

Study on the Technology of Low Alcohol Hawthorn Flavor Beer

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Abstract. Hawthorn fruit is bright red in color, contains a variety of nutrients, and has many health effects. In this paper, through the study of yeast, fermentation temperature, acid reduction, high residual sugar and other factors, we finally selected NO303 Aerospace yeast with rich ester aroma and low fermentation degree reserved in the yeast bank of Qilu University of technology for fermentation. Fermentation temperature is 19.0°C, the main fermentation duration is:1-2days, total fermentation time is about 10 days. The physical and chemical indexes of low alcohol hawthorn beer are as follows: Original wort concentration is 11°P, residual sugar is 9.8°P, alcohol level is 0.45 %vol, total acid is 2.55mL/100mL, pH3.87, chroma is 13.5EBC. Finally, low alcohol hawthorn beer with light red color, hawthorn aroma and strong ester aroma was obtained. The beer has low acidity, balanced between acidity and sweetness, unique taste and low alcohol content. It is more like a carbonated beverage with strong killing taste and is suitable for the general public, especially young female consumers.

Keywords: Hawthorn Beer; Low Alcohol Ester; Sweet and Sour Balance.

1. Introduction

Hawthorn, also known as shanlihong, contains a variety of vitamins and is distributed in Heilongjiang, Liaoning, Henan, Shandong, Jilin, Inner Mongolia and other places in China. hawthorn can promote digestion and reduce blood pressure [1]. Hawthorn has a high content of flavonoids, which can significantly reduce blood lipid [2]. At the same time, in ancient times, people found that hawthorn can be used as medicine. Hawthorn juice, hawthorn cake, hawthorn vinegar, sugar gourd and many other hawthorn products can be made from hawthorn[3].

The main contents of this paper are as follows: using dry hawthorn slices as raw materials, hawthorn juice was obtained by leaching method, and then added to wort for restrictive fermentation to brew low alcohol hawthorn flavor beer[4], and the physical and chemical analysis, evaluation and comparison of the beer were carried out.

2. Material and Experimental Equipment

2.1 Materials

Table 1. Specifications and manufacturers of main test reagents

Reagent Name	Specifications	Manufacturer
NO303	Liquid	From the laboratory of Qilu University of Technology
LALLZYNE EX-V pectinase	Specifications10g/bag	Tianjin baishi chemical LTD
75% ethanol for disinfection	500ml/bottle	Shandong huangshengtang pharmaceutical LTD
Granulated sugar	480g/bag	Shandong haoweilai food LTD
Hawthorn piece	Market	Jinan farmer's market
Barley malt	50kg/bag	Yongshuntai (changle city) malt LTD

Bitter grain hops	5kg/bag	Xinjiang lvbao hops Co., Ltd
NaoH	Food grade	Shantou xilong chemical Co., Ltd

2.2 Experimental Equipment

Table 2. Specifications and manufacturers of main test equipment

Reagent Name	Specifications	Manufacturer
Small scale brewing equipment	40L/batch	Jinan zhengmai machinery equipment LTD
EBC Standard mill		Switzerland buehler LTD
pH meter	PB-10	Shanghai lichen instrument technology LTD
Hydrometer meter	0-20°P	Hebei wuqiang chemical glass LTD
Roller mill		Tai'an taishan agricultural machinery LTD
Alcohol distillation unit		Tianchang xuli glass instrument LTD
Diacetyl distiller		Tianchang xuli glass instrument LTD
Electromagnetic furnace	W0298	Lechuang electronic technology LTD
Infrared heating furnace	HGJR-02	Zhengzhou tanbang Instrument LTD
Basic burette	50mL	Tianchang xuli glass Instrument LTD
Ultraviolet spectrophotometer	UV2350	Unico (shanghai) Instrument LTD
Low speed centrifuge	JW-1042	Anhui jiawen instrument equipment LTD
Colorimetric disk	0-20EBC	Germany gerhardt LTD
Carbon dioxide meter		Netherlands haffmans LTD
Blood cell counting plate		Shandong xinhua medical instrument LTD
Turbidity meter		Germany sartorius LTD
Electronic analytical balance	ME204E/02	Mettler toledo instrument (shanghai) LTD

2.3 Hawthorn Juice Preparation Process

Select hawthorn slices → wash → heat treatment → natural cooling → pectinase action → filtration → hot water rewashing → refiltration → heating sterilization → cooling → hawthorn juice → standby

2.4 Beer Production Process

Malt milling → saccharification → filtration → wort boiling (hawthorn juice is added 2 minutes before the end of boiling) → wort cooling (cultured No303 yeast is added) → limited fermentation method → rapid cooling → cold storage for 3 days → centrifugation → filling → sterilization → finished product

2.5 Control Point of Hawthorn Juice Preparation

(1) Selection of material water ratio in hawthorn juice preparation

After the hawthorn slices are simply washed to remove the dust, the material and water ratio is 1:2, 1:3, 1:4 and 1:5 for heat treatment, and the effects of different material water ratio on the quality of hawthorn juice are compared.

