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Accelerating Effect of Squid Viscera on the Fermentation of *Alaska pollack* Scrap Sauce

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Abstract

Fish sauce is a liquid form of salt-fermented fish and has played an important role in Korean dietary life. Fish sauce was manufactured by utilizing *Alaska pollack* scrap from Himedara (seasoned and dried *Alaska pollack* tail) processing. In addition, the effects of squid viscera as a fermentation enhancer were also evaluated. pH of *Alaska pollack* scrap sauce with squid viscera was lower than that of control over the entire fermentation process. Squid viscera accelerated the production of amino-nitrogen, VBN, TBA and free amino acids, and the degradation of IMP and Inosine. The addition of squid viscera and koji at 5% concentration, respectively, also accelerated the digestion of *Alaska pollack* scrap and was similar to the results of squid viscera at 10% concentration.

Key words: fish sauce, squid viscera, fermentation enhancer

INTRODUCTION

Fermented foods have played an important role in Korean dietary life in which they constitute the basis of taste of Korean traditional meals and contribute significantly to the nutrition of the Korean people. The typical fermented fishery foods are divided into three groups: *Jeotgal (Jeot)* which is "fermented fish", *Sikhae* which is "fermented fish with cooked cereal", and fish sauce. Fish sauce is actually a liquid part of *Jeotgal*. It has been reported that a good quality fish sauce can be prepared from capelin with the help of squid hepatopancreas (1). These investigations concluded that the amount and type of amino acids and other non- amino-acid nitrogen compounds were important for the acceptability of capelin fish sauces. Yoshinaka et al. (2) also reported sardine fish sauce with the addition of its visceral enzymes fermented at 50°C for 5 hrs was comparable in quality with commercial products. In addition, mackeral sauce with viscera increased amino-nitrogen content and protein decomposition (3).

Alaska pollack scrap from Himedara (seasoned and dried *Alaska pollack* tail) processing consists of only the head and trunk portions. *Alaska pollack* viscera is usually used as a raw material for other foods such as *Jeotgal*. Therefore, *Alaska pollack* processing scrap might not be a good raw material for manufacture of fish sauce because of low hydrolyzing microorganism and enzymes, which enhances the digestion of fish meat.

The purposes of this study were to manufacture fish sauce from *Alaska pollack* processing scrap and to investigate the effects of squid viscera as a fermentation enhancer on the qualities of fish sauce.

MATERIALS AND METHODS

Sample preparation

Frozen *Alaska pollack* (*Theragra chalcogramma*) of about 20 cm in length stored at -20°C was obtained from a local distributor. The portion of head and trunk cut out about 7 cm from the tail was used as raw materials.

Manufacture of fish sauce

Koji consisting of *Aspergillus oryzae,* was purchased from the ChungMoo Fermentation Co. (Pusan). Frozen *Alaska pollack* scrap was chopped with a silent cutter after thawing with tap water, and mixed with 50% water and 20% NaCl. In addition, 10% of squid viscera alone, and 5% each of both squid viscera and koji were added as fermentation enhancers. Then samples were sealed in 500 ml plastic containers and fermented at room temperature, stirring up once for 1 min per day up to 3 weeks of fermentation and once per week after that. Every month, samples were centrifuged at 5,000×g for 10 min, and then their supernatants were taken as samples.

pH

pH of fish sauce during ripening was determined with a pH meter (DongWoo Medical Center, Seoul).

Amino nitrogen (NH_2-N)

The content of amino-nitrogen was determined according to the method of Spies and Chamber (4).

Volatile basic nitrogen (VBN)

The concentration of VBN was determined according to the Conway unit method (5).

Thiobarbituric acid (TBA)

TBA number was determined according to the method of Tarladgis et al. (6).

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Free amino acid

50 ml of 70% ethanol was added to 10 ml of the sample and mixed well with a stirrer. After standing for 24 hrs, the sample was centrifuged at 6,000×g for 20 min. The filtrate was mixed with 500 mg of sulfosalisylic acid and stood for 3 hr. It was then recentrifuged under the same conditions and concentrated with a rotary evaporator. The concentrated sample was made up to a volume of 10 ml with 0.01 M sodium citrate buffer, pH 2.2. Free amino acid was determined with an amino acid analyzer (LKB 4150α, Piscataway, NJ, USA).

