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## 日光萎凋对不同鲜叶嫩度与茶树品种加工红茶品质的影响

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**摘要** 为探究日光萎凋对不同鲜叶嫩度与茶树品种加工红茶品质的影响,对红茶适制品种、绿茶适制品种、红绿兼制品种等不同品种以及1芽1叶、1芽2叶等不同嫩度鲜叶进行日光萎凋处理。结果显示:日光萎凋对不同鲜叶嫩度与茶树品种加工红茶品质的影响不同。1芽2~3叶及以下嫩度原料萎凋过程叶片损伤较少,茶多酚和氨基酸含量分别降低1%、6%、8%和11%、19%、14%,可溶性糖含量分别提高15%、13%和11%,茶黄素含量较高,其中1芽3叶和1芽4~5叶红茶茶黄素含量显著增加32%和10%。结果表明,日光萎凋对1芽2~3叶及以下嫩度原料处理效果明显,适合本身花果香较弱的茶树品种,加工红茶花果香浓郁的品种没有必要进行日光萎凋,白化和紫化品种不适合日光萎凋。

**关键词** 鲜叶嫩度;茶树品种;日光萎凋;红茶;品质

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红茶是全球消费量最大的茶类,也是我国一直以来主要生产和出口的茶类之一。红茶加工主要分为萎凋、揉捻(揉切)、发酵、干燥等工序<sup>[1]</sup>,每道工序都直接影响红茶的品质。萎凋是红茶加工的首道工序。在鲜叶萎凋过程中,青草气散失,酶活性增强,促进内含物质的转化与积累<sup>[2]</sup>。常见的萎凋方式有室内自然萎凋、萎凋槽萎凋和日光萎凋。目前有关红茶萎凋的研究主要集中在萎凋槽萎凋的温度<sup>[3]</sup>、湿度<sup>[4]</sup>、时间<sup>[5]</sup>、程度<sup>[6]</sup>等,而对日光萎凋的研究较少。生产实践表明,日光萎凋不仅可以节约能源,掌握得当还能提高红茶滋味的甜醇度和鲜爽度,有时还能增加香气的甜香和花香<sup>[7-8]</sup>,已广泛应用于滇红、宜红、宁红等红茶的生产<sup>[9-10]</sup>。吴转容<sup>[11]</sup>研究发现,4、5月份,温度20~32℃、25 000 lx光照强度下日光萎凋能显著改善红茶品质,且日光萎凋程度在含水量66%~69%范围时结合室内萎凋,红茶茶黄素、氨基酸含量最高,香气物质种类与对照相比增加35种,茶叶感官品质得分最高,滋味的鲜爽度和甜醇度较好。影响茶叶日光萎凋的因素有很多,如光质、光强、环境、茶树品种、鲜叶嫩度等。在乌龙茶生产实践中发现,适制乌龙茶品种以及具有一定成熟度的原料经

日光萎凋后,叶片完整度较高,品质较好<sup>[12]</sup>。而从各地的实践看,红茶日光萎凋过程中,不同品种以及原料成熟度的茶叶品质存在较大差异,但这些因素如何影响茶叶品质的具体原因,目前尚不清晰。

因此,本研究以室内萎凋为对照,选择不同嫩度鲜叶以及代表性茶树品种进行日光萎凋试验,分析鲜叶嫩度以及茶树品种对日光萎凋红茶品质的影响,以期为红茶加工生产提供理论依据。

## 1 材料与方法

### 1.1 试验材料

试验材料定植于华中农业大学校内茶园基地。嫩度试验:茶叶采摘于2021年4月29日(晴天),品种为福鼎大白,嫩度为1芽1叶、1芽2叶、1芽3叶、1芽4~5叶。品种试验:茶叶采摘于2021年5月7日、5月18日和6月5日(晴天),品种为红茶适制品种(华红1号、黔湄809),绿茶适制品种(乌牛早、茂绿),红绿兼制品种(鸠坑早、迎霜),乌龙茶适制品种(台茶12、铁观音),白化品种(白叶1号)与紫化品种(紫鹃),嫩度为1芽2~3叶。

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## 1.2 嫩度试验

采摘不同嫩度鲜叶,每个嫩度等量分成2份,分别平摊在直径为1.0 m的竹筛上,摊叶厚度3.5~4.0 cm。1份鲜叶采用室外日光萎凋(sunlight withering, SW)(温度26.3~31.5 °C, 相对湿度21.0%~33.5%)至含水量60%;另1份鲜叶采用室内萎凋(温度22.3~26.4 °C, 相对湿度49.0%~51.5%)至含水量60%,作为对照(CK)。萎凋结束后揉切15~20 s,过孔径250 μm筛,在温度32 °C和相对湿度96%条件下发酵2 h。发酵结束后于110 °C提香机(6CTH-6.0,浙江绿峰机械有限公司)中干燥10 min,下机摊凉回潮1 h,90 °C下干燥30 min。摊凉回潮1 h后继续在80 °C下干燥1 h。试验重复3次。

## 1.3 品种试验

将采摘的1芽2~3叶鲜叶混匀,每个品种鲜叶等量分成2份,按照“本文1.2”的方法摊叶。1份鲜叶采用室外日光萎凋(温度28.0~35.0 °C, 相对湿度25.0%~26.0%)至含水量66%~69%时,转移至室内进行室内萎凋(温度24.2~29.3 °C, 相对湿度61.0%~69.2%)至含水量60%;另1份鲜叶采用室内自然萎凋,即对照(CK)。萎凋结束后按照“本文1.2”的方法进行揉切、发酵与干燥。试验重复3次。

## 1.4 分析方法

感官品质:参照茶叶审评方法<sup>[13]</sup>进行,茶叶外形、汤色、香气、滋味和叶底品质权数分别为25%、10%、25%、30%、10%。同时对茶叶的花果香、甜香、青气和异气的程度,以及滋味的酸度、苦度、涩度、鲜度、甜度及浓度进行评定,程度划分为1、2、3、4、5五个档次,表示各指标程度由轻到重。

水分(仲裁法):称取适量茶样于已知质量烘皿中,置于(103±2) °C烘箱内干燥4 h,加盖取出,于干

燥器内冷却至室温,称质量。再次置于烘箱中干燥1 h,加盖取出,于干燥器内冷却,称质量。重复加热1 h,直至连续2次质量差不超过0.005 g,以最小称量为准<sup>[14]</sup>。

