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Research Article

The Effects of Theine Content of Pu'er Tea in Hige Pulsed Electric Field

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Abstract: This essay is based on the experiment of comparing the theine content of sample Yunnan Mengku large-leaf-variety Pu'er tea before and after the treatment of Hige Pulsed Electric Field (HPEF). During this experiment, the differences of content of theine are measured based on different processing techniques of tea (fermented and not fermented), different producing years and different HPEF. The results of the experiments are as follows. First, the difference of the content of theine is notable between fermented and not fermented tea produced in the same year and the theine content of non-fermented tea is larger than that in fermented tea. Second, the content of theine is decreasing with the increase of the length of storage. Third, the content of theine is reduced drastically in samples treated by different conditions of HPEF. The decrease of the content of theine and the major index of quality of Pu'er tea in samples treated by HPEF is consistent with that of natural-aging Pu'er tea. The results of this experiment provide theoretical foundation to further research of aging tea by HPEF.

Keywords: HPEF, Pu'er tea, theine

INTRODUCTION

Pu'er tea, classified to "Sheng" and "Shu" (GB/T 22111-2008) based on different processing technic, is a special kind of fermented tea that made by raw material produced within certain region in Yunnan Province, China.

It has a unique fragrance generated during the procedure of aging and it is also featured by its shiny red, mellow-tasting and long-lasing sweet tea liquor (Wu, 2005). Pu'er tea is welcomed by foreign and domestic tea-drinkers because of its special health efficacy and its "aging-favorable" storage. Through centuries of productive practice, people have conducted a complete process of fermenting, hoarding and aging, especially the highly regarded process of hoarding and aging.

Fresh Pu'er tea has incentive, bitter and astringent taste which need to be stored for a long period of time for aging to diminish. When it reaches to its best drink-timing, its taste would be transformed to be tender and mellower. With the surge of demand in Pu'er market and the promotion of living standard, the method of accelerating the aging of Pu'er tea draws a lot of attention.n The content of theine is one of the three major elements to determine the quality of Pu'er tea. Theine has several sanitarian functions such as helping digestion, refreshing, promoting diuresis and enhancing reasoning. Moderate ingestion of theine could agitate ganglia, which is beneficial to shorten reaction speed, improving concentration and relieving tiredness. Therefore theine is commonly used as stimulant. However, because of its strong excitating effect, over ingesting of theine could cause some undesirable symptoms such as restlessness, insomnia, festless sleep, diarrhea, elevation of blood pressure, cardio palmus and fetus deforming. Therefore tea is not suitable for children, expectant mothers, seniors and patients of neurasthenia or so to drink (Van Dieren *et al*., 2009; Sharma and Rao, 2009; Riksen *et al*., 2009; Heckman *et al*., 2010).

Currently, some countries including US and Japan set limit to the theine content of tea product (Zhao and Du, 2008). Considering this situation, the research of method for reducing the theine content of tea product effectively is becoming a hot sopt. Since foreign and domestic media started to report that the theine in tea could produce side effects, in order to satisfy the demand of the population who are not encouraged to drink tea much, some techniques to produce de-theine or low-theine tea are developed such as hot-water desorption, solvent extraction, column chromatography and supercritical CO_2. Nevertheless, these techniques have several obvious shortcomings: low reduction ratio, low product safety, high energy-consumption and high cost (Yao *et al*., 2009; Liang *et al*., 2007; Iwai *et al*., 2006; Xu *et al*., 2008; Ramarethinam and Rajalakshmi, 2004; Gokulakrishnan *et al*., 2005).

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Our research analyze the theine content of 14 kinds of Yunnan Mengku large-leaf-variety Pu'er tea manufactured in different years, comparing the discrepancy of theine content of same sample hoarded different time span. The result shows that the longer Pu'er tea is hoarded, the lower theine content it has. By comparing samples manufactured by different processing technic, we conclude that the theine content of variety "Sheng" is higher than that of variety "Shu".

HPEF technique is a newly developed technique with great potentiality. Because of its special properties such as uniform transmission, speedy processing, low heat-producing, low food nutrition affecting and avoidance of adverse effect from heating treatment or chemical engineering operation, HPEF is increasingly used in food industry especially in food fresh-keeping and sterilization.

