Universe Scientific Publishing

ORIGINAL ARTICLE

Comparison of Effects of Different Deodorization Methods for Deodorizing Sturgeon Fish (Acipenser Sinensis)

Yi Su[1,2], Wenshui Xia[1,2*], Qixing Jiang[1,2]

[1] School of Food Science and Technology, Jiangnan University, Wuxi, Jiangsu 214122, China

[2] Synergetic Innovation Center of Food Safety and Quality Control, Jiangsu Province, Wuxi, Jiangsu 214122, China

Abstract: Sturgeon fish with heavy fishy odor was used as raw material to investigate the effect of three different kind of deodorization methods. The sensory evaluation, thiobarbituric acid value (TBARS), and protein loss rate were used to compare the deodorization effects, and the volatile compounds were further analyzed by GC-MS. The results showed that the salt dissolving method had the worst deodorization effect, the deodorization effect was not obvious, and the TBARS and protein loss rate were relatively higher. The alkali deodorization was better than the acid one, and the effect was significant at pH 11.5 and 25 °C. The best effect of yeast fermentation can effectively reduce the fishy odor, TBARS and protein loss rate of raw materials. A total of 66 volatile compounds were detected by GC-MS, including aldehydes, ketones, hydrocarbons, alcohols and amines. The number and content of volatile compounds are significantly reduced after deodorization. Hexanal, octanal, furfural, 1-octene-3-ol, etc., which has a large contribution to fishy odor, and the content was significantly reduced after deodorization. The most significant reduction in volatile compounds was followed by alkali, acid and salt dissolution methods, consistent with previous sensory evaluation and TBARS values. To comprehensive compare all the methods, the yeast fermentation can effectively remove the fishy odor, which is an ideal means of deodorization.

Keywords: Aquatic Product Processing and Storage Engineering; Sturgeon; Deodorization; TBARS; Sensory Evaluation; Protein Loss Rate; GC-MS

Introduction

In recent years, sturgeon, as a popular freshwater fish, has gradually entered people's eyes. Sturgeon (sturgeon) belongs to an ancient class of bony fishes (osteichthyes)[1] with extremely high nutritional and economic values[2]. At present, sturgeon is mainly used for processing caviar, and the processing utilization rate of sturgeon meat as a by-product is relatively low. The sturgeon meat contains a large amount of high-quality protein, but its fishy smell is heavy and difficult to remove, which seriously affects the taste and flavor of fish meat products and is an industry difficult problem restricting the deep processing of sturgeon meat. Therefore, removing or effectively reducing the fishy smell in sturgeon meat has become an urgent problem to be solved.

There have been a lot of researches on fishy smell of fish. The fishy smell of fish is mainly some volatile substances such as aldehydes, alcohols, ketones, earthy smell substances, and a small amount of furan, naphthalene and other substances[3]. The sources of fishy smell substances are complex, mainly including breeding environment, catalytic decomposition of enzymes, especially decomposition of trimethylamine oxide, oxidative decomposition of free fatty acids, etc. At present, the deodorization methods mainly include sensory masking method, physical method (soaking /rinsing method, adsorption method, microcapsule deodorization method, embedding method, irradiation method), chemical method (acid, alkali and salt deodorization method, antioxidant deodorization method, organic solvent

doi: 10.18686/fsa.v1i2.1315

extraction method, ozone method), biological method (yeast fermentation deodorization)etc. Yeast deodorization, as a popular deodorization method in recent years, has the advantages of high safety factor, low cost and the like, and can also endow products with special fragrance. The existing deodorization methods are mainly applied to freshwater fish such as silver carp, channel catfish and other marine products such as hairtail, and the researches on deodorization of sturgeon are rarely reported.

In this study, sturgeon meat with heavy fishy smell was selected as the research object to investigate the deodorization effect of different deodorization methods on sturgeon meat, and the root was selected to be more suitable for deodorization of raw materials according to the changes of sensory value, thiobarbituric acid value (TBARS), protein loss rate and other indicators fishy smell method and GC-MS were used to further investigate the changes of volatile flavor substances in raw materials before and after deodorization. In order to provide some theoretical basis and guidance for sturgeon deodorization and promote the further development of sturgeon deep processing industry.

1. Materials and methods

1.1 Materials and reagents

Siberian sturgeon (Acipenser sinensis) with an average weight of 60.0 and 10.0 kg was provided by 65 of Zhenjiang huada ocean co., ltd. the live fish was quickly divided at 4 c and packaged in polyethylene self-sealing bags immediately after slaughter, and stored at-18 c for later use. Salt, Jiangsu Jinqiao Salt Making Co., Ltd.; Yeast, Angel Yeast Co., Ltd.

1.2 Instruments and equipment

JYL-D020 cooking machine, Jiuyang Household Appliances Co., Ltd.; 4K15 Frozen Centrifuge, American Sigma Company; Graphite 70 digester, Shandong Haineng Scientific Instrument Co., Ltd.; KDN-103F Automatic Nitrogen Determination Instrument, Shanghai Fiber Inspection Instrument Co., Ltd.; C-MAG HS 4 magnetic stirrer, german IKA company; UV1000 spectrophotometer, Tianmei Technology Co., Ltd.; Horizontal refrigeration and freezing conversion cabinet, Qingdao Haier electric freezer co., ltd. Gas chromatography-mass spectrometer (GC-MS), U.S. Thermo Technology company.

