SHORT REPORT

Fish sauce brewing technology using squid viscera and carcass scraps as raw material

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The squid viscera and carcass scraps are the by-product of squid processing, which account for about 25% of the total squid and are rich in amino acids, fatty acids, and other active ingredients. Most of the squid viscera and carcass scraps have not been effectively utilized, which results in waste of resources and environmental pollution problems. The brewing technology of fish sauce was explored and optimized by singe factor experiment using squid viscera and carcass scraps as raw materials in this study to provide reference for the comprehensive utilization of squid offal resources. The results showed that the brewing of fish sauce with squid viscera had more advantages than that of the mixing of viscera and carcass scraps. Under the condition of 10% salt content, the contents of amino acid nitrogen, total nitrogen, and soluble salt-free solid all met the first-grade standard of fish sauce after 56 days of fermentation. The brewed fish sauce had bright color, delicious taste, and good saltiness. The results confirmed the feasibility of producing fish sauce with squid viscera and provided a new idea for the high value utilization of squid processing waste.

Keywords: fish sauce; brew; squid viscera; carcass scraps.

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Introduction

The annual output of squid in China is about 700,000 ton, and the waste generated during the processing accounts for about 25% including squid guts and muscle fragments [1]. At present, processing waste from squid is mainly processed into aquatic feed through autolysis, which has low economic benefit [2]. Some of the squid waste is disposed of by burying, which not only pollens the environment, but also causes huge waste. How to make reasonable and effective use of squid waste and turn waste into treasure has become a problem worth exploring.

Fish sauce is a kind of seafood seasoning with delicious taste, brown color, and unique flavor, which is obtained by natural fermentation with low-value marine fish and shrimp [3]. The production of fish sauce can realize the efficient utilization of low-value seafood resources. Researchers both domestically and internationally have conducted in-depth studies on the production technology of fish sauce. Siringan *et al*. brewed fish sauce with Indian anchovies as raw materials and found that temperature played a major role in its autolytic trypsin [4]. Gustaf *et al*. analyzed the fermentation process of fish sauce with multi-spring fish as raw materials and found that appropriate temperature could accelerate the

fermentation of fish sauce [5]. Aquerreta *et al*. brewed fish sauce with tuna guts and mackerel as raw materials and accelerated the fermentation process by adding exogenous protease [6]. The processing waste of squid, especially squid viscera and carcass scraps, is rich in protein, endogenous protease, and flavor amino acids, which can be used in the fermentation of condiments [7].

Traditional fish sauce is produced by natural fermentation, which takes more than a year to ferment. To shorten the fermentation time of fish sauce, soy sauce brewing technology has been introduced into traditional fish sauce production, and the method of additional koji has been adopted to accelerate the fermentation of fish sauce. In this study, squid viscera and carcass scraps produced during squid processing were used as raw material to prepare fish sauce. The production process was optimized to provide technical support for the development and utilization of squid processing waste. The results would provide a new idea for the high value utilization of squid processing waste.

Materials and methods

Brewing technology of fish sauce

Squid viscera and carcass scraps were provided by Yantai Tongde Food Co., Ltd. (Yantai, Shandong, China) and were crushed and mixed in a mass ratio (squid viscera : carcass scraps) of 2:1, 2:0, 1:1, 1:2, 0:2, respectively. Salt was added to adjust the salt dosage (salt/raw materials, w/w) to 10%, 30%, and 50%. After inoculated 5% ($M_{material}$: $V_{seed\ liquid}$) activated *Aspergillus oryzae* AS3.042 (Bioengineering Laboratory, Yantai University, Yantai, Shandong, China) into the fermentation system, the reaction mixture was fermented at room temperature. The change of amino acid nitrogen during fermentation was determined every seven days. The fermentation was terminated when the content of amino acid nitrogen tended to stabilize or decrease.

Determination of amino acid nitrogen

The reaction mixture was centrifuged at 8,000 rpm for 10 min. The content of amino acid nitrogen was determined by formol titration method. The total nitrogen was determined by Kjeldahl determination. The soluble salt-free solid was determined by direct drying method and silver nitrate titration method according to the industry standard SB/T10324-1999 [8]. Three parallel repeated tests were set up for each experiment.

