Effect of drying on the quality of raw tea of Pu'er tea

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Abstract. Fresh leaves were selected as raw materials to investigate the effect of drying on the quality of raw tea of Pu'er tea. The results showed that tea polyphenols were highest in solar drying (S), followed by oven drying (O) treatment, which was significantly higher than that of 27.7% in insulated and then airing (IA) treatment. Moisture content, amino acid content and water leachates content were significantly lower in S and O treatments than in IA treatment. In the sensory results, the highest score was 77.66 points for S, followed by insulated and then oven drying (IO), and then baked and then solar drying (BS) treatment. Therefore, oven drying can be used to maximize the quality of tea leaves when the sun-baked raw tea production process encounters unfavorable factors.

1. Introduction
Yunnan is the second largest Province of tea in China [1], which is the origin of the tea and has superior natural environmental conditions for excellent quality of Yunnan large-leaf tea[2]. Pu'er tea (Camellia sinensis var. assamica (Mast.) Kitamura) is a representative tea of Yunnan large-leaf tea, its raw material is sun-blue raw tea. Sun-blue raw tea is rich in tea polyphenols, amino acids, etc [5]. These substances and their derivatives are the main flavor-presenting substances of tea broth, and their most intuitive effect on tea broth is in the water-leach content, which is the main factor of tea quality and health functions. However, the overall development of tea primary technology in Yunnan Province is slow, is still in the low-end resource-based industry stage with low added value [2].

Sun-drying is a unique processing process of sun-blue raw tea and is the key process to the formation of sun-blue tea quality. Luo et al. proposed that sun-blue raw tea should be stored in a cool and light-proof place immediately when it is dry enough [4] Xia et al. [6] showed that the quality of sun-blue raw tea was significantly weaker than that of S and roasted by 60° C gross fire after a night of smothering in terms of physicochemical composition and sensory quality. It means that, under the unfavorable factors such as rain and cloudy sky, the quality of tea is not very satisfactory, despite the quality of tea can be ensured to a certain extent by boring pile. Although the sensory quality of the tea baked under 60° C hair fire is different from that of the S one, and the aroma and taste are slightly deficient compared with the S one, the soup color and leaf bottom are not inferior to the S one, and even slightly better than the S one to a certain extent, and the physical and chemical quality is also better than the S one.

Sun-blue raw tea is less circulated in the market and is mostly used to process into Pu'er tea in order to increase its economic value. Therefore, the quality of sun-blue raw tea directly affects the goodness of Pu'er tea [3]. The current research on Yunnan sun-blue raw tea is also mostly on its biochemical composition, but there are fewer studies on the process improvement and innovation of sun-blue raw tea.
2. Materials and methods

2.1 Materials
The fresh leaves of Yunnan big-leaf species from the Yingpan Mountain area of Pu'er City (E101.10714°, N22.658813°) were used as raw materials.

Main instruments and reagents: Hydrated ninhydrin (analytical pure), ferrous sulfate (analytical pure), potassium sodium tartrate (analytical pure), potassium dihydrogen phosphate (analytical pure), disodium hydrogen phosphate (analytical pure), stannous chloride (chemical pure), analytical balance (FA2004B), grinder (LFP-800), oven (6CTH-6.0), killing pot (6CG-65).

Reagent preparation: 1/15 mol/L disodium hydrogen phosphate solution: weigh 23.9 g of disodium hydrogen dodecanoate, dissolve with water and fix the volume to 1 L; 1/15 mol/L potassium dihydrogen phosphate solution: weigh 9.08 g of potassium dihydrogen phosphate dried at 110 ℃ for 2 h, add water to dissolve and fix the volume to 1 L; ferrous tartrate solution: weigh 1.0 g of ferrous sulfate and 5 g of sodium potassium tartrate, dissolve with water and fix the volume to 1 L; pH 7.5 phosphate buffer: take 85mL of the above 1/15 mol/L disodium hydrogen phosphate solution and 15 mL of 1/15 mol/L potassium dihydrogen phosphate solution, mix well; phosphate buffer: take the above 1/15 mol/L of disodium hydrogen phosphate solution 95 mL and 1/15 mol/L potassium dihydrogen phosphate solution 5 mL, mix well; 2% hydrated ninhydrin solution: weigh 2 g of hydrated ninhydrin, add 50 mL of water and 80 mg of stannous chloride, mix well, add a small amount of water to dissolve, put in a dark place, stand for a day and night, filter and add water to 100 mL of volume.

