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Effect of Different Enzymes Deactivation Methods on the Quality of Seepweed Tea

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***Abstract*—In order to study the effects of different enzymes deactivation methods on the quality of seepweed tea, the enzymes deactivation methods such as pan firing, steaming, water bathing and microwave on the quality of seepweed were discussed. The results show that the temperature of the steaming increase faster, the heat is even, and cause the sensory evaluation score of this method is the highest. The four enzymes deactivation methods have a significant effect on the color difference. And the brightness of the sample with the water bathing method is the highest. Steaming have a higher response value to the sensor of the electronic nose, with the most significant effects on the R(1), R(6), and R(8) components. Different enzymes deactivation methods also have a significant effect on the salty taste of seepweed tea, however there is no significant difference with other flavors. The total flavonoids and total phenols of samples by the steaming is the highest, with the value is 19.7 mg/g and the total phenol was 8.819 mg/g respectively. The sample by steaming have a strong penetration and the time is short, which is beneficial to the retention and conversion of organic chemical composition. It can be seen from the experimental results that the tea obtained after the steaming of the seepweed had a higher quality.**

***Keywords*—seepweed; quality characteristics; color difference; flavor**

I. Introduction

Seepweed is an annual herb, generally distributed in Saline land in Northeast China, Shandong province, Jiangsu province and others. Seepweed is a halophyte, the leaves are linear and small in size. They are high salt tolerance and have strong vitality. In addition, seepweed has a delicious taste and high nutritional value. It is rich in protein, minerals and lipid [1]. Seepweed also has certain medicinal value. It can prevent the formation of thrombus through the consumption of seepweed, and it also has the function of anti-tumor and anti-atherosclerosis. Seepweed seeds contain high linolenic acid that is a kind advanced health products. By making tea with seepweed, it can bring certain economic value to the development of Saline land. At present, there are few studies on the development of seepweed products, and there are fewer studies on seepweed. This study was about the different methods to inactivate seepweed's enzymeand further effects on the quality of seepweed tea, which provides a theoretical basis for the development of seepweed.

II. Materials and Methods

A. Material

The freshly planting sweepweed was from Panjin Liaoning. Sweepweed was packaged and shipped to the laboratory for reserving.

B. Preparation of Seepweed Samples

Seepweed was cleaned and Spread indoors for natural withering 12 h, then the four methods of pan firing, steaming, water bathing and microwave were used to treat the seepweed. Pan firing: fired in a pan for 3 min. Steaming: enzymes deactivation time is 10 min. Water bathing: boiled at 100°C for 1 min. Microwave: seepweed was carried out in a microwave heating at an intensity of 800 W for 2 min.

C. Sensory Quality Evaluation of Seepweed Tea

Sensory evaluation was according to GB/T 23776-2009 that 100 mL of boiling water was added to 2 g seepweed tea and kept for 5 min. Then the tea infusion was poured out and the shape, liquor color, aroma, taste and leaf bottom were evaluated. Each item was based on 100 points. The total score was calculated by reference to the tea evaluation weighting method. The total score was obtained according to the shape of 20%, liquor color 15%, aroma 25%, taste 30%, leaf bottom 10% calculate.

D. Determination of Color Difference

2 g seepweed tea was taken and 100 mL of boiling water was added and kept for 5 min, the tea infusion was poured out. The tea infusion was measured by color difference meter and the measurement was repeated three times. Color was expressed as L^*, a^*, and b^*, which indicating luminosity, chromaticity on a green (−) to red (+) axis, and chromaticity on a blue (−) to yellow (+) axis, respectively. Chroma [$C^* = (a^{*2}+b^{*2})^{1/2}$] and hue angle [$h° = (\arctan b^*/a^*)$] were calculated from a^* and b^* values. Three parallel experiments were carried out in the sample. The total color difference (ΔE^*) was calculated on the basis of the following formula:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (1)$$

E. Determination of Electronic Nose

1 g seepweed tea was taken and 50 mL of boiling water was added and kept for 5 min, the tea infusion was poured out. They were sealed with preservative film and allowed to stand for 15 min after headspace injection. Each group of samples was tested 3 times in parallel. Set the detection time to 120 s, the cleaning time to 100 s, and the sample flow at the rate of 300 mL/min. The Win Muster software was used to analyze the detected indicator information. (See Table I)

