# The Brewing Process of the Schisandra Sour Beer

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**Abstract:** Using Australian barley malt, SafAle S04 yeast, Tsingdao hops, and lactic acid bacteria as raw materials, a schisandra sour beer is brewed using a fermentation process. The effects of the addition type, amount and time of Schisandra on the flavor of sour beer were studied. The results show that the beer brewed by adding 2% schisandra enzymatic hydrolysate before sealing has a more balanced sourness, a strong overall beer taste, a clear and transparent body, a white and delicate foam, long-lasting, and contains the unique medicinal value of schisandra.

## 1. Introduction

Schisandra is a common tonic Chinese medicine. It is the dried and mature fruit of Schisandra of Magnoliaceae. It was first collected in “Shen Nong's Materia Medica” as the top-grade Chinese medicine. The medicinal parts of Schisandra are mainly fruits, canes, branches and leaves. After years of research, it has been found that its chemical components are mainly lignans, polysaccharides, aromatic oils and triterpenoids. Because of its rich pharmacological effects,It has achieved great development and value. In recent years, various studies have shown that schisandra can also play a role in liver and kidney protection by reducing transaminase and inflammatory factors, inducing tumor cell apoptosis, inhibiting tumor cell growth and tumor metastasis, etc., playing anti-tumor, sedative and hypnotic, improving memory, and immunomodulating effects. [1]. Therefore, schisandra is rich in lignans [1] and trace elements and other nutrients are integrated with beer. Due to the popularity of craft beer in recent years, sour beer has gradually become more popular among consumers. Schisandra is just sour, so a novel and characteristic typical schisandra-flavored sour beer has been developed, which not only ensures the rich taste of sour beer [2], but also exerts the economic value of schisandra for edible and medicinal purposes, which is in line with contemporary consumption. The needs of people for a healthy life have certain research significance.

## 2. Materials and Methods

### 2.1 Materials and Equipment

#### 2.1.1 Materials and Reagents

Tsingdao hops (Jinan Shuangmai Beer Raw Material Co., Ltd.);
Imported Australian malt: Yongshuntai (Changle) Malt Co., Ltd.;
Belgium S04 Yeast (Fermentis Company of France);
Lactic acid bacteria (LALLEMAND Company of Canada);
Schisandra (Juancheng, Shandong) Zhiyuan Chinese Medicine Decoction Pieces Co., Ltd.);
iodine solution, sodium hydroxide, phenolphthalein, hydrochloric acid, organic silicon defoamer (Tianjin Fuchen Chemical Reagent Factory);
o-phenylenediamine (analytical purity, Tianjin Beilian Fine Chemicals Development) Co., Ltd.);
Cellulase (Hesbi Biotechnology Co., Ltd.).

#### 2.1.2 Instruments and Equipment

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YXQ-LS-75SII vertical pressure sterilizer (Shanghai Boxun Industrial Co., Ltd. Medical Equipment Factory);
SW-CJ-1BU sterile ultra-clean workbench (Suzhou Shangtian Clean Technology Co., Ltd.);
SD9012BEBC colorimeter (Shanghai Xin Rui Instrument Equipment Co., Ltd.);
WGZ-2PJ Turbidity Meter (Shanghai Xin Rui Instrument Equipment Co., Ltd.);
SPL-250 Biochemical Incubator (Tianjin Laibo Terui Instrument Co., Ltd.);
WYT-J Handheld Brix Meter (Chengdu Haochuang Photoelectric Instrument Co., Ltd.);
EBC standard mill grinder (Tianjin Laibo Terui Instrument Co., Ltd.);
GSP-77-03 magnetic stirrer (Jiangyan Analytical Instrument Factory, Jiangsu);
ME204 analytical balance: METTLER TOLEDO Instrument (Shanghai) Co., Ltd.;
UV2350 ultraviolet-visible spectrophotometer: Unico (Shanghai) Instrument Co., Ltd.

### 2.2 Test Method

#### 2.2.1 Process Flow

Spent grains↖ Lactobacillus↘
Malting → mashing → Wort filtration → Boiling for 15min → cooling → Lactobacillus fermentation → Wort boiling → Whirlpool separator → Wort cooling → fermentation
↖Hops ↖$O_2$,Yeast
→ filtration → Filling → Pasteurising

#### 2.2.2 Operating Points

Malting: The Australian barley malt is crushed by the two roller mills. The malt must be broken into smaller pieces. So the enzymes can degrade them. But after mashing the wort must be separated with spent grains, the husks are needed as a filter material. The ratio of the partical and power should be appropriate, without unbroken whole grains, and should not be crushed too finely to prevent the husks from breaking. And the proportion of fine powder is too high, which will prolong the filtration time and increase the risk of wort oxidation [3].

