therefore, these correlations can be well used as auxiliary indicators when selecting Hainan *Camellia oleifera* varieties (Yuan et al., 2012; Zhong et al., 2015).

Table 4 Statistics of good tree diseases and insect pests

Variety number	Blade is damaged	Damage (%)	Disease	Insect pests
DAST-1	+	10	+	Nothing
DAST-2	+	10	Nothing	Nothing
DAST-3	Nothing	0	Nothing	+
DAST-4	+	5	Nothing	Nothing
DAJC-1	Nothing	0	Nothing	Nothing
DAJC-2	Nothing	0	Nothing	Nothing
CMFS-1	+	5	+	Nothing
CMFS-2	Nothing	0	Nothing	Nothing
CMFS-3	+	10	Nothing	Nothing
CMFS-4	Nothing	0	Nothing	Nothing
QHSK-1	Nothing	0	Nothing	+
QHSK-2	Nothing	0	Nothing	+
QHSK-3	Nothing	0	Nothing	Nothing
QHSK-4	+	20	+	Nothing
QHSK-5	Nothing	0	Nothing	+
WZSHS-1	Nothing	0	Nothing	Nothing
WZSHS-2	+	5	+	Nothing
WZSHS-3	+	5	Nothing	Nothing
WZSFS-1	Nothing	0	Nothing	+
WZSFS-2	+	5	+	Nothing
WZSFS-3	Nothing	0	Nothing	Nothing
WZSFS-4	+	10	Nothing	Nothing
WZSND-1	Nothing	0	Nothing	+
WZSND-2	+	5	+	Nothing
TCTZ-1	Nothing	0	Nothing	Nothing
TCTZ-2	+	5	+	Nothing
TCTZ-3	Nothing	0	Nothing	Nothing
TCTZ-4	Nothing	0	Nothing	Nothing
TCTZ-5	Nothing	0	Nothing	Nothing
TCTZ-6	Nothing	0	Nothing	Nothing

Note: + Indicates damage or pests and diseases situation

2 Discussion

At present, there have been studies on fruit traits and biological characteristics in a certain area, but the economic benefits are not significant and there are certain limitations (Jia et al., 2018). This study aims to improve the market competitiveness of Hainan *Camellia oleifera* seed oil with the breeding requirements of high yield and quality. The excellent germplasm resources and quality of Hainan *Camellia oleifera* were analyzed, which can improve the quality of Hainan *Camellia oleifera* and increase economic benefits to a certain extent. In order to select and breed high-quality varieties suitable for promotion in Hainan, this experiment focuses on the study of excellent *Camellia oleifera* trees with good growth, which is more conducive to improving the economic benefits and application and promotion of *Camellia oleifera* in Hainan. For the deficiencies of the investigated *Camellia oleifera* superior tree varieties, continuous optimization research is needed, which is also the direction of further research in the future.