TABLE I. STANDARD SENSOR ARRAY AND PERFORMANCE IN PEN3 PORTABLE ELECTRONIC nose

Sensor	Performance profile	Remarks
R(1)	Sensitive to aromatic component	C_7H_8 ,10mL/m^3
R(2)	Sensitive to nitrogen oxides	NO_2 ,1mL/m^3
R(3)	sensitive to ammonia	C_6H ,10mL/m^3
R(4)	Selective for hydrogen	H_2 ,100mL/m^3
R(5)	Sensitive to short-chain alkanes	C_3H_8 ,1mL/m^3
R(6)	Sensitive to methane	CH_4 ,100mL/m^3
R(7)	Sensitive to inorganic sulfides	H_2S ,1mL/m^3
R(8)	Sensitive to ethaol	CO ,100mL/m^3
R(9)	Sensitive to organic sulfides	H_2S ,1mL/m^3
R(10)	Sensitive to high concentrations of alkanes	CH_4 ,10mL/m^3

F. Determination of Electronic Tongue

Tea infusion flavor was determined with SA402B electronic tongue. The system is equipped with 8 sensors, each sensor is sensitive to sourness, bitterness, astringency, saltiness, richness, fresh, astringent and bitter aftertaste, but the sensitivity is different. Before the data collection, the electronic tongue system needs to be self-tested to ensure the reliability and stability of the response signal of the electronic tongue sensor. The operating temperature of the electronic tongue system is controlled at around 25°C.

G. Determination of Physico-Chemical Composition

1) Preparation of seepweed tea extract:

Four different treatments of tea was weighed and extracted with microwave of 320 W for 5 min with 95% ethanol, and rotary evaporation was extracted with 95% ethanol then dissolved in a 100 mL constant volume to obtain an extract.

2) Determination of total flavonoids

The volumetric flask was added with gallic acid solution then 2.0 mL of 20% sodium carbonate solution and 1.5 mL of Folin-Ciocalteu were added. The agent was volume with distilled water and insulated at 55°C for 1.5 h, measured the absorbance at 760 nm to make linear regression equation. 0.4 mL extract was taken into a 50 mL volumetric flask. Then measure the absorbance of the system after the liquid sample reacted with reagents as described above.

3) Determination of total phenolic

The graduated tubes was added rutin solution then add 0.3 mL of 0.5% $NaNO_2$ and let it stand 6 min and added 0.3 mL of 10% $Al(NO_3)_3$ and let it stand for 6 min., then added 4 mL of NaOH, and finally volumed to 10 mL with distilled water. After reacting for 15 min at room temperature, measuring the absorbance at 510 nm. 5 mL of the extract was extracted and made up to a 10 mL volumetric flask, to measure the absorbance after the liquid sample was reacted as described above [2].

H. Statistical Analysis

One-way ANOVA test by SPSS Statistics 20.0 was used to test significant differences ($p < 0.05$) among eight varieties apples. Experimental dates were expressed as mean±standard error ($p < 0.05$).

III. RESULTS AND DISCUSSION

A. Analysis of Sensory Quality of Seepweed Tea

It could be seen from Table II that sensory evaluation of the shape, aroma and taste of the sample treated by steaming was better than the other three methods, because steaming can make the temperature of seepweed tea rise rapidly, the heating was more uniform, the retention of chlorophyll was higher, it could quickly destroy the enzyme activity, so it was better in shape and aroma than the others [3]. The color of the tea after the water bathing was greener, so its color was translucent green, so the score was relatively lower. The taste was closely related to the aroma, and the good aroma was accompanied by a refreshing taste, strong atmosphere must be accompanied by a better taste. The pan firing was easy to appear high-fired brought the taste of scorched flavor, so the score was lower [4]. The sensory evaluation score of the bottom leaf of the water bathing was higher than that of the other three methods, so the water bathing could better maintain the quality of the leaf bottom.