Nucleic acids and their related compounds

Nucleic acids and their related compounds were determined according to the method of Lee et al. (7).

Total viable cell count

Total viable cell count of the microorganism was determined by the Standard Plate Count method (8).

RESULTS AND DISCUSSION

Changes of pH

Changes of pH during fermentation of *Alaska pollack* scrap sauce are shown in Fig. 1. pHs of all samples were decreased over the entire fermentation periods, especially somewhat rapidly in later stages of fermentation. The pH of the control showed higher values over the entire fermentation period than that of the samples added with fermentation enhancers. Cho (9) explained that even though microorganisms produced organic acids constantly, the reason why pH decreased slowly or stayed constant during fermentation was that other organic substances such as free amino acids, contributed to the increase of pH. In this study, pH was constant early in the fermentation period, especially in the control but decresed more rapidly during progressing fermentation mainly due to high production of organic acids. The pH of the samples with only squid viscera showed a higher pH value than with squid viscera and koji. Bacteria or their enzymes are only of minor importance during digestion because of the inhibitory effects of high salt concentration (10). Therefore, the hydrolysis of fish tissue appears to be mainly an autolytic process by endogenous fish enzymes (11). One of the reasons why the samples with fermentation enhancers showed lower pH values than the control during fermentation might be from the higher production of organic acids by microorganisms and endogenous enzymes of fermentation enhancers.

Changes of amino-nitrogen

Changes of amino-nitrogen contents during the fermentation of *Alaska pollack* scrap fish sauce are shown in Fig. 2. The amino-nitrogen content of the control was significantly increased up to 90 days of fermentation and then increased very slowly, while those of the samples added with fermentation enhancers increased very rapidly up to 60 days and then was a somewhat constant or decreased very slowly. The higher amino-nitrogen production with squid viscera and/or koji than the control might be due to the higher digestion of proteins by the enzymes or microorganisms of squid viscera and koji. Therefore, the addition of squid viscera, and both squid viscera and koji were considered to increase the amounts of amino-nitrogen by enhancing the digestion of protein during fermentation. This was almost the same result as that of Kataoka et al. (3), in which the content of amino nitrogen increased with the increase of viscera addition. The TCA-soluble nitrogen content of the male capelin fish sauce increased as fermentation progressed and the addition of squid viscera increased the amount of TCA-soluble nitrogen (1), which was the same as these results.

Changes of volatile basic nitrogen (VBN)

The amounts of VBN during fermentation are shown in Fig. 3. The concentrations of VBN increased with increasing fermentation periods over all samples, but there were no significant differences in the VBN contents among samples after 120 days of fermentation. However, the VBN content of the control was lower than that of fermentation enhancers up to

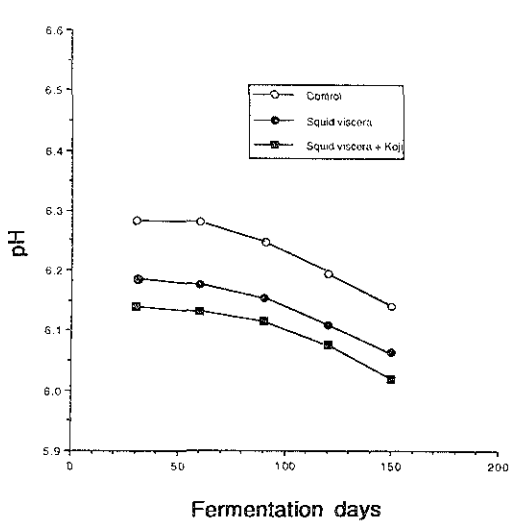

Fig. 1. Changes of pH during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature.