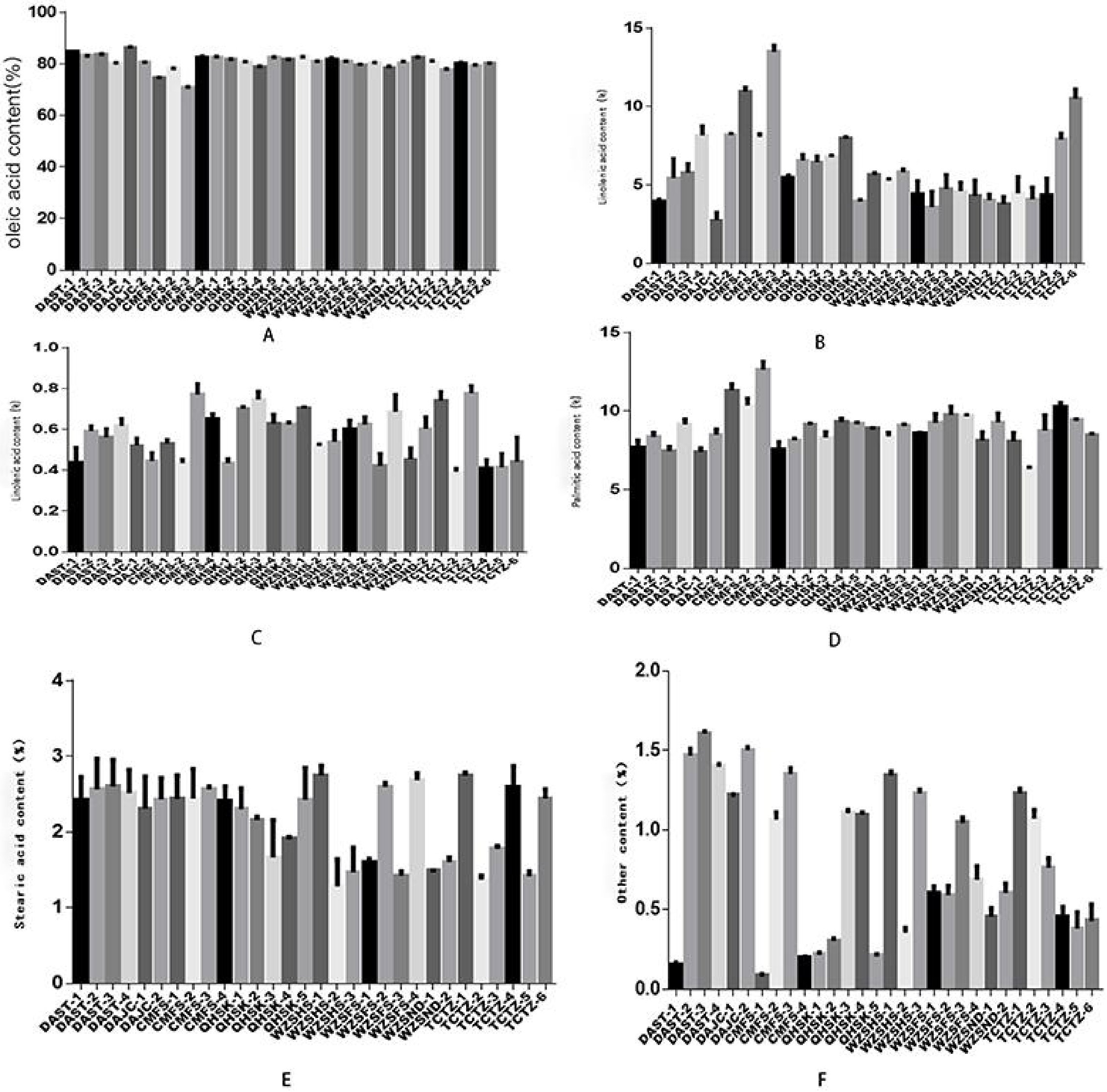

Figure 2 Composition and content of fatty acid in tea oil

Note: A: Oleic acid content; B: Content of linoleic acid; C: Content of linoleic acid; D: Palmitic acid content; E: Content of stearic acid; F: Other content

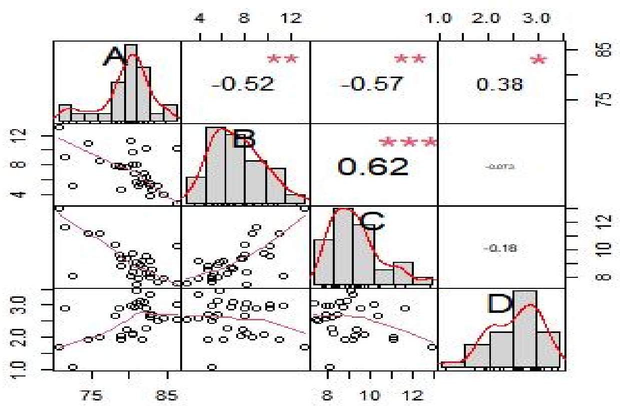

Figure 3 Correlation analysis of the four main fatty acids

Note: **: Significant correlation at the 0.01 level; *: Significant correlation at the 0.05 level; A: Oleic acid, B: Linoleic acid, C: Palmitic acid, D: Stearic acid

Comprehensive analysis of the economic and biological characteristics of the fruits of superior trees in different places of Hainan can effectively improve their yield and quality (Yang et al., 2018). Wang et al. (2016) showed that the differences in economic characteristics were mainly due to varieties, while this study showed that they were mainly affected by fruit characteristics and biological characteristics. In this study, it was found that Tunchang, Ding'an and other areas in Hainan province had the best comprehensive characteristics of fruit and the best quality of tea oil, which had obvious advantages over other areas and could be used as excellent materials for breeding. The fruit economic characters of Hainan *Camellia oleifera* superior trees have obvious advantages, and there are significant differences in all indicators (P<0.01), and its oleic acid content is rich, which can promote the improvement of its quality; Through the comprehensive analysis of the biological characteristics of superior trees in different places, it is shown that their growth characteristics, flower bud growth, diseases and insect pests all affect the quality of tea oil. If the biological characteristics of superior trees are good, the quality is better; otherwise, the quality is worse; It not only reflects the polymorphism of *Camellia oleifera* superior trees in Hainan, but also shows the rich genetic variability of *Camellia oleifera* in Hainan.

The comprehensive analysis of the economic and biological characteristics of the fruit proved that it had a great impact on the quality of Camellia oleifera, and also reflected that the superior trees of *Camellia oleifera* in Hainan had great selection potential.