TABLE II. SENSORY EVALUATION OF SEEPWEED TEA WITH DIFFERENT METHODS OF ENZYMES DEACTIVATION

Methods	Review content and score					
	Shape (25%)	Soup color (10%)	Aroma (25%)	Taste (30%)	Leaf bottom (10%)	score
Pan firing	More uniform	Lighter	More pure	More mellow	More neat	
	86.6±1.6	86±2.4	81.1±1.0	83±4.0	82.6±1.2	83.69
Steam	More uniform	Lighter	pure	More mellow	More neat	
	88.4±2.1	85±1.4	90±1.1	86±3.5	88.4±2.0	87.74
Water bath	Less uniform	Lighter	More pure	More mellow	More neat	
	79.6±1.3	84.3±2.0	83.7±2.2	83.5±1.0	88.9±3.1	83.2
Microwave	More uniform	Lighter	More pure	More mellow	More neat	
	86.2±3.2	86.3±1.3	84.1±1.5	85.4±2.6	87.1±2.5	85.53

B. Analysis of Color Difference of Seepweed Tea

It could be seen from Table III that the brightness value by the water bathing was the biggest. The intensity of the water bathing was weak, the tea was crisp green viridis and the brewed tea infusion was relatively clear, so the brightness value was high. In the red-green degree, the absolute value of steaming was the largest, and the tea infusion was green. On the contrary, the yellowness of steaming in the yellow-blue degree was the smallest. The steaming great intensity and heating uniform, the retention of chlorophyll was higher so that the tea infusion was green. It could be seen from the table that the color difference between the four methods was more significant. In the comprehensive deviation of the color difference, the value of the water bathing was the biggest, and the value of the pan firing was the smallest.

TABLE III. COLOR DIFFERENCE OF SEEPWEED TEA WITH DIFFERENT METHODS OF ENZYMES DEACTIVATION

Methods	L*	a*	b*	⊿E*
Pan firing	19.83±0.46^{c}	0.75±0.02^{c}	5.46±0.10^{c}	15.68±0.45^{c}
Steam	20.78±0.56b^{c}	0.97±0.15^{d}	4.96±0.14^{d}	16.60±0.55^{bc}
Water bath	22.40±0.67^{a}	0.13±0.04^{a}	8.74±0.27^{a}	18.71±0.72^{a}
Microwave	21.16±0.37^{b}	0.37±0.14^{b}	5.84±0.25^{b}	17.04±0.39^{b}

Values of a-d are significantly different in the same column, $p < 0.05$

C. Analysis of the Electronic Nose of Seepweed Tea

It could be seen from Table IV that the response value of R(9) was relatively big, indicating that the aromatic component in the seepweed tea had a higher content of organic sulphide, followed by the oxynitride (R2) and alkanes (R10). In the four methods of enzymes deactivation, the methods of steaming that R(1), R(2), R(3), R(5), R(6), R(8), R(9), R(10) the response value was bigger, and the response values of R(2) and R(9) are the biggest [5]. It was indicated that steaming can make the seepweed tea release more aromatic components. The aromatic substances also had a great influence on the quality of the tea. If there was no aromatic substance in the tea, it would lose taste. The production of aromatic substances was also affected by the processing technology [6]. The enzymes deactivation intensity was high, and the water was high moisture after treatment so that promoting the production of aromatic components, while retaining more ketones, aldehydes, etc, so that steaming had a better flavor. And the four methods of enzymes deactivation had the most significant effects on the R(1), R(6), and R(8) components.

TABLE IV. SEEPWEED TEA ELECTRONIC NOSE RESPONSE VALUE

	Pan firing	Steam	Water bath	Microwave
R(1)	0.81±0.02^{b}	0.93±0.03^{a}	0.70±0.03^{c}	0.65±0.02^{d}
R(2)	1.24±0.01^{a}	1.27±0.05^{a}	1.12±0.05^{b}	1.10±0.04^{b}
R(3)	0.87±0.01^{b}	0.96±0.02^{a}	0.80±0.02^{c}	0.77±0.01^{c}
R(4)	1.06±0.01^{a}	1.04±0.01^{c}	1.04±0.00^{bc}	1.05±0.01^{ab}
R(5)	0.99±0.01^{b}	1.01±0.01^{a}	0.93±0.01^{c}	0.92±0.01^{c}
R(6)	0.80±0.04^{b}	0.93±0.06^{a}	0.49±0.06^{c}	0.40±0.03^{c}
R(7)	0.53±0.02^{b}	0.54±0.03^{b}	0.63±0.04^{a}	0.62±0.04^{a}
R(8)	0.94±0.02^{b}	1.06±0.04^{a}	0.81±0.03^{c}	0.78±0.01^{c}
R(9)	1.27±0.02^{a}	1.24±0.03^{a}	1.19±0.02^{b}	1.18±0.02^{b}
R(10)	1.17±0.00^{a}	1.13±0.01^{a}	1.12±0.00^{b}	1.12±0.01^{b}