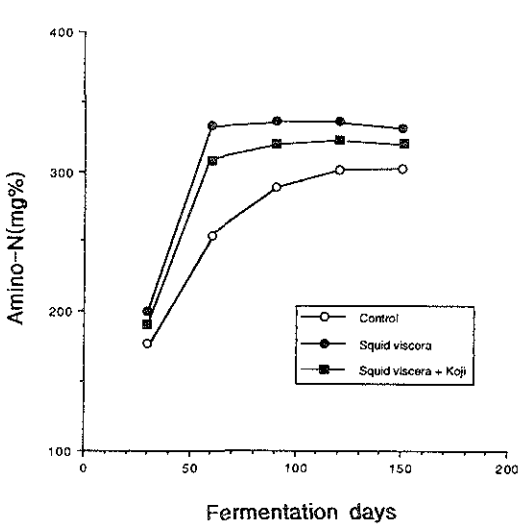

Fig. 2. Changes of amino-N content during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature.

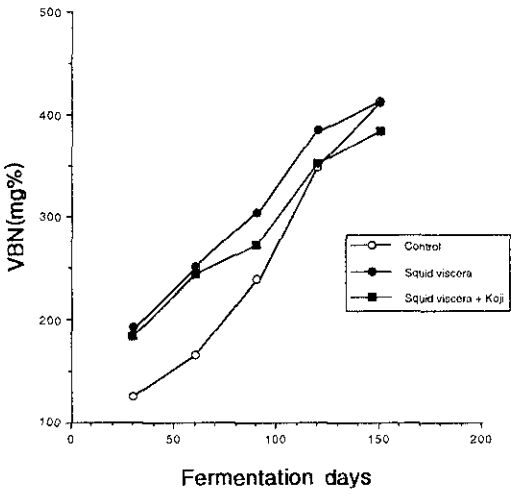

Fig. 3. Changes of VBN content during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature.

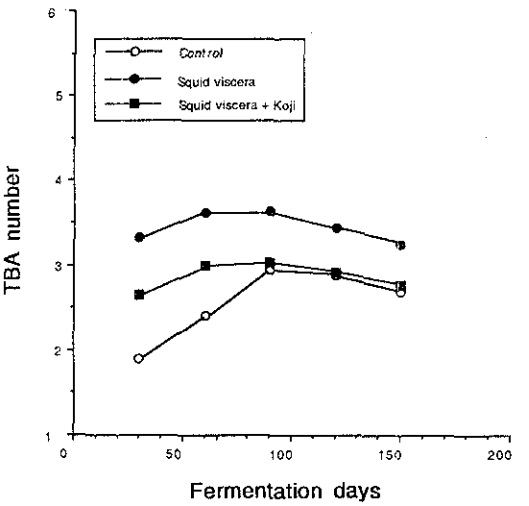

Fig. 4. Changes of TBA number during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature.

90 days of fermentation, while the samples with squid viscera showed a higher production of VBN up to 120 days of fermentation. Yamazaki et al. (12) reported that squid liver had an inhibitory action on microbial growth. Takai et al. (13) also reported that squid ink inhibited the production of TMA and VBN. However, even though squid viscera contained ink and the liver, the results of this study were not similar to above. This might be due to the stronger digestion actions of enzymes or microorganisms in the squid viscera.

Changes of thiobarbituric acid (TBA)

Changes of TBA contents during fermentation were shown in Fig. 4. The TBA content of control increased rapidly up to 90 days of fermentation and then decreased slowly, while those of the samples with fermentation enhancers increased up to 60 days and then decreased very slowly. The samples with squid viscera and koji had higher production of TBA than control up to 90 days of fermentation period, but fish sauce with squid viscera alone showed the highest TBA value over the entire fermentation period. This might be due to a higher lipid content, 14.1%, in squid viscera (14). There was not much significant difference in the TBA value between control, and squid viscera and koji at 5% concentration after 90 days of fermentation, in which koji might inhibit the production of TBA.

Changes of nucleic acids and their related compounds

Changes of nucleic acids and their related compounds are shown in Table 1. ATP, ADP, and AMP were not detected even after 30 days of fermentation. This might be due to the frozen *Alaska pollack* which were degraded completely. This result was similar to that of Yoo and Chang (15) in which ATP and ADP of fermented clam products degraded completely after 7 and 28 days of fermentation, respectively. IMP and Inosine contents of the control were 12.2 and 3.76 μg/ml respectively after 30 days of fermentation, and then decreased rapidly. IMP contents of the samples with squid viscera alone and both viscera and koji were 15.3 and 15.8 μg/ml respectively after 30 days of fermentation, but it was not detected after 60 days of fermentation. Inosine contents of control were 3.67 and 3.5 μg/ml respectively after 30 and 60 days of fermentation, and then inosine degraded completely after 90 days of fermentation. Inosine was not detected in the samples with only squid viscera, and both viscera and koji after 30 days of fermentation. The Hx contents of the samples with fermentation enhancers increased up to 90 days and then decreased a little on 120 days of fermentation, while that of control increased constantly after 60 days of fermentation. According to Shin and Lee (16), ATP, ADP, and AMP of fermented *Alaska pollack* flesh were not detected