3 Materials and Methods

3.1 Test materials

From August 2018 to September 2020, this experiment conducted a detailed visit and investigation on the excellent *Camellia oleifera* trees in Hainan Island, from Ding'an, Chengmai, Qionghai, Wuzhishan, Tunchang and other places. According to Zhu et al. (2016), 30 excellent trees were selected for high yield and large fruit. All the selected excellent trees can bloom and bear fruit normally. The tree age is generally 10~50 years, and the average tree height is 4~8 m (Table 5).

Table 5 Number of materials tested

Code	Number	Source	Code	Number	Source
1	DAST-1	Dinganshitang	16	WZSHS-1	Wuzhishanhongshan
2	DAST-2	Dinganshitang	17	WZSHS-2	Wuzhishanhongshan
3	DAST-3	Dinganshitang	18	WZSHS-3	Wuzhishanhongshan
4	DAST-4	Dinganshitang	19	WZSFS-1	Wuzhishanfansai
5	DAJC-1	Dinganjiucun	20	WZSFS-2	Wuzhishanfansai
6	DAJC-2	Dinganjiucun	21	WZSFS-3	Wuzhishanfansai
7	CMFS-1	Chengmaifushan	22	WZSFS-4	Wuzhishanfansai
8	CMFS-2	Chengmaifushan	23	WZSND-1	Wuzhishannanding
9	CMFS-3	Chengmaifushan	24	WZSND-2	Wuzhishannanding
10	CMFS-4	Chengmaifushan	25	TCTZ-1	Tunchangtenzhai
11	QHSK-1	Qionghaishangke	26	TCTZ-2	Tunchangtenzhai
12	QHSK-2	Qionghaishangke	27	TCTZ-3	Tunchangtenzhai
13	QHSK-3	Qionghaishangke	28	TCTZ-4	Tunchangtenzhai
14	QHSK-4	Qionghaishangke	29	TCTZ-5	Tunchangtenzhai
15	QHSK-5	Qionghaishangke	30	TCTZ-6	Tunchangtenzhai

3.2 Determination of economic characteristics of fruits

Randomly select several *Camellia oleifera* fruits from each sample, and weigh the single fruit weight, 100 seed weight, fresh seed weight, dry seed weight and kernel weight of each *Camellia oleifera* fruit with a balance; Determine the dry seed rate, fresh seed rate and other main parameters, and count the number of seeds. Fresh seed rate=fresh seed weight/fruit weight×100%; Dry seed yield=dry seed/fresh seed weight×100%; Kernel yield=dried kernel weight / dried seed×100% (Song et al., 2013).

3.3 Observation and evaluation of biological characteristics of superior trees

Through on-the-spot investigation and sampling, the selected excellent trees were measured with tape measure, counter and other tools. The biological characteristics were mainly analyzed from their growth characteristics, flower bud conditions, pests and diseases. Refer to the Forestry Industry Standard "Regulations of Selection and Breeding for of Plus Tree and Superior Clone" LY/T 1730.1-2008.

3.4 Fatty acid composition and content analysis

Take 400 μL oil into 10 mL tube, and 0.5 mL benzene is added to dissolve it. Then add 0.4 mol/L $KOH\text{-}CH_3OH$ solution 200 μL. Shake to convert all oil and fat into fatty acid methyl ester, stand for 15 minutes, add a little distilled water, take the upper liquid after layering and analyze the fatty acid composition with gas chromatograph.

3.5 Data analysis

In this experiment, Excel 2010 was used to process the mean and standard deviation of data, and R 4.0 language software was used to analyze the difference and fatty acid correlation.

Authors' contributions

WH is the executor of the experimental design and research of this study; WH, DYJ and SJM completed the data analysis and the writing of the first draft of the paper; ZY participated in the experimental design and the analysis of experimental results; LHG is the designer and principal of the project, guiding the experimental design, data analysis, paper writing and revision. All authors read and approved the final manuscript.

Acknowledgments

This study was jointly supported by the Special Fund for World-class Discipline Construction of Hainan University (NO.RZZX201902), the Research and Development of Key Technologies and Processing Products for High Quality and High Yield of Hainan *Camellia oleifera* (ZDKJ2017004), and the Branch of *Camellia oleifera* Germplasm Resources of the National Tropical Plant Germplasm Resources Bank (HD-KYH-2020009).