2.2 method

2.2.1 Processing of sun-blue raw tea
After the fresh leaves were collected in the evening, they were placed in the greening process, and then killed at 9:00 a.m the next day. The killing process was carried out manually with a 6CG-65 type killing pot, with the temperature of the pot at about 280 ℃. The temperature was at 35 ℃. When the tea leaves are dried to full dryness (hand squeezed into powder), they are collected in a sealed bag in time and stored at room temperature, sealed from light. And then through five different drying methods, respectively solar drying (S), oven drying (O), insolated and then airing (IA), insolated and then oven drying (IO), baked and then solar drying (BS).

2.2.2 Moisture content
Moisture determination with 103 ℃ constant weight method. The weighing dish and cover placed in 103 ± 2 ℃ drying oven, heating 1 h cooling to room temperature, weighing (accurate to 0.001g). Sampling according to GB8304-87 grinding.

Determination: weigh the ground sample 5 g (accurate to 0.001 g) 2 times repeatedly, transferred into the known weighing dish, the dish and cover placed in 103 ± 2 ℃ oven, heating 4h, cover removed, cooled in the desiccator, weighing, and then heated for 1h, cooling, weighing, so repeatedly until the difference between two consecutive weighing (absolute value) does not exceed 0.005g, that is, the constant weight. The smallest one shall prevail.

2.2.3 Tea polyphenol content
Weigh 3 g (accurate to 0.001 g) of the ground specimen in a 500 mL conical flask, add 450 mL of boiling distilled water, immediately transfer to a boiling water bath and extract for 45 min (shaking every 10 min). Immediately after the extraction, filter the sample under reduced pressure while it is still hot. The filtrate was transferred into a 500 mL volumetric flask, and the residue was washed 2~3 times with a small amount of hot distilled water, and the filtrate was filtered into the above volumetric flask and diluted to the scale with distilled water after cooling. Accurately aspirate 1 mL of the test solution into a 25 mL volumetric flask, add 4 mL of water and 5 mL of ferrous tartrate solution, mix thoroughly,
then add pH 7.5 phosphate buffer to the scale, and measure the absorbance (A) with a 10 mm colorimetric cup at the wavelength of 540 nm with the reagent blank solution as reference.

2.2.4 Free amino acid content
The free amino acids were determined using hydrated ninhydrin, and the test solution was prepared as for tea polyphenols. 1 mL of the test solution was accurately aspirated into a 25 mL volumetric flask, 0.5 mL of pH 8.0 phosphate buffer 0.5 mL of 2% ninhydrin solution was added and heated in a boiling water bath for 15 min. After cooling, water was added to fix the volume to 25 mL. After 10 min, the absorbance (A) was measured in a 5 mm colorimetric cup at the absorbance (A) was measured at 570 nm with the reagent blank solution as reference.

2.2.5 Water leachate content
The aluminum box with 15 cm qualitative fast filter paper was placed in a constant temperature oven at 120℃±2℃, dried for 1 h, removed, cooled to room temperature in the desiccator, and weighed (to the nearest 0.001 g).
Weight 2 g (accurate to 0.001 g) of the ground sample in a 500 mL conical flask, add 300 mL of boiling distilled water, immediately transfer to a boiling water bath, and extract for 45 min (shaking every 10 min).
Immediately after the extraction, the sample was filtered under reduced pressure while still hot, i.e., by filtration (using 3-treated filter paper). Wash the tea residue several times with about 150 mL of boiling distilled water, transfer the tea residue together with the known mass of the filter paper into an aluminum box, and then move into a constant temperature oven at 120℃ ± 2℃ for 1 h, remove the cover and cool for 1 h and then bake for 1 h. Immediately move into a desiccator and cool to room temperature and weigh.