Table 1. Changes of nucleic acids and their related compounds during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature (μg/ml)

Fermentation days	30			60			90			120		
Fish sauce	A	B	C	A	B	C	A	B	C	A	B	C
Nucleic acids and their related compounds												
IMP	12.2	15.3	15.8	2.3	-	-	1.7	-	-	-	-	-
Inosine	3.67	-	-	3.5	-	-	-	-	-	-	-	-
Hx	13.8	16.2	17.2	13.5	18.3	18.5	14.6	18.9	19.0	15.4	17.6	18.6

A, Control; B, Squid viscera; C, Squid viscera+Koji

during fermentation, while IMP, Inosine, and Hx contents fluctuated, which is similar to the results of this study.

Changes of free amino acids

Changes of free amino acid content are shown in Table 2. The contents of free amino acid increased rapidly up to 90 days of fermentation and then increased slowly after that. Free amino acid content of the control was lower than those of fermentation enhancers, but there was not much difference of free amino acid content between squid viscera, and both squid viscera and koji. Though not mentioned here, Lys, Arg, Leu, Phe, and Tyr were the major components of the free amino acids of *Alaska pollack* scrap sauce. According to Yoshinaka et al. (2), the major amino acids of sardine sauce with its vicsera were Lys, Arg, Leu, His, and Ala, which is similar to these results.

Changes of total viable cell count

Changes of total viable cell counts are shown in Table 3. The microbial growth of all samples increased constantly up to 120 days of fermentation. The viable cell count of fish sauce with squid viscera and koji was higher at the beginning of fermentation but lower at a later period of fermentation than the control. There was not much difference of total viable cell contents between squid viscera at 10% concentration, and both squid viscera and koji at each 5% concentration. This was the same as the results of Cha et al. (17), in which they reported that the fermented fish product added with koji had a higher activity of protease which might improve the qualities of Jeotgal and shortened the fermentation period.

Table 2. Changes of free amino acid content during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature (mg%)

Fermentation days / Fish sauce	30	60	90	120
Control	156.09[1)] (79.86)	372.39 (259.05)	466.64 (278.24)	533.39 (314.64)
Squid viscera	248.65 (137.80)	466.90 (235.57)	556.86 (329.07)	580.10 (353.85)
Squid viscera +Koji	252.40 (138.94)	446.01 (240.87)	552.78 (327.85)	567.96 (327.48)

[1)]The contents of total amino acids (the contents of essential amino acids)

Table 3. Changes of total viable cell counts during the fermentation of *Alaska pollack* scrap sauce with squid viscera at room temperature (CFU/ml)

Fermentation days / Fish sauce	30	60	90	120	150
Control	4.0×10^{1}	8.7×10^{3}	3.8×10^{5}	2.0×10^{7}	1.1×10^{7}
Squid viscera	4.5×10^{3}	8.0×10^{4}	2.7×10^{6}	3.0×10^{7}	2.1×10^{8}
Squid viscera +Koji	5.6×10^{3}	3.1×10^{4}	1.7×10^{6}	3.1×10^{7}	2.0×10^{7}

CONCLUSIONS

In order to utilize *Alaska pollack* scrap wasted during Himedara (seasoned and dried *Alaska pollack* tail) processing, a fish sauce was manufactured and the effects of squid viscera as a fermentation enhancer was also investigated.

Squid viscera accelerated the production of amino-nitrogen, VBN, TBA, and free amino acids, and the degradation of IMP and Inosine. The addition of squid viscera and koji at each 5% concentration also accelerated the digestion of *Alaska pollack* scrap and was similar to the results of squid viscera at 10% concentration.

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