茶多酚(福林酚试剂法):磨碎茶样用70%甲醇水溶液在70 °C水浴中浸提,用福林酚比色法测定多酚含量<sup>[15]</sup>。

游离氨基酸(茚三酮比色法):取适量茶样于沸水中萃取过滤,采用茚三酮比色法于分光光度计下测定其含量<sup>[16]</sup>。

可溶性糖(蒽酮比色法):取适量茶样于沸水中萃取过滤,用蒽酮比色法测定其可溶性糖含量<sup>[17]</sup>。

茶色素(系统检测法):取适量茶样于沸水中萃取过滤,用乙酸乙酯、正丁醇分离茶色素,用分光光度计进行比色测定<sup>[18]</sup>。

茶黄素组分含量测定(高效液相色谱法):磨碎茶样用70%甲醇水溶液在70 °C水浴中浸提,采用高效液相色谱法进行茶黄素组分含量测定,主要包括茶黄素(theaflavin, TF)、茶黄素-3-没食子酸酯(theaflavin-3-gallate, TF-3-G)、茶黄素-3'-没食子酸酯(theaflavin-3'-gallate, TF-3'-G)和茶黄素-3,3'-双没食子酸酯(theaflavin-3,3'-digallate, TFDG),具体方法参照文献[19]。

## 1.5 数据处理

使用SPSS Statistics 26软件进行统计分析,采用t检验进行显著性分析。

## 2 结果与分析

### 2.1 不同嫩度鲜叶日光萎凋对红茶品质的影响

不同嫩度原料日光萎凋和室内自然萎凋红茶萎凋叶变化如图1所示。与CK相比,1芽1叶日光萎凋

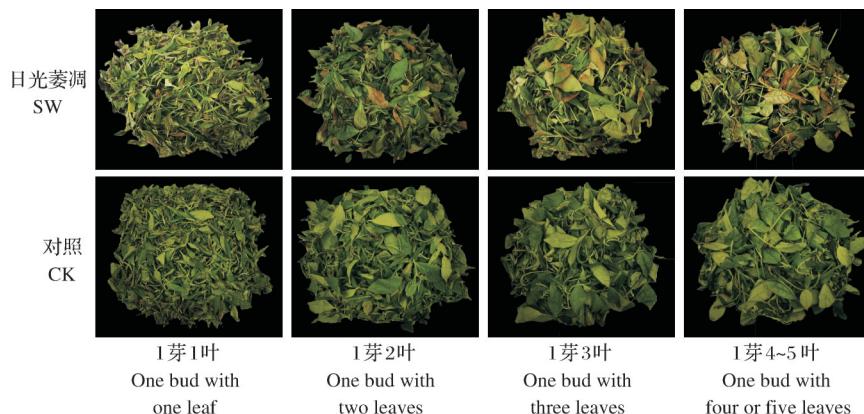


图1 不同嫩度原料日光萎凋红茶萎凋叶变化

Fig. 1 Changes of withered leaves of black tea with different tenderness of sunlight withering

水分散失较快,叶边较硬,部分红变;1芽4~5叶萎凋结束后部分嫩叶重度萎蔫而垂软,出现了叶质脆硬、部分叶片干枯现象。相比较而言,1芽2叶和1芽3叶日光萎凋后发生红褐变的现象相对较少,萎凋叶质量较好,更加适合日光萎凋。试验结果还表明,日光萎凋可以节约萎凋时间。相比于室内自然萎凋,1芽1叶、1芽2叶、1芽3叶和1芽4~5叶日光萎凋可分别节约5.2、5.1、8.4和8.8 h。

日光萎凋对不同嫩度鲜叶加工的红茶滋味和香气影响较大,对汤色、外形和叶底影响较小(表1)。相比于室内自然萎凋,日光萎凋提高了红茶的滋味

品质,主要体现在增强了滋味的鲜爽度。对于4种原料而言,日光萎凋对1芽3叶和1芽4~5叶原料红茶的滋味品质改善最明显,尤其是青涩味显著下降,基本消失。在香气方面,日光萎凋对1芽1叶原料加工的茶叶品质影响较小,但对1芽2叶及以下原料影响较大,突出表现在经日光萎凋后茶叶释放出了花果香,而且花果香浓度随原料的老化显著增加,同时粗青气消失(图2)。从感官审评结果来看,原料成熟度越高,日光萎凋效果越好。对于1芽1叶等高嫩度原料而言,日光萎凋的作用不大,但对于1芽2叶及以上成熟度的原料,日光萎凋能明显改善滋味和香气品质。

表1 不同嫩度原料日光萎凋红茶感官审评

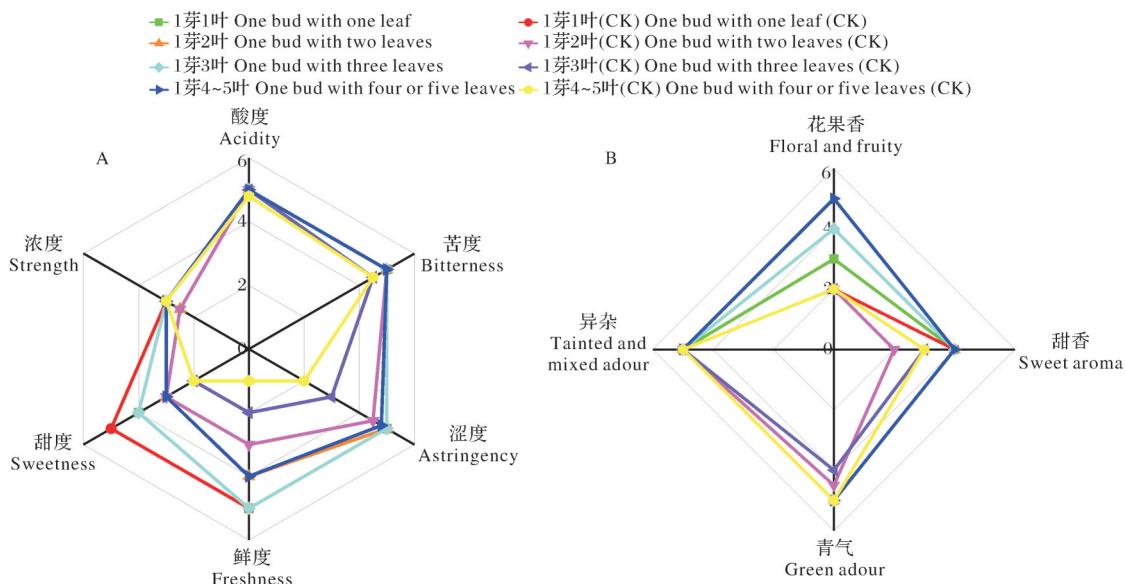
Table 1 Sensory evaluation of black tea with different tenderness of sunlight withering