Preparation of schisandra enzymatic hydrolysate: take the dried schisandra, measure distilled water according to the mass ratio of schisandra to water of 1:40-50, then add cellulase at 0.2% of the mass of schisandra, keep the enzyme at 50-55℃ Dissolve for 1h, then keep at 85~90℃ for 5min to inactivate the enzyme, cool quickly, and Save for future use [4] .

Mash: single mash heating leaching saccharification method [5]. The saccharification temperature is shown in Table 1. Adopt the material-to-water ratio 1:3.5 (kg/L), feed at 52℃ hot water, stir and keep at constant temperature for 30 min after filling, heat up to 67.5 ℃, keep for 50 min, heat up to 72 ℃, keep for 15 min, this In the iodine test, dip the glass rod into the wort solution and put it on the iodine reaction porcelain plate. After it becomes cool, drip the iodine solution into the wort, using the principle that iodine meets starch to turn blue. If the iodine solution turns blue Black indicates that the starch is not completely decomposed, and the saccharification time needs to be increased until the iodine does not change color. When the iodine detection reaction does not change color, the temperature is increased to 78°C, and the saccharification is completed after filtering. In the saccharification process, the saccharification stages at different temperatures have different effects on enzymes. The temperature is appropriately controlled to provide different optimum temperatures for various enzymes, and various desired products can be obtained.

Table 1 Saccharification Temperature And Its Effect

| Temperature/℃ | effect |
|---|---|
| 50 | The role of organic carboxypeptidase, the formation of low-molecular-weight nitrogen-containing substances. And there is partial protein decomposition, β-glucan decomposition, and R-enzyme debranching effect on pullulan |
| 65 | Conducive to the action of α-amylase, the action of β-amylase is relatively weakened, the production of maltose is reduced, and the production of dextrin is relatively increased |

| | |
|---|---|
| 68 | Endopeptidase, phosphatase, β-amylase, etc. are inactivated, and a large amount of short-chain dextrin is produced |
| 72 | The reaction speed of malt alpha-amylase is accelerated and a large amount of dextrin is formed |
| 78 | Alpha-amylase and certain high-temperature-resistant enzymes still work, and the leaching rate begins to decrease |

Wort filtration: first add 78 ℃ hot water to the filter tank, the amount of water just below the sieve plate, add the saccharified wort to the filter tank, let it stand for 20 min, repeat the reflux several times, until the wort is clarified. filter. Pour the hot water of 78 ℃ evenly into the filter tank and wash the grains twice until the filtration is completed.

The wort is boiled for 15 minutes: count the time when the wort starts to boil, and boil for a total of 15 minutes.

Cooling and acidification: Use a plate heat exchanger that has been sterilized to reduce the temperature of the wort to about 40°C and enter it into the boiling pot, connect the lactic acid bacteria for acidification, and stop the acidification when the pH of the wort drops to about 3.5.

Wort boiling [6]: Timing from when the wort starts to boil, add 0.34 g/L Qingdao Dahua in 3 times. Add 25% in 10 min after the wort is boiling; add 50% in 30 min after boiling; add 25% in 50 min after boiling. The appropriate amount of hops gives the beer a refreshing bitterness and unique aroma, which makes the beer more layered [7].

Cyclone sedimentation [8]: After the wort is boiled, it enters the vortex sedimentation tank, rests for 20 minutes, and separates the hot coagulum to obtain clarified wort.

Wort cooling [9]: Use a plate heat exchanger that has been sterilized to reduce the temperature of the wort to about 11 ℃ into the tank, and use the Venturi tube to oxygenate the wort. The dissolved oxygen content of the wort is 8-9 mg. /L.

Fermentation: Inoculate Belgian S04 yeast, the amount of yeast inoculation is about 2×107/mL. The fermentation temperature is maintained at 11 ℃ until the sugar content of the fermentation broth drops to 4±0.2 °P, and the can is sealed and enters the post-fermentation stage. At this time, the zinc ion in the beer promotes the reduction of diacetyl[10], and the diacetyl is detected every 24 h. Content, when the measured diacetyl content drops below 0.1 mg/L, the temperature starts to drop [11-12], and after it drops to 0 ℃, it is stored cold for about 7 days, and the wine body is matured.

Sterilization: After the fermentation is completed, the finished beer is filtered by the micro-membrane filtration method. This method can achieve a good sterilization effect and ensure the color and aroma of the beer [13].

### 2.3 Evaluation Criteria

The beer sensory evaluation team of the Sino-German Beer Technology Center Laboratory of Qilu University of Technology evaluated the Schisandra sour beer. The comments were made on the appearance, foam, aroma, and taste of the beer [14]. The specific scoring rules are shown in Table 2.

