Effects of LED Light Withering on the Quality of White Tea

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Abstract. Fresh leaves were used to evaluate the effects of LED light on the main contents of white tea during the withering process. According to the results, the content of tea water extract was increased by LED light withering; tea polyphenols in blue light group was the lowest compared to other treatments; amino acids in red-light group was the highest. LED light withering had obvious effect on the appearance, aroma and taste of white Tea. The tea in red and blue light treatments had natural shape, dark green color, fresh aroma, mellow taste, and in the red-light treatment had flower fragrance; however, the tea in the green light treatment had pure aroma and mellow taste; the sensory evaluation results showed that the quality of the light group was better than that of the control group, and the sensory quality of the comprehensive evaluation was the best.

1. Introduction

Tea, as a cash crop, has a history of more than 4000 years in China, so China is regarded as the origin of tea. China has a history of over two hundred years of White Tea, but it has been mainly sold abroad for a long time, and the domestic market is growing slowly. According to the National Bureau of Statistics in 2012, the total output of dried tea in China was 1.7898 million tons, of which 10200 tons were White Tea, accounting for 0.57 percent of the total output of six tea types in China, only higher than that of yellow tea. White Tea is a light fermented tea, mainly produced in Fujian Province. The traditional White Tea making method does not stir-fry and does not knead, which makes the tea have the quality characteristics of "natural shape, white, bright apricot color, bright endoplasmic fragrance, fresh taste" quality characteristics. The new-technique White Tea has carried on the rolling modelling to the traditional White Tea, forming the quality of "the winding forming, the soup color apricot yellow, the fragrance sweet alcohol" with the regulation of immune function and antioxidant function of White Tea [1] anti-cancer and anti-cancer activity [2] and so on function is discovered, the White Tea has been loved by more and more people. Withering is the key to White Tea processing technology. Withering mode, time and environment are important factors affecting the quality of White Tea. The outstanding quality of White Tea requires high content of fuzz and amino acid in fresh leaves [3]. Although the White Tea processing is simple, it is difficult to control, withering requires high environmental requirements.

Yunnan is the origin of tea trees in the world. It has a long history of planting and drinking tea. Yunnan tea raw material resources are very rich, but there is a phenomenon that the utilization rate of resources is not high in the tea producing area. Yunnan White Tea is mainly divided into two colors: big White Tea (single bud) and moonlight white (one bud, one leaf or one bud, two leaves) according to the tenderness of fresh leaves. The processing of White Tea consists of two processes: natural withering, compound withering and heating withering. Withering is the key process for the formation of White Tea quality, and the quality of White Tea withering at different technological levels varies greatly [4].
LED is a kind of cold light source, which can effectively transform electric energy into radiation energy. It is suitable for the regulation of light environment during plant growth. In recent years, it has been reported that light is one of the factors of tea aroma formation, and the aroma components of tea can be increased obviously by sunlight withering. In the process of tea withering, light source irradiation can promote the transformation and accumulation of aroma substances with flower fragrance and fragrance. To a certain extent, the light and heat of light source promoted the loss of water in withering leaves and the activation of enzyme activity in leaf cells, while the quality of tea was closely related to the intensity of enzyme activity in withering leaves [5]. As a result, this study intends to study the processing technology of Yunnan White Tea LED light withering and make full use of Yunnan variety resources to produce White Tea products suitable for tea drinking habits in Yunnan tea area.

2. Materials and methods

2.1 material
The material used in this study is YunKang10, picked in early October 2019, the picking standard is one bud two, three leaves, do not pick extra leaves, pest leaves, etc. Tea was collected from northern latitude 22°42’~22°51’, east longitude 100°56’~101°00’, The elevation range is 1200~1500 m tea tree seed field. The climate here is subtropical plateau monsoon climate, annual mean temperature 17.9℃, average annual rainfall of 1535.4 mm, average rainfall 150 days, relative humidity is 85.

Drugs and instruments: potassium sodium tartrate, ferrous sulfate, disodium hydrogen phosphate, potassium dihydrogen phosphate indanone stannous chloride visible spectrophotometer, electrothermal thermostatic drying box, electrothermal thermostatic water bath pot, tea dryer, analytical balance, LED lamp tube (long 0.6 m, power 18 W as shown in table 1), infrared thermometer, etc.

| Light source | Red-light | Yellow light | Blue light | Green Light |
|--------------|-----------|--------------|------------|-------------|
| Wavelength (nm) | 620-625 | 586-592 | 452-455 | 520-525 |
| Illuminance (lx) | 702-874 | 255-301 | 147-178 | 1304-1582 |

2.2 method
The experiment was carried out in the tea laboratory of Pu’er. Four kinds of LED, red, yellow, blue and green light were used to wither the whole process (1 lamp tube in each group), and the non-light treatment was used as the control. The amount of spreading leaves in each group was 1 kg, the thickness of withering spreading leaves was 3 cm, and the light source was 20 cm higher than that of tea. During withering, leaf temperature was measured every 6 h, and Antirhea chinensis was finally sampled. Repeat 3 times.

2.2.1 Determination of leaf temperature in wilting leaves
The leaf temperature was determined every 6h by TES1326 infrared thermometer. 9 fixed points were selected as the measuring points in each group.