嫩度 Tenderness	外形 Appearance	汤色 Liquor color	香气 Aroma	滋味 Taste	叶底 Infused leaf	总分 Total score
1芽1叶 One bud with one leaf	日光萎凋 SW	尚乌黑,油润 Approach black bloom	红尚浓,明亮 Light red and bright	较浓,甜香较高 Heavy, sweet aroma	鲜醇 Fresh and mellow	红,明亮 Red, bright 91.6±0.1
		91.0±0.0	90.5±0.0	91.0±0.0	92.3±0.3	93.0±0.0
	对照 CK	尚乌黑,油润 Approach black bloom	红尚浓,明亮 Light red and bright	尚高甜 Approach high and sweet	甜醇 Sweet and mellow	红,明亮 Red, bright 91.4±0.1
		91.0±0.0	90.5±0.0	91.0±0.0	91.8±0.3	93.0±0.0
	日光萎凋 SW	乌黑,油润 Black bloom	红明 Red and clear	带花果香,尚浓 Heavy, little flowery and fruity aroma	尚鲜醇 Little fresh and mellow	红,明亮 Red, bright 89.6±0.2**
		92.0±0.0	90.5±0.0	88.7±0.6**	87.7±0.6**	92.0±0.0**
1芽2叶 One bud with two leaves	对照 CK	乌黑,油润 Black bloom	红明 Red and clear	略青,尚浓 Little grassy, approach heavy	醇和 Mellow	红,尚明 Red, approach bright 87.6±0.0
		92.0±0.0	90.5±0.0	85.0±0.0	85.0±0.0	91.5±0.0
	日光萎凋 SW	尚乌黑 Approach black	红明 Red and clear	尚浓,花果香较浓 Heavy flowery and fruity aroma	鲜醇 Fresh and mellow	红,明亮 Red, bright 90.2±0.2**
		89.0±0.0	91.0±0.0**	88.7±0.6**	91.8±0.3**	91.5±0.0
	对照 CK	尚乌黑 Approach black	红明 Red and clear	略青 Little grassy	略青,略涩 Little grassy and astringent	红,明亮 Red, bright 85.8±0.1
		89.0±0.0	90.5±0.0	84.0±0.0	81.8±0.3	91.5±0.0
1芽3叶 One bud with three leaves	日光萎凋 SW	红棕 Reddish brown	红明 Red and clear	花果香浓郁 Heavy flowery and fruity aroma	醇和,尚鲜 Mellow and approach fresh	尚红,尚明亮 Approach red and bright 88.3±0.1**
		87.0±0.0	91.0±0.0**	90.0±0.0**	86.3±0.3**	88.5±0.0**
	对照 CK	红棕 Reddish brown	红,尚明 Red, approach clear	略粗 Little harsh	涩 Astringent	尚红,尚明亮 Approach red and bright 84.0±0.2
		87.0±0.0	89.7±0.3	84.0±0.0	78.7±0.6	88.0±0.0

注: \*和\*\*分别表示0.05和0.01水平上差异显著。下同。Note: \* and \*\* indicate significant difference at 0.05 and 0.01 level, respectively. The same as follows.

日光萎凋对不同嫩度鲜叶加工红茶品质成分的影响如表2所示。日光萎凋显著降低氨基酸含量。

相较于CK,经日光萎凋后各种嫩度红茶氨基酸含量均显著下降,一方面可能是由于日光萎凋时间短,不



A:滋味因子雷达图 Radar chart of taste factors; B:香气因子雷达图 Radar chart of aroma factors.

图2 不同嫩度原料日光萎凋红茶滋味和香气因子雷达图

Fig. 2 Radar chart of taste and aroma factors of black tea with different tenderness of sunlight withering

表2 不同嫩度原料日光萎凋红茶理化分析

Table 2 Physical and chemical analysis of black tea with different tenderness of sunlight withering mg/g

嫩度 Tenderness		茶多酚 Polyphenols	游离氨基酸 Amino acids	可溶性糖 Soluble sugar	茶黄素 Theaflavins	茶红素 Thearubigins	茶褐素 Theabrownine
1芽1叶 One bud with one leaf	日光萎凋 SW 对照 CK	127.13±0.57 127.60±0.63	12.72±0.18** 14.82±0.34	25.64±0.70 24.63±1.05	3.84±0.06 3.62±0.18	32.55±0.72** 37.73±2.65	60.00±0.56** 66.38±0.84
1芽2叶 One bud with two leaves	日光萎凋 SW 对照 CK	114.14±1.82 115.76±2.04	11.14±0.49* 12.54±0.45	35.63±0.86** 31.03±0.94	3.89±0.32 3.89±0.02	36.04±2.74 36.38±1.19	62.55±0.52 64.07±1.45
1芽3叶 One bud with three leaves	日光萎凋 SW 对照 CK	92.48±0.39** 98.89±1.24	12.37±0.36** 15.32±0.50	39.28±0.54** 34.69±0.95	4.05±0.33** 3.06±0.14	39.25±3.43** 28.53±1.36	56.85±2.08 55.23±0.44
1芽4~5叶 One bud with four or five leaves	日光萎凋 SW 对照 CK	83.99±1.74** 91.65±1.59	13.26±0.61** 15.39±0.28	46.35±0.08** 41.78±0.34	3.18±0.12* 2.89±0.07	24.88±1.61* 22.11±1.62	50.91±1.42* 47.43±0.53