Table 2 Sensory Evaluation Rules

| project | Full score requirements | Deduction content | Deduction standard/分 |
|---|---|---|---|
| Appearance (8 points) | Clear and transparent, without obvious suspended matter and sediment, light yellow | Poor gloss | 1~2 |
| | | Obviously suspended matter | 1~2 |
| | | Poor color | 1~2 |
| | | Poor foam | 1~2 |
| Foam (12 points) | Pour into the cup, there is obvious foam rising, the foam is white and delicate, and the foam hangs in the cup for a long time | The foam is not white | 1~3 |
| | | Thick foam | 1~3 |
| | | Short lasting time | 1~3 |
| | | Poor hanging cup | 1~3 |
| Aroma (20 points) | There is obvious sour taste of schisandra, pure, no peculiar smell, no aging smell and other peculiar | The slightly sour smell of schisandra is not obvious | 1~2 |

| | | | |
|---|---|---|---|
| | smell | Have raw hop fragrance | 1~2 |
| | | Wine is too light | 1~2 |
| | | The beer is greasy and thick | 1~2 |
| | | Impure taste | 1~2 |
| | | Have a bitter taste | 1~2 |
| | | Bitterness is rough and unpleasant | 1~2 |
| | | Has a strange fragrance | 1~3 |
| | | Smell of aging | 1~3 |
| Taste (60 points) | Pure taste; carbon dioxide stimulation, unique flavor characteristics, soft and harmonious wine body; no obvious taste defects | Softness and poor coordination | 1~3 |
| | | Rough taste | 1~3 |
| | | Pungent sourness | 1~3 |
| | | Pollution odor | 1~3 |
| | | The taste of diacetyl | 1~3 |
| | | Yeast taste | 1~3 |
| | | High mellow taste | 1~3 |
| | | Iron taste | 1~3 |
| | | Epidermis | 1~3 |
| | | Squirt | 1~3 |
| | | Other unpleasant | 1~30 |

## 3. Results and Analysis

### 3.1 Schisandra Sour Beer Process Optimization

The sensory quality was used as the main evaluation index to explore the influence of three factors, the type of schisandra, the content of schisandra, and the time of schisandra addition, on the acidity and taste of schisandra beer. On the basis of single factor, the three-factor three-level orthogonal test was used to analyze, and the most suitable balanced acidity was obtained. The design results of the test plan are shown in Table 3. It can be seen from Table 4 and Table 5 that the F ratio is: Schisandra addition time (5.572)> Schisandra addition type (4.072)> Schisandra addition amount (0.236), and the larger the F ratio, the more significant the influencing factors. Therefore, the addition time of Schisandra has an effect on beer. The effect of schisandra is the most significant. The type of schisandra has the second effect on beer, and the last is the amount of schisandra. It can be seen from Figure 1 that the change trend of the addition type of schisandra is first rise and then decrease, and the change is rapid. The addition amount of schisandra increases slowly, and the addition time of schisandra rises slowly and then rises rapidly. The beer score has a great influence, so the best combination is to add 2% schisandra hydrolysate before sealing.

Table 3 Orthogonal Test Factors and Levels of Schisandra Sour Beer Technology

| Level | factor | | |
|---|---|---|---|
| | A Schisandra addition type | B Schisandra addition/% | C Schisandra addition time |
| 1 | Schisandra | 1 | After boiling 30 min |
| 2 | Schisandra enzymatic hydrolysate | 2 | End of boiling |
| 3 | Schisandra+Schisandra enzymatic hydrolysate | 3 | Before sealing |

Table 4 Visual Analysis Table of Orthogonal Test of Schisandra Sour Beer Technology

| Test number | A | B | C | Sensory Evaluation/Points |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 69 |
| 2 | 1 | 2 | 2 | 77 |
| 3 | 1 | 3 | 3 | 79 |
| 4 | 2 | 1 | 2 | 81 |
| 5 | 2 | 2 | 3 | 94 |
| 6 | 2 | 3 | 1 | 83 |
| 7 | 3 | 1 | 3 | 89 |
| 8 | 3 | 2 | 1 | 73 |

| | | | | |
|---|---|---|---|---|
| 9 | 3 | 3 | 2 | 74 |
| Mean 1<br>Mean 2<br>Mean 3<br>Range | 75.000<br>86.000<br>78.667<br>11.000 | 79.667<br>81.333<br>78.667<br>2.666 | 75.000<br>77.333<br>87.333<br>12.333 | |

Table 5 Schisandra Sour Beer Process Orthogonal Test Variance Analysis Table

| factor | Deviation sum of squares | Degree of freedom | F ratio | F critical value | Significance |
|---|---|---|---|---|---|
| A | 188.222 | 2 | 1.236 | 5.140 | ** |
| B | 10.889 | 2 | 0.072 | 5.140 | |
| C | 257.556 | 2 | 1.692 | 5.140 | *** |
| error | 456.67 | 6 | | | |