Statistical analysis

The experimental results were expressed as mean ± standard error (n = 3). SPSS (IBM, Armonk, NY, USA) was used to conduct one-way ANOVA and multiple comparison through Tukey-Kramer test.

Results and discussion

Effect of material ratio on fermentation of squid fish sauce

When only squid carcass scrap was used as raw material (squid viscera : carcass scrap = 0:2), the rot occurred on the 4th day of fermentation, indicating that this raw material ratio was not suitable for the fermentation production of fish sauce. The changes of ammonia nitrogen content during fermentation in other experimental groups were shown in Figure 1. The content of amino acid nitrogen gradually increased with the extension of fermentation time, and gradually stabilized from the 14th day. This result might be due to the relatively rich protein content in squid viscera and the existence of a variety of enzymes and bacteria conducive to protein decomposition [9]. So that, the amino acid nitrogen content of the group with a high visceral proportion was higher than that of the group with a low visceral proportion. Therefore, pure squid offal was used as raw material in the following experiments to produce fish sauce.

Effect of salt on fermentation of squid fish sauce

Salinity affects the microbial activity in the fermentation system. High salinity may reduce the activity of protease production, resulting in a

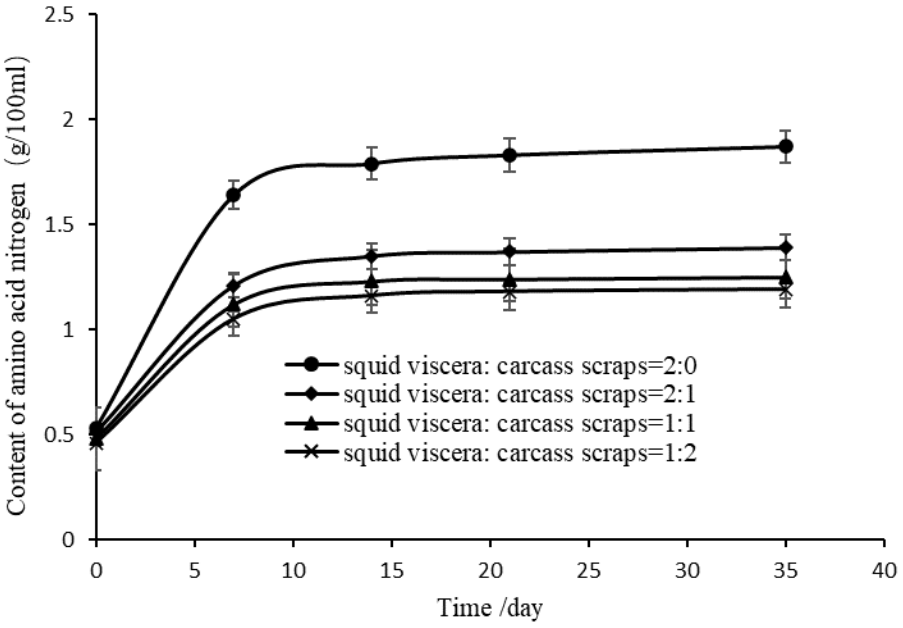

Figure 1. Effect of material ratios on content of amino acid nitrogen.