利于蛋白质水解,另一方面可能是日光萎凋过程中的光和热促进了氨基酸的转化<sup>[20]</sup>。茶多酚的含量变化同氨基酸相似,经日光萎凋后红茶茶多酚含量均低于CK,较成熟的1芽3叶和1芽4~5叶红茶茶多酚含量显著低于CK。与茶多酚和氨基酸变化相反,日光萎凋有利于可溶性糖含量的提高,经日光萎凋后不同嫩度红茶可溶性糖的含量分别提高了4%、15%、13%和11%,较成熟的1芽2叶、1芽3叶和1芽4~5叶红茶可溶性糖含量极显著高于CK,这可能是由于日光萎凋促进了多糖类物质的分解。日光萎凋有利于提高茶黄素含量,其中1芽3叶和1芽4~5叶红茶的茶黄素含量较CK分别提高32%和10%。进一步分析茶黄素组成(表3)发现,日光萎凋对各种嫩度红茶TF、以及1芽1叶和1芽2叶的TF-3'-G、TF-

3-G影响较小;但对于1芽3叶、1芽4~5叶原料,日光萎凋显著提高TFDG、TF-3'-G和TF-3-G含量。日光萎凋后1芽1叶红茶的茶红素和茶褐素含量显著降低,1芽2叶变化不显著;1芽3叶的茶红素显著提高,但茶褐素变化不显著;1芽4~5叶茶红素和茶褐素均显著提高。

## 2.2 不同品种鲜叶日光萎凋对红茶品质的影响

不同品种鲜叶日光萎凋与室内萎凋的萎凋叶色泽变化如图3所示,2种萎凋方式下萎凋叶色泽正常,相比较而言,经过日光萎凋的叶片红变现象要比室内萎凋叶片明显,尤其是红茶适制品种华红1号和黔湄809以及乌龙茶适制品种铁观音。白叶1号和紫鹃属于光敏型茶树品种,白叶1号受日光胁迫较大,日光萎凋后鲜叶萎蔫,顶叶红褐变现象明显;紫鹃受

表3 不同嫩度原料日光萎凋红茶茶黄素组分含量

Table 3 Content of theaflavin components in black tea with different tenderness of sunlight withering mg/g

嫩度 Tenderness		茶黄素 Theaflavin (TF)	茶黄素-3-没食子酸酯 Theaflavin-3'-gallate (TF-3'-G)	茶黄素-3'-没食子酸酯 Theaflavin-3'-gallate (TF-3'-G)	茶黄素-3,3'-双没食子酸酯 Theaflavin-3,3'-digallate (TFDG)
1芽1叶 One bud with one leaf	日光萎凋 SW 对照 CK	72.65±0.12 72.61±0.11	101.67±0.18 101.77±0.11	127.38±0.39 125.41±0.31	241.77±0.67 241.26±0.89
1芽2叶 One bud with two leaves	日光萎凋 SW 对照 CK	69.35±0.58 68.87±0.19	105.89±0.24 105.53±0.34	130.21±1.22 128.88±0.45	237.12±1.64 238.22±2.15
1芽3叶 One bud with three leaves	日光萎凋 SW 对照 CK	67.99±0.16 67.61±0.07	108.39±0.42* 105.13±0.22	131.63±0.87* 127.13±0.38	234.51±0.67* 228.99±0.98
1芽4~5叶 One bud with four or five leaves	日光萎凋 SW 对照 CK	67.72±0.04 67.60±0.07	109.83±1.00* 104.79±0.58	129.86±1.81* 124.95±0.95	233.21±3.54* 222.59±2.13

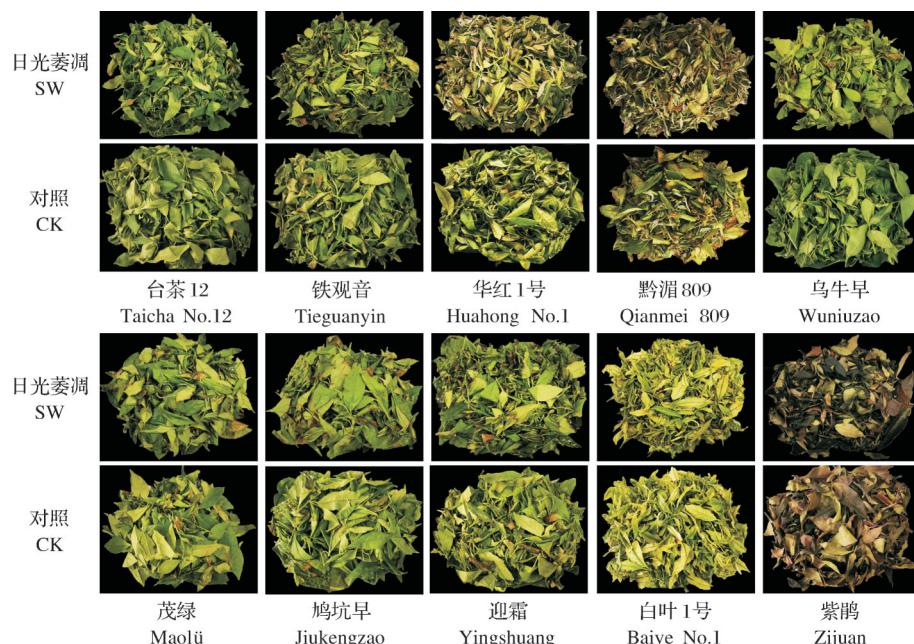


图3 不同品种原料日光萎凋红茶萎凋叶变化

Fig. 3 Changes of withered leaves of black tea with different tea plant varieties of sunlight withering

日光胁迫较小,日光萎凋后叶子几乎没有损伤,但更卷曲,且叶片紫化色泽度明显下降。此外,不同品种日光萎凋+室内复合萎凋的总时间为5.1~8.3 h,而对照全部室内萎凋的时间为8.0~11.7 h,说明不同品种日光萎凋后均可以缩短萎凋时间,提高生产效率。

不同品种加工红茶日光萎凋感官审评结果见表4,香气和滋味因子审评结果见图4。与CK相比,日光萎凋主要影响茶叶的香气和滋味品质,对外形色泽、汤色和叶底色泽影响较小。从香气看,日光萎凋能显著提升香气品质的主要品种是适制红茶品种(华红1号、黔湄809)和适制绿茶品种(乌牛早、茂绿),而对适制乌龙茶(台茶12、铁观音)、红绿兼制品种(鸠坑早、迎霜)、白化(白叶1号)和紫化品种(紫鹃)的提升