(2) Selection of extraction temperature and time

The extraction temperature is 70 °C, 80 °C, 90 °C and 100 °C, and the treatment time is 5-8h.

(3) Pectinase treatment

The hawthorn slices after heat treatment were filtered and washed to obtain mixed hawthorn juice. And then treated with pectinase to make the juice more clear and stable. According to the data, the

optimal temperature of pectinase is 45-55 °C, so we cooled the hawthorn juice to 50 °C, added pectinase, stirred evenly, and the enzymatic hydrolysis time was 180min.

2.6 Brewing

(1) Adding proportion of hawthorn juice

The hawthorn juice was added into wort at different proportions of 5%, 10%, 15% and 20% for fermentation, and the beer was then evaluated and compared. We want to choose the best adding proportion with good taste.

(2) Restricted fermentation process

After the mixed liquor of wort and hawthorn juice is cooled and oxygenated, yeast is added for fermentation. When the fermentation degree reaches 5%, 10%, 20% and 30%, the fermentation is stopped through controlling the temperature of fermentation from 20 °C dropping to 0°C rapidly. after storage for 5 days, then we taste the beer to compare its mouthfeel and aroma.

(3) Selection and comparison of yeast

After the proportion of hawthorn juice was determined, the next wort is prepare wort for brewing test. Three kinds of yeast were selected for the test, two beer yeast NO303 and US-05, and one fruit wine yeast EC-1118.

(4) The effect of the the fermentation temperature on flavor and taste of hawthorn fruit beer

After the yeast is determined, four temperatures of 16 °C, 18 °C, 20 °C and 22 °C are selected for fermentation in this test to compare the effect of fermentation temperature on the flavor and taste of hawthorn wine.

(5) Evaluation comparison

Make use of the best conditions determined above to carry out brewing experiments, and then evaluate [5] the final products according to scientific group evaluation.

3. Results and Discussion

3.1 Selection of the Material Water Ratio in Hawthorn Juice Preparation

Table 3. Comparison of the material water ratio and sugar extraction of hawthorn juice

Material water ratio	Juice yield	Concentration /°P	Color and flavor	Technological process
1: 2	0.9	7.3	It has deep color, strong sour taste and strong hawthorn taste	Difficult filtration and clarification, low sugar output
1: 3	1.8	6.5	Deep color, strong sour taste and strong Hawthorn taste	Difficult filtration and clarification, low sugar output
1: 4	3.0	5.7	The color is red, the sour taste is strong, and the hawthorn taste is strong	Easy filtration and clarification, low sugar output
1: 5	4.1	4.8	The color is light red, the sour taste is strong, and the Hawthorn taste is strong	Easy filtration and clarification, high sugar yield
1: 6	5.2	3.8	Light red color, light sour taste, light hawthorn taste	Easy filtration and clarification, high sugar yield

The water is divided into two parts. Most of the water is used for extracting hawthorn and filtering, and then a small part of the water is used for washing the extracted and filtered hawthorn mud, so that the yield is higher.

From table 3, we can see that the material water ratio is too low, and the hawthorn juice is not easy to filter and clarify, we get the yield of hawthorn juice low too. The results showed we can get more hawthorn juice when choosing the material water ratio 1:5 or 1:6.

3.2 Selection of Extraction Temperature and Time

Under the same material water ratio, the extraction temperature was 70 °C, 80 °C, 90 °C and 100 °C for comparison. The extraction time was finally determined to be 6 hours after searching and comparing the data.

Table 4. The influence of different temperature on extraction effect at the same time

Extraction time	Extraction temperature	Concentration/°P	Quality of hawthorn juice
6h	70°C	3.7	Low yield, light red color, light hawthorn flavor
6h	80°C	4.0	The harvest rate is slightly high, the color is light red, and the hawthorn taste is strong
6h	90°C	4.2	High yield, light red color, strong hawthorn flavor
6h	100°C	4.3	The highest harvest rate, light red color, strong hawthorn flavor

It can be seen from table 4 that the higher the temperature, the better the extraction effect and the higher the yield. Moreover, the color of hawthorn juice from the higher temperature is not different from that of low-temperature extraction. It can be seen that the temperature has little effect on the browning of hawthorn juice.