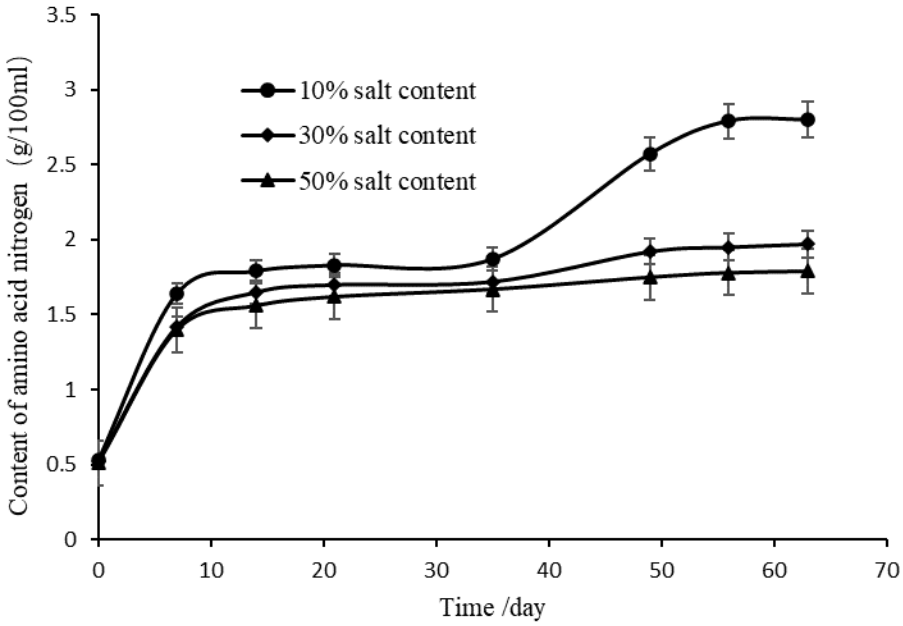

Figure 2. Effect of salt content on content of amino acid nitrogen.

decrease in the degree of protein hydrolysis and the content of amino acid nitrogen and total nitrogen in the fermentation process [10]. During the fermentation process of squid viscera, a large amount of protein in the raw material was decomposed and precipitated with the fermentation, resulting in an increase in the content of amino acid nitrogen with the increase of time (Figure 2). Under the condition of 10% salt content, the content of amino acid nitrogen gradually increased with the extension of fermentation time, and gradually stabilized from

Table 1. Physicochemical indexes of squid fish sauce fermented under different salt contents.

Salt dosage (salt/raw materials, w/w)	Ammonia nitrogen (g/100 mL)	Total nitrogen (g/100 mL)	Soluble salt-free solid (g/100 mL)
10%	2.79	3.05	22.35
30%	1.97	2.37	20.37
50%	1.79	1.85	19.21

the 14th day. After fermenting for about one month, the ammonia nitrogen content increased again and reached the highest value of 2.79 g/100 mL on about 56 days. The increase of ammonia nitrogen content under 30% and 50% salt content was slower than that in 10% salt content group, especially after 30 days. There was no obvious secondary increase of ammonia nitrogen, indicating that high salt content would slow down the precipitation of amino acid nitrogen in the fermentation system.

Physicochemical index of squid fish sauce

The fish sauce fermented under the three salinity conditions had no significant difference in appearance. All of them were brown red. The liquid was clear, and the taste was delicious. The physicochemical indexes including content of ammonia nitrogen, total nitrogen, and soluble salt-free solid of three squid fish sauce obtained under different salt content were shown in Table 1. According to the standards listed in “SB/T10324-1999, Fish Sauce" [8], the three indexes of the fish sauce obtained under the three salt conditions all reached the first-grade standard, but the physicochemical indicators of the three kinds of squid fish sauce were significantly different. Among which the content of ammonia nitrogen, total nitrogen, and soluble salt-free solid in the fish sauce obtained under the condition of 10% salt content were the highest as 2.79 g/100 mL, 3.05 g/100 mL, and 22.35 g/100 mL, respectively. Fermentation of fish sauce under low salt conditions could not only reduce raw material costs, but also provide a new option for the low salt diet currently advocated.

Conclusion

In this study, the processing waste of squid was used to ferment fish sauce. The results showed that squid viscera were more suitable to produce fish sauce than carcass scraps. When 10% salt was added to squid viscera and fermented at room temperature for 56 days, the contents of amino acid nitrogen, total nitrogen, and soluble salt-free solid reached 2.79 g/100 mL, 3.04 g/100 mL, and 22.35 g/100 mL, respectively, which met the first-grade standard of fish sauce and were significantly higher than those of 30% and 50% salt content treatment groups. This study confirmed the feasibility of producing fish sauce with squid viscera and provided a new idea for the high value utilization of squid processing waste.

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