效果不显著。从滋味品质看,除了白化和紫化品种外,日光萎凋显著提升适制红茶、绿茶、乌龙茶以及红绿兼制品种红茶滋味的鲜爽度,但相比较而言,适制红茶、绿茶以及红绿兼制品种红茶鲜爽度提升效果更为显著,乌龙茶相对小一点。对于白化和紫化品种而言,日光萎凋起到相反的作用,表现在酸味和涩味明显增加。

日光萎凋对不同品种加工红茶主要品质成分的影响不同。如图5所示,日光萎凋显著影响茶多酚、氨基酸、可溶性糖含量,经过日光萎凋后多数品种保持了较高的茶多酚含量(除茂绿、白叶1号、紫鹃)和可溶性糖含量(除华红1号、白叶1号、紫鹃),但氨基酸含量显著下降。日光萎凋后,除台茶12外多数品种

表4 不同品种原料日光萎凋红茶感官审评结果

Table 4 Sensory evaluation of sunlight withering of black tea with different varieties

品种 Cultivar	外形 Appearance	汤色 Liquor color	香气 Aroma		滋味 Taste	叶底 Infused leaf	总分 Total score
			红,尚明	浓郁,花果香较高			
日光萎凋 SW	乌黑,油润	Black bloom	Red, approach clear	Fragrant, flowery and fruity aroma	甜醇,鲜爽	Approach red and clear	92.3±0.1**
台茶12 Taicha No.12	乌黑,油润	Black bloom	91.3±0.6	92.0±0.0	95.0±0.0**	87.5±0.0**	
对照 CK	乌黑,油润	Black bloom	Red, approach clear	Approach fresh and sweet, high flowery and fruity aroma	Sweet and mellow	Approach red and clear	91.6±0.0
日光萎凋 SW	乌黑,油润	Black bloom	91.0±0.0	92.0±0.0	93.0±0.0	87.0±0.0	
铁观音 Tieguanyin	乌黑,油润	Black bloom	橙红,尚明亮	Fragrant, little flowery and fruity aroma	Fresh and mellow	Approach red and bright	92.2±0.1**
对照 CK	乌黑,油润	Black bloom	87.3±0.6*	93.0±0.0**	94.0±0.0	89.5±0.0**	
日光萎凋 SW	尚棕褐,油润	Approach brownish auburn, bloom	Approach red and bright	High flowery and fruity aroma	Fresh and mellow	Approach red and bright	92.6±0.1
华红1号 Huahong No.1	棕褐,油润	Brownish auburn, bloom	90.8±0.6	94.0±0.0	94.0±0.0	89.0±0.0	
对照 CK	棕褐,油润	Brownish auburn, bloom	红浓,明亮	Heavy flowery and fruity aroma	Strong, fresh and brisk	Red and brilliant	91.7±0.1**
日光萎凋 SW	86.0±0.0**	90.8±0.6	90.8±0.6	93.7±0.6**	93.0±0.0**	94.0±0.0	
黔湄809 Qianmei 809	黄棕	Yellowish brown	Deep red, bright	Approach high and sweet, little flowery and fruity aroma	Approach strong, fresh and brisk	Red and brilliant	89.8±0.1
对照 CK	黄棕	Yellowish brown	91.8±0.3	89.8±0.3	89.5±0.0	94.0±0.0	
日光萎凋 SW	黄棕	Yellowish brown	红尚浓,尚明亮	花果香较浓郁,较高锐	尚浓厚,尚鲜爽	红艳,明亮	
对照 CK	黄棕	Yellowish brown	Light red, approach bright	High flowery and fruity aroma	Approach strong and fresh, little astringent	Red and brilliant	89.4±0.0**
日光萎凋 SW	红棕,较润	Reddish brown, more bloom	90.0±0.0**	92.0±0.0**	89.0±0.0**	93.0±0.0	
乌牛早 Wuniuzao	红棕,较润	Reddish brown, more bloom	Light red, bright	尚高甜,带花果香	Approach strong and astringent	Approach red, bright	88.1±0.1
对照 CK	红棕,较润	Reddish brown, more bloom	91.0±0.0	89.3±0.3	87.0±0.0	93.0±0.0	
日光萎凋 SW	90.0±0.0	Orange red, approach clear	橙红,尚明	尚浓,带甜香	Heavy and sweet aroma	醇和,尚鲜	
乌牛早 Wuniuzao	90.0±0.0	88.0±0.0**	87.3±0.6**	84.7±0.6**	84.7±0.6**	92.0±0.0**	
对照 CK	90.0±0.0	Red, approach clear	红,尚明	略青,略涩	Little grassy and astringent	红,明亮	85.5±0.2
	90.0±0.0	90.0±0.0	90.0±0.0	84.0±0.0	80.7±0.6	91.0±0.0	