Zhang Qiao et al. found that the heat treatment temperature was negatively correlated with the browning degree in the study of hawthorn heat treatment [6]. They believed that the high-temperature heating reduced the activities of polyphenol oxidase and peroxidase in the fruit, thus inhibiting the enzymatic browning reaction [7]. Our test proved that this conclusion is correct. Therefore, 100 °C was selected for the extraction process, with high extraction rate and sterilization.

3.3 Pectinase Treatment

Adjust the temperature of hawthorn juice drop to 50 °C with pure water, add pectinase, stir evenly, and the enzymatic hydrolysis time is 180min [8].

The commercially available pectinase was selected to treat hawthorn juice. According to the instructions of the enzyme, the recommended dosage was 100-150g/100kg. We selected 100, 125 and 150g/100kg hawthorn for the experiment.

Table 5. The effect of different pectinase addition on extraction effect

Pectinase addition (g/100kg)	Enzymolysis time	Enzymatic hydrolysis increases concentration/°P
100	180min	0.25
125	180min	0.32
150	180min	0.33

The test results in table 5 showed that the clarification degree of hawthorn juice is increased after pectinase treatment, and the concentration of extract is also increased. The added amount of 125 g pectinase / 100kg is more cost-effective.

3.4 Proportion of Hawthorn Juice to Wort

The prepared hawthorn juice was added into wort at different proportions of 5%, 10%, 15% and 20%, boiled, and fermented after the final wort concentration was 11°P. After the beer was prepared, it was evaluated and compared. The best proportion [9] is the proportion of those with good taste. The yeast was selected as the experiment. The fermentation temperature was 18-19 °C, and the fermentation speed was controlled not to be too fast. The fermentation was stopped after 2 sugar

degrees were fermented, and the temperature was rapidly dropped to 0°C, and then stored for 3 days to taste.

Table 6. Comparison of fermentation taste of hawthorn juice with different proportion

Hawthorn juice addition ratio	Apparent fermentation degree	Tasting results
5%	10.5%	High sweetness, light acidity, wort flavor, weak hawthorn arom
10%	10.8%	Sweet and sour balance, weak wort flavor, strong hawthorn aroma
15%	10.0%	Strong sour taste, weak sweet taste, weak wort taste, strong hawthorn aroma
20%	10.1%	Strong sour taste, weak sweet taste, weak wort taste and strong hawthorn aroma

From table 6, we can see that when the amount of hawthorn juice added is 10%, the fermentation degree reaches about 10%, the sweet and sour balance of hawthorn juice and wort mixed fermentation liquid, the hawthorn aroma is rich, the wort taste is weak, and the taste [10] is more suitable for young consumers. Therefore, we determine that the amount of hawthorn juice added is 10%.

3.5 Restricted Fermentation Process

In this experiment, the original wort concentration target was 11 ° P, and the hawthorn juice was added at 10%. When the fermentation degree was 5%, 10%, 15%, 20% and 25%, the taste of fermented beer was compared. When the fermentation liquid meets the above fermentation degree, the beer will be rapidly cooled to 0 °C, the yeast fermentation will be stopped, and some sugar will be retained to balance the acidity[11] in hawthorn juice.

Table 7. Different fermentation degree and taste of wort with 10% hawthorn juice

Fermentation degree	Aroma and taste
5%	High sweetness, light sour taste, poor taste, wort taste and strong hawthorn aroma
10%	Sweet and sour balance, moderate killing taste, weak wort taste and strong hawthorn aroma
15%	Strong sour taste, weak sweet taste, strong killing taste, weak wort taste, strong hawthorn aroma
20%	Strong sour taste, weak sweet taste, strong killing taste, weak wort taste, strong hawthorn aroma
25%	Strong sour taste, weak sweet taste, strong killing taste, weak wort taste, strong hawthorn aroma

From table 7, we can see that the higher the fermentation degree, the stronger the killing taste of beer, but the stronger the sour taste. If the fermentation degree is higher, the residual sugar will be lower, and the yeast metabolism[12] will also produce much more acid, and the beer will be more acidic. Considering comprehensively, we choose the sample with a fermentation degree of 10%, and the unfermented sugar [8] in the beer is about 10%, which can balance the acid sense well.