As for its effects and principles for sterilization, they are comprehensively reported by foreign and domestic media (Qin *et al*., 2005a; You *et al*., 2006). HPEF can not only be used in food fresh-keeping and sterilization, but also change the flavor and quality of some provisions (Jin *et al*., 2009). The result of our research provides both an innovative method to elevate the quality of Pu'er tea and a theoretical foundation to further processing of Pu'er tea and the development of related functional food.

MATERIALS AND METHODS

Samples of Pu'er tea: Samples of Pu'er tea which are Tae#7572 and Tae#7542, known as "Standards of Pu'er tea", from the top brand of Pu'er tea, TAE, manufactured by Yunnan Menghai Tea Processing Factory. All the ingredients are from the main tea growing region, Menghai Yunnan. The names, varieties, shapes, classes, manufacturing dates, manufacturing places are presented in Table 1.

Measuring theine content: After ground by plant disintegrator, the samples are filtered by 80-mesh fineness. Applying proper quantities ground sample into flask, operate according to the method of measuring the theine content of tea regulated by GB/T 8312-2002.

Table 1: Samples

Number	Name	Variety	Class	Date	Place
1	Tae7572	Shu	7	2005	Menghai
2	Tae7572	Shu	7	2006	Menghai
3	Tae7572	Shu	7	2007	Menghai
4	Tae7572	Shu	7	2008	Menghai
5	Tae7572	Shu	7	2009	Menghai
6	Tae7572	Shu	7	2010	Menghai
7	Tae7572	Shu	7	2011	Menghai
8	Tae7542	Sheng	4	2005	Menghai
9	Tae7542	Sheng	4	2006	Menghai
10	Tae7542	Sheng	4	2007	Menghai
11	Tae7542	Sheng	4	2008	Menghai
12	Tae7542	Sheng	4	2009	Menghai
13	Tae7542	Sheng	4	2010	Menghai
14	Tae7542	Sheng	4	2011	Menghai

Table 2: The parameter of HPEF

Serial number	The electric field strengths (KV)	Frequency (Hz)	Time (min)
A	10	60	60
B	15	120	60
C	30	150	60

Generating HPEF: This experiment adopted High voltage direct current generator developed by Institute Of Technology Of Dalian, Static and Special Power Supply Research Center.

Two groups of capacitors, storage capacitor Ce and pulse capacitor Cp, achieve the charge of pulse capacitor and discharge between reactor plate and ground plate connected to the high voltage interface plate by manipulating two perpendicular spark gap switches RSG1 and RSG2 as one open and one closed, forming steep HPEF between two polar plates (Fig. 1). Major Performance Parameters: Output voltage: 0-60 KV adjustable, pulse width: ≤300 ns, rise time: ≤50 ns, repetition frequency: 0-200 pps adjustable.

Processing sample through HPEF: The major parameters affecting sterilization rate of HPEF are electrical field strength (voltage), frequency and time. This experiment processed 14 kinds of Pu'er tea based on orthogonal test.

According to laboratorial experience, we selected 3 groups of HPEFs with different electrical field strengths, frequencies and time spans to sterilize samples (Table 2).

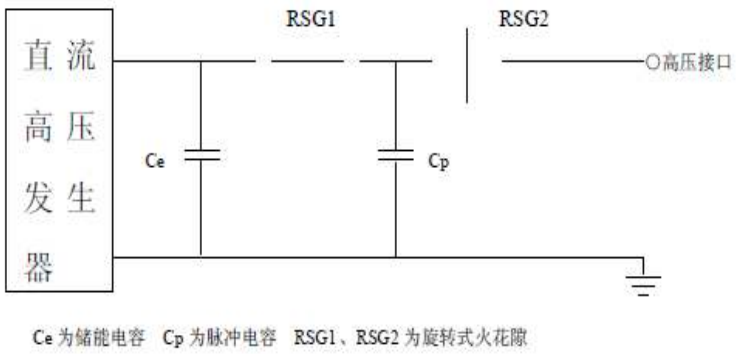

Fig. 1: The generator of High Pulsed Electric Field (HPEF)