续表 4 Continued Table 4

品种 Cultivar	外形 Appearance	汤色 Liquor color	香气 Aroma	滋味 Taste		叶底 Infused leaf	总分 Total score
				尚浓 Heavy	尚浓,带甜香 Heavy and sweet aroma		
茂绿 Maoliu	日光萎凋 SW	尚红棕 Approach reddish brown	红,尚明 Red, approach clear	尚浓,带甜香 Heavy and sweet aroma	醇和,尚鲜 Mellow, approach fresh	红,明亮 Red and bright	85.9±0.0*
	对照 CK	尚红棕 Approach reddish brown	红,尚明 Red, approach clear	略青,略杂 Little grassy and mixed	略青,略涩 Little grassy and astringent	红,明亮 Red and bright	91.0±0.0
鸠坑早 Jiukengzao	日光萎凋 SW	红棕,较润 Reddish brown, more bloom	红浓,尚明亮 Deep red, approach bright	浓郁,花果香较浓 Heavy flowery and fruity aroma	浓郁,花果香较浓 Fresh and brisk	红,明亮 Red and bright	83.7±0.0
	对照 CK	红棕,较润 Reddish brown, more bloom	红浓,尚明亮 Deep red, approach bright	浓郁,花果香较浓 Heavy flowery and fruity aroma	浓郁,花果香较浓 Fresh and strong	红,明亮 Red and bright	91.0±0.0
迎霜 Yingshuang	日光萎凋 SW	红棕,较润 Reddish brown, more bloom	红浓,尚明亮 Light red, approach bright	浓郁 Heavy	浓郁,花果香较浓 Sweet and mellow, fresh and brisk	红,明亮 Red and bright	92.7±0.0*
	对照 CK	红棕,较润 Reddish brown, more bloom	红浓,尚明亮 Deep red, approach bright	浓郁 Heavy	浓郁 Sweet and mellow	红,明亮 Red and bright	92.4±0.0
白叶1号 Baeye No.1	日光萎凋 SW	棕红 Brownish red	红,略暗 Red, little dull	尚浓,带果香 Little mixed and fruity	略酸,涩 Little sourish, astringent	红,明亮 Red and bright	91.0±0.0
	对照 CK	棕红 Brownish red	红,略暗 Red, little dull	带果香,略杂 Little mixed and fruity	略涩 Little astringent	红,明亮 Red and bright	92.0±0.0
紫鹃 Zijuan	日光萎凋 SW	红棕 Reddish brown	红,略暗 Red, little dull	尚浓,带果香浓郁 Heavy fruity	略酸,涩 Little sourish, astringent	红,略暗 Red, little dull	86.1±0.0*
	对照 CK	红棕 Reddish brown	红,略暗 Red, little dull	果香浓郁,高锐 High fruity aroma	略涩 Little astringent	红,略暗 Red, little dull	88.0±0.0*

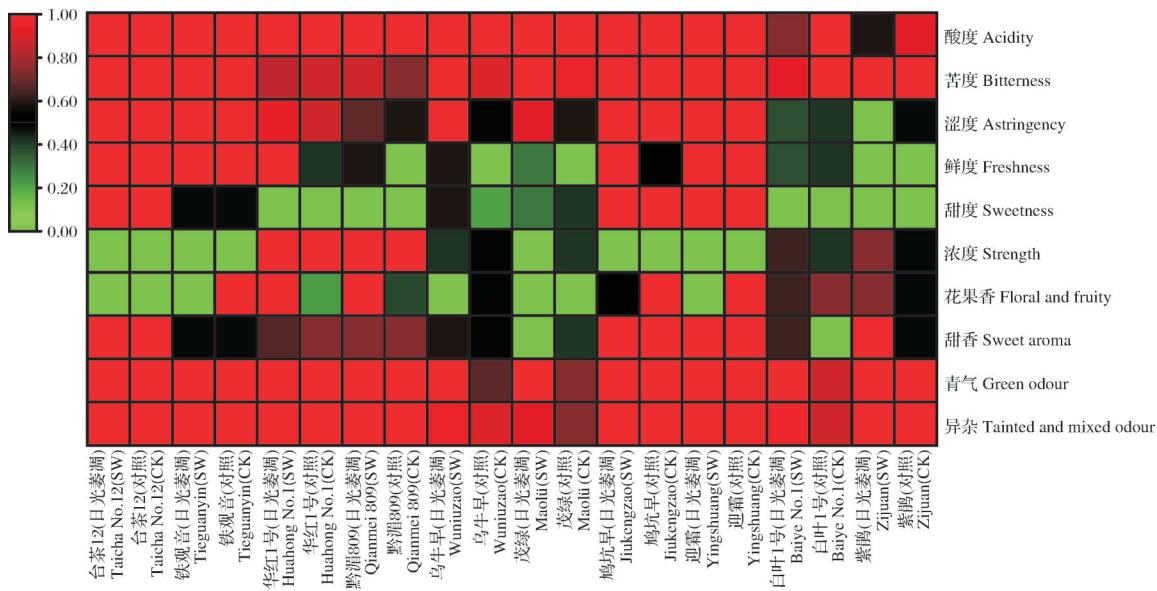


图4 不同品种原料日光萎凋红茶香气和滋味因子热图

Fig. 4 Heat map of aroma and taste factors of black tea with different tea plant varieties of sunlight withering

种茶黄素含量显著增加。从茶黄素组成看(图6),日光萎凋后各品种TF-3-G、TF-3'-G、TFDG、TF含量都有所增加,但不同品种表现趋势不同。台茶12、黔湄809、迎霜和白叶1号,TF-3-G、TF-3'-G、TFDG、TF含量增加都不显著;鸠坑早、乌牛早、铁观音除TF含量增加不显著外,TF-3-G、TF-3'-G、TFDG显著增加;华红1号和紫鹃TFDG含量显著增加,TF-3-G增加不显著,华红1号TF含量显著增加,紫鹃TF-3'-G含量增加显著。这说明不同品种对于日光萎凋的敏感性不同。经过日光萎凋后,仅茂绿茶红茶素含量显著增加,其他品种含量增加不明显。茶褐素变化比较复杂,经过日光萎凋后台茶12、华红1号、黔湄809茶褐素含量增加,白叶1号、紫鹃含量变化不明显,其他品种含量下降。

### 3 讨论

光对采后植物生理生化有较大影响,如西兰花采后进行可见光持续照射,可减少硫代葡萄糖苷的损失,延缓叶片黄变与叶绿素的降解<sup>[21]</sup>。在茶叶的加工工序中,光也是影响茶叶品质的重要因素,实际生产中茶叶的日光萎凋应用普遍。日光萎凋是乌龙茶加工的必要工序,日光萎凋处理的乌龙茶苦涩味降低,花香和果香提升<sup>[22]</sup>。日光萎凋后白茶中的茶多糖、儿茶素减少,茶色素含量增加,促进鲜味与醇和的品质形成<sup>[23]</sup>。适时的日光萎凋可使红茶香气种类增加,花果香提升<sup>[11]</sup>。