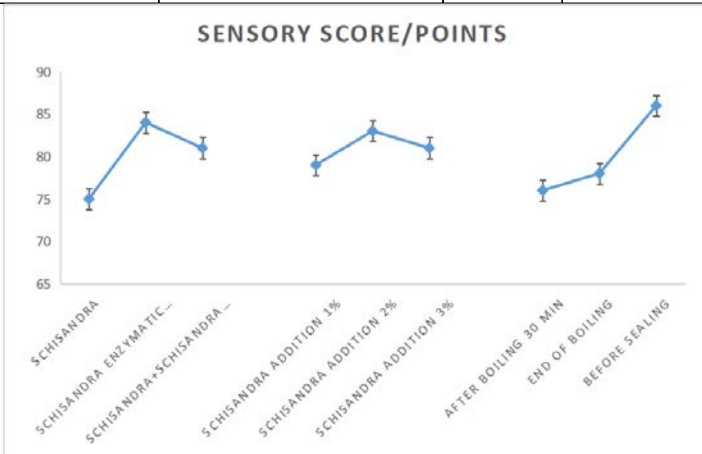


Fig.1 The Orthogonal Test Effect Curve of Schisandra Sour Beer Technology

### 3.2 Quality Analysis of Schisandra Sour Beer

#### 3.2.1 Physical and Chemical Indicators

According to the optimal plan based on the results of the orthogonal experiment, the schisandra sour beer was brewed under the optimized conditions, and its quality was tested and analyzed. The results are shown in Table 6. The results show that the physical and chemical indicators of the final finished beer meet the relevant standards of GB/T 4927-2008 [15]. This provides a solid theoretical basis for its development.

Table 6 Physical and Chemical Indexes of Finished Schisandra Sour Beer

| Physical and chemical indicators | result |
|---|---|
| Original wort concentration /°P | 15.03 |
| Bubble retention /s | 198 |
| pH | 3.55 |
| Alcohol content / %vol | 4.33 |
| Acid value /(mL·100 mL-1) | 3.39 |
| Diacetyl/(mg·L-1) | 0.07 |
| Chroma(EBC) | 9.80 |
| Turbidity (EBC) | 2.60 |
| Bitterness value(BU) | 10.6 |

#### 3.2.2 Sensory Evaluation

The physical and chemical indicators and instrumental analysis of beer are not enough to fully express the flavor of beer. Sensory evaluation also plays a decisive role in beer quality supervision. It is difficult for instruments to make comprehensive judgments about human preferences, and human senses can intuitively make comprehensive judgments through a variety of senses such as sight, hearing, touch, smell and taste.

After sensory evaluation, the evaluation results of Schisandra Sour Beer are shown in Figure 2. The color of Schisandra Sour Beer is light yellow; the foam is white and rich, and it takes a long time to hang the cup; the aroma includes the malt of barley, the fragrance of hops and the slightly acidic odor of schisandra; the taste is clean and fresh, the taste is sour and not irritating. Pure, no off-flavor, no high-grade alcohol top taste, fresh and killing taste, of which the beer with 2% schisandra enzymatic hydrolysate before sealing has the highest score, and the various aromas reach a common balance point, and there is no foreign aroma. A beer that meets the standards. This optimization process is consistent with the prediction, which proves the feasibility of the scheme.

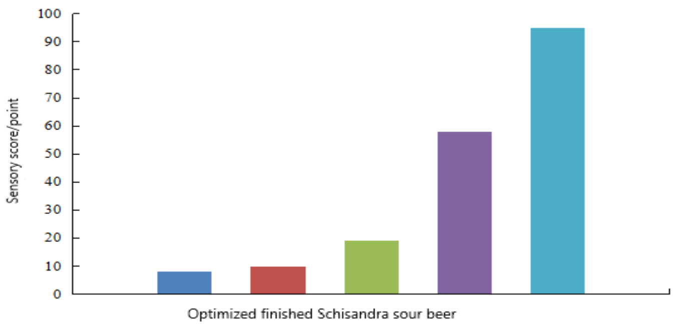


Fig.2 Sensory Evaluation of Finished Schisandra Sour Beer

## 4. Conclusion

The results show that the optimal combination of production processes is to add 2% schisandra enzymatic hydrolysate before sealing. The schisandra sour beer brewed under this optimized condition has white and fine foam, pure taste, fresh taste, and a touch of schisandra's unique sourness. It has a health care effect while enjoying the flavor of beer. It is an emerging health care product. According to consumers' requirements for a healthy life and the diversified demand for beer in the market, Schisandra Sour Beer has a huge market potential.


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