3.6 Selection and Comparison of Yeasts

Yeasts have a great influence on the fermentation flavor, so three kinds of yeasts were selected for comparison: two kinds of beer yeast No303 and US-05, and one kind of fruit wine yeast EC-1118. The original wort concentration target is 11°P, the addition amount of hawthorn juice is 10%, the fermentation temperature is 20-21 °C, and the fermentation degree is controlled at 10%. The experimental results are shown in table 8.

We can see that under the same conditions, the beer aroma fermented by NO303 yeast is better than US-05 and EC-1118, and EC-1118 has a slight sulfur odor. By comparison, NO303 yeast is more suitable for low alcohol hawthorn beer brewing.

Table 8. The effect of different yeasts on hawthorn beer flavor

Yeasts	Beer aroma and taste
No303	It is a strong fruit aroma, balanced sweet and sour, moderate killing taste, weak wort taste, and strong hawthorn aroma
US-05	It is light fruit aroma, balanced sweet and sour, moderate killing taste, weak wort taste, and strong hawthorn aroma
EC-1118	It is light fruit aroma, light sulfur odor, balanced between sweet and sour, moderate killing taste, weak wort flavor, and strong hawthorn aroma

3.7 Effect of Fermentation Temperature on the Flavor of Low Alcohol Hawthorn Beer

After the yeast is determined, four temperatures of 16 °C, 18 °C, 20 °C and 22 °C are selected for alcohol fermentation in this test to compare the influence of fermentation temperature on the flavor of low alcohol hawthorn beer. See table 9 for the results.

Table 9. The effect of different fermentation temperature on the flavor of hawthorn beer

Fermentation temperature	Aroma and taste of low alcohol hawthorn beer
16°C	Slightly weak fruit aroma, balanced sweet and sour, good killing taste, light wort flavor, strong hawthorn aroma
18°C	Slightly weak fruit aroma, balanced sweet and sour, good killing taste, light wort flavor, strong hawthorn aroma
20°C	Rich fruit aroma, balanced sweet and sour, moderate killing taste, weak wort taste, strong hawthorn aroma
22°C	Rich fruit aroma, basically balanced sweet and sour, slightly sour, moderate palatability, weak wort flavor, light hawthorn aroma

It can be seen from the comparison of the results in Table 9 that 18-20 °C fermentation is more appropriate for the fruit aroma of low alcohol hawthorn beer, the balance of beer acidity and sweetness, and the unique aroma of hawthorn, so the middle value of 19 °C is selected as the best temperature.

3.8 Comparison of Evaluation

Through the above single factors, the optimal process of low alcohol hawthorn beer was determined as follows: the concentration of wort was 11 °P, the addition of hawthorn juice was 10%, the fermentation temperature was 19 °C, the fermentation degree was controlled at 10%, and the residual sugar was 10 °P.

Use the best conditions determined above to conduct brewing test, and then select a group composed of national wine tasting committee members and professionals to evaluate the final product according to scientific group evaluation.

The brewed low alcohol hawthorn beer has a strong aroma of fruit, balanced sweet and sour, delicious, light wort flavor, and obvious hawthorn aroma, reaching the expected goal.

3.9 Physical and Chemical Indexes of Low Alcohol Hawthorn Beer

Table 10. Physical and chemical analysis index of low alcohol hawthorn beer

Project	Analysis results	Project	Analysis results
Original wort concentration/°P	10.9	pH	3.87
Residual sugar /°P	9.8	CO ₂ g/L	4.33
Alcohol/ %vol	0.45	Diacetyl /mg/L	0.10
Apparent ermentation degree/ %	10.1	Chroma /EBC	13.5
Acidity mL/100mL	2.55		

From table 10, we can see that the main indicators are consistent with the characteristics of low alcohol beer. The suspension fermentation process is adopted. The fermentation degree is very low and the residual sugar is high. Due to the addition of hawthorn juice and the metabolism of yeast, the acidity is higher and the pH is lower than that of the normal beer.

4. Summary

In this experiment, a low alcohol hawthorn beer with acid and sweet balance and CO₂ gas was produced by limited fermentation way. It is not only a beer, but also a beverage. The main parameters are original wort concentration 11°P, adding 10% hawthorn juice in wort, using No303 top fermentation yeast, fermentation temperature of 19°C, apparent fermentation degree of about 10%, residual sugar about 10 ° P, acidity of 2.55ml/100ml, pH of 3.8, Diacetyl of 0.10 mg/L, and total fermentation time of about 10 days.

The raw material of this test is hawthorn tablets, if we use hawthorn concentrated juice it may be considered easier and simple. The process should be simpler and more efficient, and the test can be carried out next time.

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