本研究发现日光萎凋对不同鲜叶嫩度加工红茶

的香气和滋味影响较大。这可能与不同嫩度叶片细胞中叶绿体状态、光受体以及酶活性等有关,但具体机制有待深入研究。与CK相比,室外日光萎凋处理的红茶中氨基酸与茶多酚含量均显著下降,说明日光能够促进氨基酸与茶多酚的转化,一方面在光热效应下产生大量具有花果香的萜烯类化合物,有利于香气品质的形成;另一方面日光萎凋促进茶多酚、茶多糖等发生剧烈反应,使茶黄素、茶红素和可溶性糖的含量显著增加,提升红茶滋味的鲜爽度,在一定程度上改善粗老原料的滋味品质。此外,可溶性糖的增加为美拉德反应与焦糖化反应提供更多前体物质,有利于后续工序糠醛类物质积累,提升茶叶香气品质<sup>[24]</sup>。结合感官审评和理化分析结果,1芽2~3叶及以下嫩度原料,萎凋过程叶片损伤较少,茶多酚和氨基酸含量降低,可溶性糖含量增加,茶黄素组分总量较高,适宜用来进行日光萎凋。

日光萎凋对不同茶树品种加工红茶品质影响不尽相同。这可能与不同品种本身特性及对光的敏感性不同有关。植物体内的光敏色素、隐花色素、趋光素及UV-B受体等光受体使植物能够感知光线的方向、波长、光照和时间,但不同植物有较大差异<sup>[25]</sup>,如长豇豆不同品种对光照敏感性差异较大,碧秀、小富、合浦农家豇等敏感类豇豆品种随光照时长的增加,开花结荚明显推迟<sup>[26]</sup>。茶树品种的不同对光照萎凋的要求也不同,如采用黄旦品种制作白茶时,日照使茶青部分失水,青草气散失,香气品质提升;而英红九号、云南大叶群体种属于大叶种茶树品种,芽

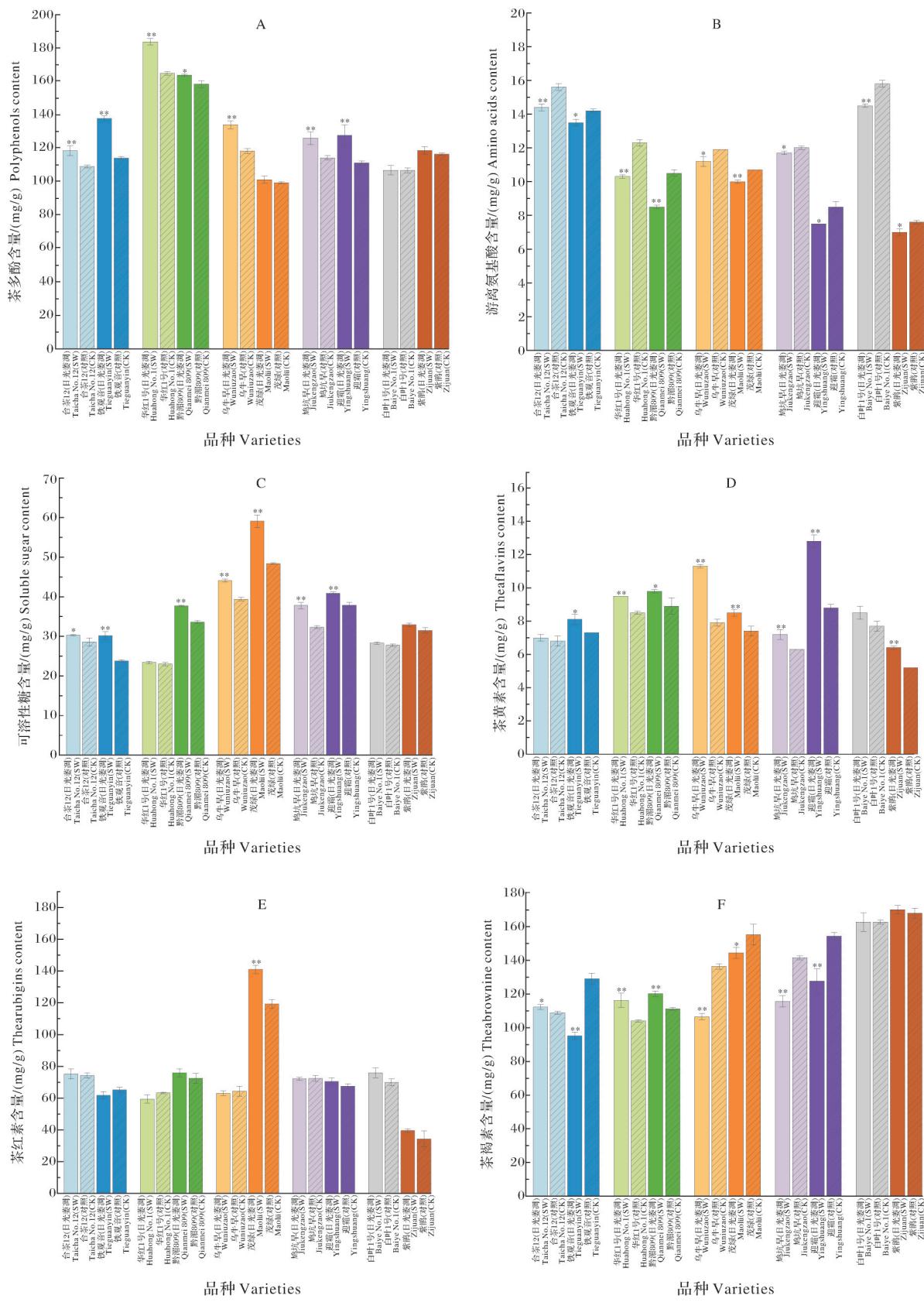


图5 不同品种原料日光萎凋红茶理化分析

Fig. 5 Physical and chemical analysis of black tea with different varieties of sunlight withering