Values of a-d are significantly different in the same row, $p < 0.05$

D. Analysis of the Electronic Tongue of Seepweed Tea

It could be seen from the electronic tongue radar chart that the four different ways of enzymes deactivation had a significant effect on the sour taste, richness, and bitterness but no significant effect on saltiness, umami taste and astringency [7]. The saltiness response of seepweed tea was the biggest because it is a halophyte organism and contains a large amount of salt, so the saltiness response was high [8]. (See Figure I)

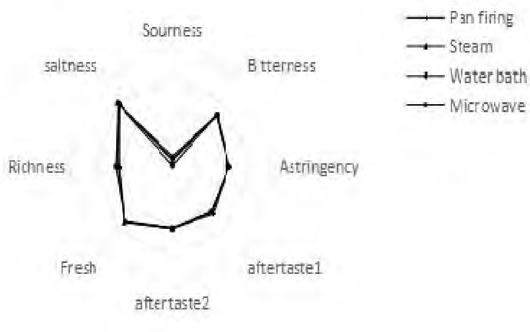

FIGURE I. SEEPWEED TEA ELECTRONIC TONGUE RADAR CHART

E. Analysis of Physico-Chemical Composition of Seepweed Tea

It could be seen from the chart that the content of total flavonoids and total phenols in seepweed tea by steaming was the highest. Microwave was equivalent to the content of the water bathing [9]. Because the temperature of these two methods rose faster, which inhibited the changes in the biochemical composition of Suaeda, so that the organic components in the tea were not rich in steaming, which affected the quality of the tea [10]. The method of pan firing was the lowest, which might be due to the long-term heat effect in the process of pan firing, promoting the accumulation and transformation of certain substances [11]. However, the temperature of this method rose slowly, the heat was not uniform, the chlorophyll was destroyed more, the steaming penetration was strong and time was short, which was beneficial to the retention and conversion of organic chemical components [12]. (See Figure II)

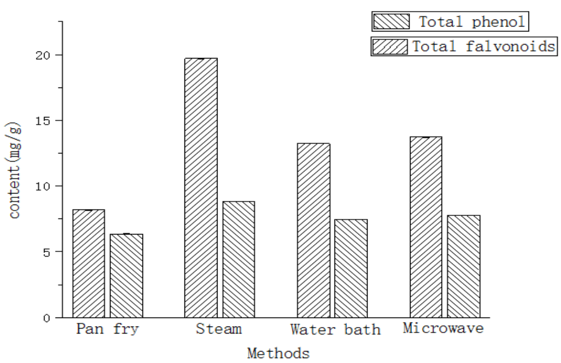

FIGURE II. PHYSICO-CHEMICAL COMPOSITION OF SEEPWEED TEA

IV. Conclusion

In this study, seepweed tea was used as the research object. The effects of different methods on the quality of seepweed tea were studied by comparing the four methods of steaming, water bathing, microwave and pan firing. The results showed that the temperature of steaming was increased faster and the heat was even, so the sensory evaluation score was the highest. The four methods of enzymes deactivation have a significant effect on the color difference, and the brightness of the water bathing is the highest. Steaming has a higher response value to the sensor of the electronic nose, with the most significant effect on the R(1), R(6), and R(8) components. Different methods of enzymes deactivation have a significant effects on the salty taste of seepweed tea, and there is no significant difference in other flavors. The content of total flavonoids and total phenols in the steaming are the highest. Steaming penetration is strong, and the time is short, which is beneficial to the retention and conversion of organic chemical components. It can be seen from the experimental results that the tea obtained after the steaming has a higher quality.

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