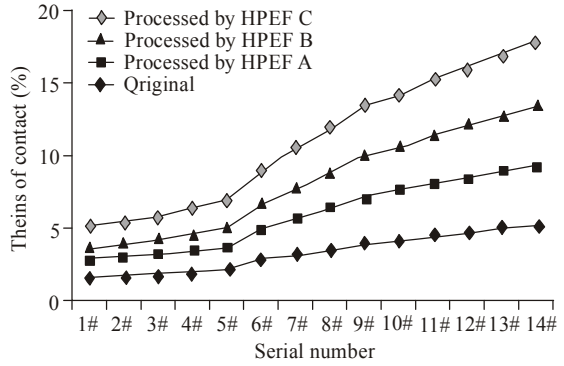

Fig. 2: Comparison of theins content Pu'er tea before and after processed by HPEF

Table 3: Theine content (%)

Samples	Original	Processed by HPEF A	Processed by HPEF B	Processed by HPEF C
1#	1.426	1.212	0.914	1.365
2#	1.541	1.322	1.017	1.428
3#	1.688	1.399	1.148	1.496
4#	1.824	1.512	1.207	1.588
5#	1.995	1.628	1.396	1.791
6#	2.701	2.116	1.803	2.287
7#	3.013	2.53	2.282	2.565
8#	3.369	2.85	2.598	2.971
9#	3.903	3.215	2.872	3.485
10#	4.012	3.433	3.163	3.523
11#	4.325	3.658	3.387	3.945
12#	4.623	3.821	3.509	4.011
13#	4.895	3.99	3.845	4.248
14#	5.011	4.362	4.079	4.456

RESULTS

The compare of theine content of 14 kinds of samples before and after HPEF process (Table 3 and Fig. 2). The results indicate that the HPEF treatment has effects on the theine content of Pu'er tea.

The above results show that theine content of Sheng and Shu has obvious discrepancy. In addition, theine content of tea manufactured in different years are quite different too. Sensually speaking, the longer Pu'er tea is stored, the better its texture tastes. The result shows that the content of theine is decreasing as the storing time gets longer and HPEF can reduce tea theine content effectively.

DISCUSSION

Comparison of theine content of Pu'er tea manufactured in different year: Theine acts as a central nervous system stimulant and is the major alkaloid in tea plant (Lv *et al*., 2013). The results Table 3 and Fig. 2 indicate that the content of tea extract is different for same brand but different storing time. Furthermore, by measuring theine content in same tea sample at different time points, the data exhibited as storing time gets longer, the theine content is prone to decrease, which illustrates that storing time is a key factor of theine content.

Comparison of theine content of Pu'er tea processed by different technique (Sheng and Shu): The post-fermentation processing technology of Pu-erh tea (ripe tea) is the core procedure to form the special feature (Chai *et al*., 2013). Based on processing technique, Pu'er teas are classified as Sheng and Shu. The greatest feature of Shu is that it has been Pile-fermentation before being pressed into model. The principle of Pile-fermentation is that some biochemistrical reactions happen with the continuously heating and it changes the active ingredients of Pu'er tea. Because of the property of Pu'er tea as living organism and its different processing procedure, the content of theine presents a clear difference. The results (Table 3 and Fig. 2) show that stored for the same time span but processed by different procedures, Pu'er tea has different content of theine which is higher of Sheng than that of Shu. This phenomenon reveals that numerous substances are decomposed to other compounds through oxygenolysis.

The relationship of variation in theine content of samples processed by HPEF: HPEF is one kind of non-heating sterilization technique with great potentiality because of its high efficiency, low cost and no effect on food's original color, scent, taste, nutritional facts and texture. The experimental result demonstrates that the theine contents of samples increased notably by HPEF treatment except the drastic decrease caused by HPEF B (14KV/120HZ/60 min).

The effectiveness of the technique will strongly depend on the treatment time, electric field strength and specific energy of the pulses. HPEF technology has recently been used in alternative applications including drying enhancement, enzyme activity modification, preservation of solid and semisolid food products, waste water treatment as well as the pretreatment applications for improvement of metabolite extraction. The ability of HPEF to increase permeabilization means it can be successfully used to enhance mass and heat transfer to assist the drying of plant tissues. Studies conduct on different plant tissues such as coconut (Ade-Omowaye *et al*., 2000), mango (Taiwo *et al*., 2002) and apple slices (Ade-Omowaye *et al*., 2002).

Generally speaking, this research conducts that theine contents of samples increased notably with HPEF treatment through processing 14 kinds of Pu'er tea by 3 groups of HPEF. The results of our research provide an innovative method to elevate the quality of Pu'er tea, a theoretical foundation to further processing of Pu'er tea and the development of related functional food.

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