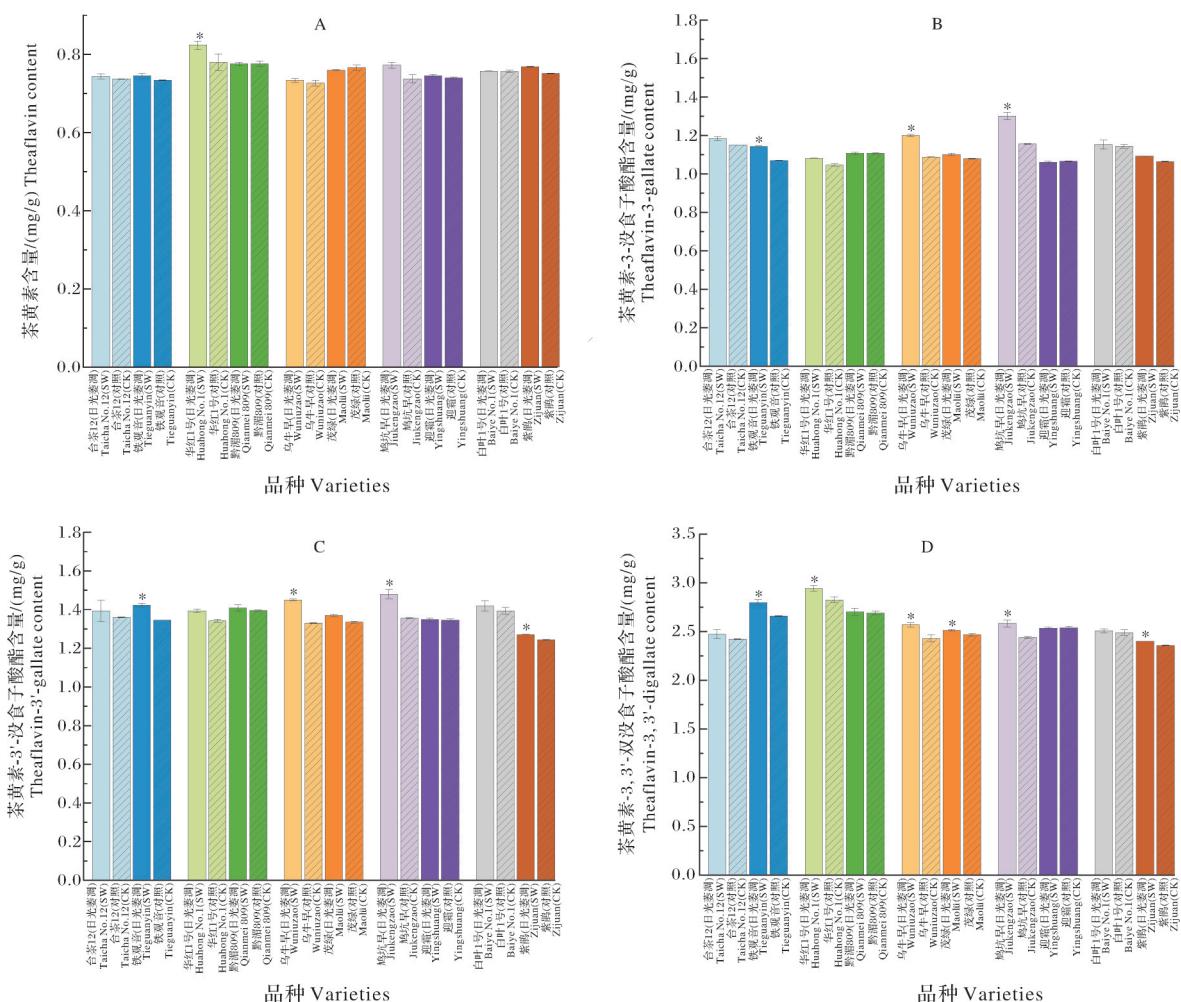


图6 不同品种原料日光萎凋红茶茶黄素组分含量

Fig. 6 Content of theaflavin components of black tea with different varieties of sunlight withering

头肥壮、叶张偏大且叶层偏薄,茶青易损伤不宜日光晒青<sup>[27]</sup>。从感官审评结果看,日光萎凋对适制乌龙茶和部分红绿兼制品种香气提升不显著,这主要是所选品种台茶12、铁观音、鸠坑早等本身含有丰富的花果香物质,在自然萎凋下加工红茶花果香就已经较浓郁<sup>[28]</sup>,日光萎凋的效果不明显。对于白化和紫化品种而言,日光萎凋起到相反的作用,表现在酸味和涩味明显增加,这一现象值得深入研究。此外,在本试验中,不同品种日光萎凋红茶茶多酚含量要高于室内自然萎凋,这一结果与嫩度试验不一致,主要原因在于这种萎凋实质上是日光与室内相结合的复合萎凋,前期是日光萎凋,后期是室内自然萎凋,茶多酚的转化程度相比全日光萎凋要轻一些,故保留量提高<sup>[29]</sup>。从感官审评结果看,日光萎凋更适合本身花果香较弱的品种,加工红茶花果香浓郁的品种没有必要进行日光萎凋,白化和紫化品种不适合日光萎凋。

本研究仅选用10个代表性品种进行了日光萎凋试验,数量偏少,后期可以进一步扩大品种范围进行对比试验,同时可针对不同品种日光萎凋作用机制进行深入分析,挖掘适宜于日光萎凋的特异资源,为红茶品质提升提供依据。

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## Effects of sunlight withering on quality of processed black tea with different fresh leaf tenderness and tea plant varieties

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**Abstract** Sunlight withering treatment was conducted on different tea varieties including black tea, green tea and red green mixed varieties, and different tenderness of fresh leaf including one bud with one leaf, one bud with two leaves to study the effects of sunlight withering on the quality of processed black tea with different fresh leaf tenderness and tea plant varieties. The results showed that the effects of sunlight withering on the quality of processed black tea of different fresh leaf tenderness and tea plant cultivars were different. There was less damage to the leaves and the content of tea polyphenols and amino acids respectively decreased by 1%, 6%, 8% and 11%, 19%, 14% during the withering process of the tenderness of fresh leaf including one bud with two or three leaves and below. The content of soluble sugar increased more, increasing by 15%, 13% and 11%, respectively. The content of theaflavins was relatively high, with a significant increase of 32% in black tea with one bud with three leaves and 10% with one bud with four or five leaves. It is indicated that sunlight withering has a significant effect on treating the tenderness of fresh leaf including one bud with two or three leaves and below, and is suitable for tea tree varieties with weaker floral and fruity aromas. It is not necessary to perform sunlight withering on varieties of processed black tea with strong floral and fruity aromas. Albino and purple varieties are not suitable for sunlight withering.

**Keywords** fresh leaf tenderness; tea plant varieties; sunlight withering; black tea; quality

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