2.2.2 Determination of biochemical components
The content of dry matter was determined by GB/T8303-2002 method; the content of water was determined by GB/T8304-2002 method; the content of water extract was determined by GB/T8305-2002 method; the content of amino acid was determined by GB/T8314-2002 method; and the content of tea polyphenols was determined by GB/T8313-2002 method.

2.2.3 sensory review
According to the evaluation method of White Tea in GB/T23776-2009, the weighted scoring coefficient is 25% shape, 25% aroma, 10% soup color, 30% taste and 10% leaf bottom.
2.3 Data processing
The Excel2003 software is used for data collation, the SPSS25.0 data processing software is used for statistical analysis, and the single factor test Duncan method is used for multiple comparison analysis to obtain the significant difference results.

3. Experimental results and analysis

3.1 Changes of leaf temperature under LED light withering
The experimental results showed that the temperature of withered leaves increased during wilting under artificial light. The mean temperature of leaves in blue light group was significantly higher than that in CK group (P <0.05). It can be seen that artificial light irradiation can significantly increase the temperature of dead leaves.

3.2 Effect of LED Light Withering on White Tea Quality
The results of determination of biochemical components of tea under different LED of light (Table 1) showed that the content of water extract in the five treatment groups was significantly higher than that in the yellow light group (P<0.05), the highest content of tea polyphenols was in the green light group (39.87), the blue light group was significantly lower than the other four groups (P<0.05). The amino acid content in red-light group was significantly higher than that in other groups (P<0.05), and the yellow light group was significantly higher in water content than the other four groups (0.05).

The results of variance analysis of quality components of different LED of light withering A. chinensis (Table 2) showed that the effects of different LED of light withering on tea polyphenols, amino acids, water extracts and water content in tea were significant.

| Group       | Tea polyphenols/% | Amino acids/% | Water extract/% | Moisture/% | Phenolic ammonia ratio |
|-------------|-------------------|---------------|----------------|------------|-----------------------|
| Red-light   | 34.68±0.16 d      | 1.64±0.08 a   | 47.77±3.04 ab  | 6.14±0.95 ab | 21.74                 |
| Yellow light| 36.87±0.38 b      | 1.16±0.06 b   | 43.01±2.45 c   | 8.11± a 1.81| 31.78                 |
| Blu-ray     | 31.01±0.86 e      | 1.59±0.03 a   | 50.07±0.42 a   | 5.53±0.29 b | 32.99                 |
| Green Light | 39.87±0.42 a      | 0.94±0.16 c   | 43.77±2.27 bc  | 5.03±1.29 b | 25.08                 |
| CK          | 35.65±0.60 c      | 0.66±0.03 d   | 47.79±1.43 ab  | 5.30±0.46 b | 52.55                 |

Different lowercase letters attached to the same column of data showed significant differences (p <0.05)

3.3 Comparison of sensory evaluation results of A. chinensis withering under different LED light
The results of sensory evaluation were shown in Table 2. The appearance and color of the tea in yellow light group were not good, and the aroma and taste scores were 90. The overall quality of the tea in CK taste scores were 87. The red-light group got the highest score in the sensory evaluation were 93. The outstanding characteristics of the tea were pleasant flowers in aroma and taste, and apricot yellow and bright in liquor color. In the green light group, the aroma was fresh and thick, the taste was mellow, and the overall quality level was in the middle. In the blue light group, the appearance of the wool tea was the most prominent, the buds and leaves were connected and even, and the aroma was fresh and elegant, which was second only to the red-light group. CK group has the worst performance among the six groups. Its appearance is flat and sticky, with red and brown sheets, and its aroma and taste are green.
Table 3 LED Results of sensory evaluation of hair tea under light withering

| Group       | Shape (25%) | Soup color (10%) | Aroma (25%) | Taste (30 per cent) | Leaf bottom (10%) | Total  |
|-------------|-------------|------------------|-------------|---------------------|-------------------|--------|
|             | Score       | Score            | Score       | Score               | Score             |        |
| red-light   | 91          | 92               | 93          | 93                  | 91                | 92.2   |
| Yellow light| 90          | 91               | 90          | 90                  | 89                | 90.0   |
| Blue light  | 92          | 91               | 92          | 91                  | 91                | 91.5   |
| Green Light | 89          | 92               | 91          | 92                  | 89                | 90.7   |
| C K         | 87          | 88               | 89          | 87                  | 87                | 87.6   |

4. Discussion and conclusions

The effects of LED of light withering on leaf temperature were different. The higher the withering leaf temperature, the faster the withering process. LED light withering can promote the water loss of fresh leaves and accelerate the withering progress.

The quality of White Tea was significantly affected by different light quality withering, and the quality of White Tea withering under red-light (620-625nm) was the best, while the quality of White Tea withering under no light was the worst.

The content of tea polyphenols was the highest in green group, the blue group was the lowest. The amino acid content and sensory evaluation of the soup color were the highest in the red-light group and the lowest in the control treatment group. The soup color of the red and yellow light group was apricot yellow, while the soup color of the control treatment group was not bright. In this study, the ratio of phenol-ammonia to red-light was the smallest, and the tea quality score was the highest. The ratio of control treatment phenol-ammonia was the largest, and the tea quality score was the lowest. Therefore, in the sensory evaluation, the red-light group had the highest score, which was characterized by pleasant fragrance in aroma and taste; the blue light group had second with fresh and slightly sweet aroma; the green light group had the middle quality; the yellow light group had the worst aroma and taste, and the control treatment group had the worst performance in the six groups.

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