2.2.6 Sensory result
Three reviewers conducted a coded review of the appearance and inner quality of the tea samples according to the five-factor review method, firstly reviewing the appearance of the tea samples, then taking 3g of tea samples, 150ml of boiling water, brewing for 5 minutes, and quickly making the soup, then reviewing the color, aroma and taste of the tea soup, and finally observing the bottom of the tea leaves, and recording the review results.

3. Results and analysis

3.1 The effect of drying on moisture
The moisture content of S, IO and BS are around 9.5%, while the moisture content of IA reaches 10% and O is indeed only 8.8%. There was significant difference between IO and IA, O and IA, the moisture content of all five treatments met the standard for Pu’er tea (13.0%-14.0%), and all of them could be used as raw materials (P<0.05) (Fig. 1).

3.2 Effect of drying on tea polyphenols
Tea polyphenols are the main taste-presenting substances of tea leaves, which are an important source of bitterness and astringency of tea broth and an important factor affecting the quality of tea leaves. Tea polyphenol content was above 30% except for IA which was 27.7%, 33.7% for S, 33.4% for IO and 34.3% for O, except for IA, the tea polyphenol content between the remaining three and S There was no significant difference in tea polyphenol content, and the tea polyphenol content of IA was significantly lower than that of S, IO and O. (P<0.05) (Fig. 2).

3.3 Effect of drying on amino acids
Amino acids are the main source of freshness and crispness in tea leaves and are an important factor affecting the quality of tea leaves. Among the different drying methods in this study, there was no
significant difference in amino acid content between S, O and IO, which were 1.52%, 1.58% and 2.08%, respectively. While 2.45% for IA and 2.89% for BS were significantly different from S (P<0.05) (Fig. 3).

3.4 Effect of drying on water leachates
Water leachates are the total amount of substances that can be leached out by water in tea leaves, which is the overall response of tea quality. The highest water leachate was IO and the lowest was 39.7% for O, and 44% for S were not significantly different from the remaining four, but there were significant differences between IO and IA and O (P <0.05) (Fig. 4).
3.5 Sensory review results

Table 1 Sensory results

| Treatment | Colour (25%) | Soup hue (10%) | Aroma (25%) | Flavor (30%) | Foliage (10%) | Total points |
|-----------|--------------|---------------|-------------|--------------|---------------|--------------|
| S         | 75.67        | 80            | 79.17       | 77.67        | 76.5          | 77.66        |
| IO        | 74.83        | 78.50         | 76.67       | 77.17        | 74.5          | 76.33        |
| BS        | 74           | 77.83         | 75.67       | 77.50        | 75            | 75.95        |
| IA        | 74.33        | 78.33         | 75.50       | 76.17        | 76.17         | 75.76        |
| O         | 78.83        | 78.83         | 76.33       | 76.5         | 76.83         | 75.89        |

3.6 Effect of drying on sensory result

The sensory results showed that S raw tea are the best, and then the IO, followed by BS, and the worst is IA. In the appearance of IA oil moist degree is lower than the remaining four, soup color O a little green, all have a clear aroma, but O in addition to a little light fragrance and a little bean fragrance, which is also the unique aroma of baked green tea, IA a little boring taste, the closest to S or IO and BS. The bitterness and astringency of the O tea is a little stronger than that of the IA one, but it is still within a fair range, and both have sweetness; the foliage fundus is also close, and the color of the S tea is a little better (Table 1).
4. Conclusion
There are differences in the quality between simulated solar drying by oven and solar drying. However, the quality and sensory results in the combination of oven drying and solar drying treatment are similar to the solar drying treatment. Insolated and then oven drying treatment of raw tea is close to solar drying in terms of both tea polyphenols and sensory evaluation. The amino acid content of baked and then solar drying treatment is close to that of insolated and then airing treatment, so its sensory score was higher than that of insolated and then oven drying treatment. To sum up, if encounter unfavorable weather, we can use the oven to simulate daylight temperature drying method to assist tea drying, which can get similar quality of drying. If the conditions are allowed, we should try to add the sunlight in the processing of raw tea processing. Therefore, the drying method of oven simulating daylight can be used for drying in case of continuous rainy weather.

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