Reference

Chen S.S., Luo S.Z., and Zheng Z., 2016, Enzymatic lipophilization of epicatechin with free fatty acids and its effect on antioxidative capacity in crude camellia seed oil, J. Sci. Food Agri., 97(3): 868-874
https://doi.org/10.1002/jsfa.7808

Chen Y.Z., Chen L.S., Li R.F., and Ma L., 2017, Survey and the industry development proposals of *Camellia* sp. resources in Hainan, Redai Linye (Tropical Forestry), 45(1): 49-52

Chen Y.Z., Yang X.H., Peng S.F., Li D.X., Wang X.N., and Duan W., 2005, Current situation and development strategies of selection and breeding on *Camellia oleifera* in China, Linye Keji Kaifa (China Forestry Science and Technology), 19(4): 1-4

Hu J.B., and Yang G.L., 2018, Physiochemical characteristics, fatty acid profile and tocopherol composition of the oil from Camellia oleifera abel cultivated in Henan, China, Grasas Aceites, 2018, 69(2): e255
https://doi.org/10.3989/gya.1224172

Jia X.C., Chen L.Q., and Yu F.Y., and Zhang N., 2018, Preliminary report on genetic and economic traits of tea-oil Camellia in Hainan province, Redai Nongye Kexue (Chinese Journal of Tropical Agriculture), 38(6): 56-60

Li Z.M., Zhang Y.H., Yang Z.C., 2017, *Came*llia oleifera in my country under the background of rural revitalization strategy industrial development research, Nonglin Jingji Guanli Xuebao (Journal of Agriculture and Forestry Economic Management), 16(6): 809-816

Liu Q., Zhou J., and Chao Y., and Chen D., 2014, Composition of fatty acid of Camellia oil from different areas, Hunan Linye Keji (Hunan Forestry Science and Technology), 41(3): 34-37

Song X., Shi Z.G., and Yin J.B., 2013, Comprehensive evaluation of the fruit quality of Yunnan Dehong ordinary Camellia oleifera, Linye Keji Kaifa (China Forestry Science and Technology), 27(2): 66-70

Tian X.X., Fang X.Z., and Sun H.Z, Du M.H., Luo F., and Yao X.H., 2019, Seed nutritional properties of different oil Camellia species and varieties, Linye Kexue Yanjiu (Forest Research), 32(1): 133-140

Wang B.F., Zou F., Yuan D.Y., Yuan J., Xiao S.X, Gao C., Li Z., and Peng X.B., 2016, Comprehensive evaluation of fruit economic character and premium species selection of *Camellia Oleifero* in Hainan, Fujian Nonglindaxue Xuebao(Ziran Kexueban) (Journal of Fujian Agriculture and Forestry University(Natural Science Edition)), 45(2): 156-161

Xi R.C., Deng X.M., Gong C., Liu S., and Ao W.C., 2006, Studies on selecting and breeding of high linoleic acid content and high oil yield oiltea Camellia clones, Linye Jexue Yanjiu (Forest Research), 19(2): 158-164

Xu X.F., Yan H., Zhang Y., Du J.F., and Lu L.F., 2018, Research progress on extraction and activity of the three main components of *Camellia Oleifera* seeds, Baozhuang yu Shipinjixie (Packaging and Food Machinery), 36(4): 44-48

Yang L.R., Zhang Z.L., Chen J.L., Chen X., Ji Q.M., and Zheng D.Z., 2018, The quantitative characters and diversity of oiltea fruit in Hainan province, Jingjilin Yanjiu (Non-wood Forest Research), 36(3): 69-76

Yang W.B., Fu D.Q., Chen L.Q., Li Y., Zhao S.L., Ma J.L., Chen G.C., Ye H., and Wang X.S., 2012, Preliminary report on introduction and trial planting of superior subtropical *Camellia oleifera* varieties in Hainan, Jiangxi Nongye Xuebao (Acta Agriculturae Jiangxi), 2012, 24(4): 63-65

Yang Y., Zhang P., Xi R.C., and Huang R.R., 2018, Variation characteristics of oil content and fatty acid composition in *Camellia gauchowensis* fruits at different producing areas, Jijilin Yanjiu (Nonwood Forest Research), 36(4): 104-108, 144

Yuan J.J., Wang C.Z., Chen H.X., Ye J.Z., and Zhou H., 2012, Oil content and fatty acid composition analysis of different varieties of *Camellia oleifera* seeds, Zhongguo Youzhi (China Oils and Fats), 37(1): 75-79

Zhong S.M., Yang K., Wang C., Chang Y.Z., Zheng J., Yao X.H., Fei X.Q., Xu W., and Zhang F.F., 2015, Quality analysis and comparisons of different kinds of *Camellia oleifera* seed oil, Jinjilin Yanjiu (Nonwood Forest Research), 33(2): 26-33

Zhu W., Xu Y.L., Xu J.Q., Qi J.M.,and Xi R.C., 2016, Analysis and assessment on the characters of fruits from plus trees of *Camellia gauchowensis*, Fujian Fujian Linye Keji (Journal of Fujian Forestry Science and Technology), 2016, 43(4): 43-48