1.3 Test method

On the basis of Fu Xiangjin's[5] method, some changes have been made. The processed fish slices are divided into 10 groups, in which 5 groups are respectively added with 4℃ saline water (1%, 3%, 5%, 7%, 9% of different concentrations by volume (m/V), stirred on a magnetic stirrer for 15min and then frozen and centrifuged (10000g, 10min, 4℃). Take the centrifuged lower layer sample, add three times (v/w) distilled water, stir on a magnetic stirrer for 2min and freeze for centrifugation (10000g, 10min, 4℃). Continue to repeat this operation twice. The remaining 5 groups are treated in the same way, and the temperature is set to 4.

Slightly modify the method[6] to deodorize the sample. Will be treated fish. The tablets were divided into 12 groups, in which 6 groups were added with 3 times the volume (m/v) and 25 degree celsius distilled water respectively and stirred continuously on a magnetic stirrer.

Refer to Santoro and Fiego methods[7] to determine the TBARS value of the sample. Weigh 5g minced sturgeon meat, add 20mL 10% trichloroacetic acid, homogenize for 30s, freeze centrifuge (4℃, 2000g, 5min), filter, take 5mL of supernatant, add 5mL 0.02mol/L TBA solution, take out after boiling water bath for 20min, quickly cool to room temperature, measure the light absorption value at 532nm; The blank sample is 5mL trichloroacetic acid, add 5mL 0.02mol/L TBA, measure the absorbance at 532nm and calculate the TBA value. Three parallel samples were set for each group, and the results were averaged.

2. Results and discussions

2.1 Different deodorization methods on odor value

Sensory evaluation can intuitively show the deodorization effect of different treatment methods. Salt solution deodorization is a typical physical deodorization method. Its main principle is to rely on the permeation of salt to

promote the precipitation of fishy substances[8] in fish.

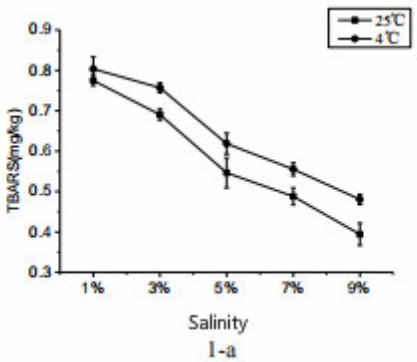
The main principle of acid-base deodorization (pH-shift processing) is that 150 is dissolved by the protein in extreme pH environment and is fully developed under the action of electrostatic repulsion. The fishy smell substance originally combined with the protein falls off the protein and finally achieves the purpose of deodorization[9].

2.2 Different deodorization methods on TBARS

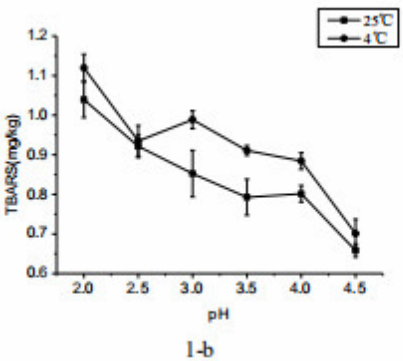
Thiobarbituric acid value is an important indicator of meat fat oxidation, which reflects the content of fat degradation products such as lower aldehydes and ketones. Siddaiah *et al.* found a good correlation between TBARS value and carp fishy smell[10] and Fu Xiangjin[5] found a close relationship between fishy smell and fat degradation products. The TBARS value of sturgeon under different salt concentrations is shown in Figure 1-a. With the increase of salt concentration, TBARS shows a gradual downward trend, and TBARS is lower than 4 at 25. When the salt concentration is 9% and the temperature is 25, the TBARS value is the lowest, reaching 0.39mg/kg. This is consistent with the result of gamey smell value of sensory evaluation.

The deodorization effects under different pH conditions and temperatures are shown in Figures 1-b and 1-c. When acid-base method is used to remove fishy smell, with the gradual increase of pH, the value of TBARS shows a gradual downward trend. 25℃ is better than 4 in deodorization effect. Under acidic conditions, pH is 4.5 while the value of TBARS is the lowest, which is 0.66 mg/kg. Under alkaline conditions, when the pH is 12.0, the TBARS value is the lowest, which is 0.62mg/kg. Compared with the TBARS value under acidic and alkaline conditions, the TBARS value is higher under low pH conditions. The possible reason is that the protein is completely expanded under extreme pH conditions. The conformation of hemoglobin under acidic conditions exposes more fatty acid binding sites, resulting in oxidation of more fatty acids. However, the conformation under alkaline conditions exposes less fatty acids, which is not conducive to oxidation of fatty acids. Therefore, the TBARS value is higher[11] under acidic conditions. Kristin SSON[12] previously used the pH shift method to extract protein from Atlantic yellow croaker, and found that the protein under alkaline condition has better oxidation stability than that under acidic condition. “This is consistent with the results in this study.

The effect of yeast addition on the TBARS value is shown in Figure 1-d. With the increase of yeast addition, the value of TBARS fluctuated and decreased. When the addition was 0.3%, TBARS was the lowest[13]. When treating bighead carp hydrolysate with yeast, it was found that the fishy smell of the hydrolysate treated with 0.25% yeast was small. When the yeast content was high, the hydrolysate basically had no fishy smell, but the yeast taste and sour taste after yeast fermentation were heavy. When the temperature is about 40℃, the increase in temperature will lead to the increase in the oxygenation of fat and produce more fishy smell substances[14] while when the temperature is higher than 40℃, the excessive temperature will lead to the inactivation of yeast cells, which will have adverse effects on the deodorization effect. Xu Jin[15] used active dry yeast as deodorizing agent to deodorize silver carp. It was found that deodorizing time had the greatest effect on removing bitter taste of fish protein hydrolysate, followed by yeast addition and treatment temperature.



1-a



1-b

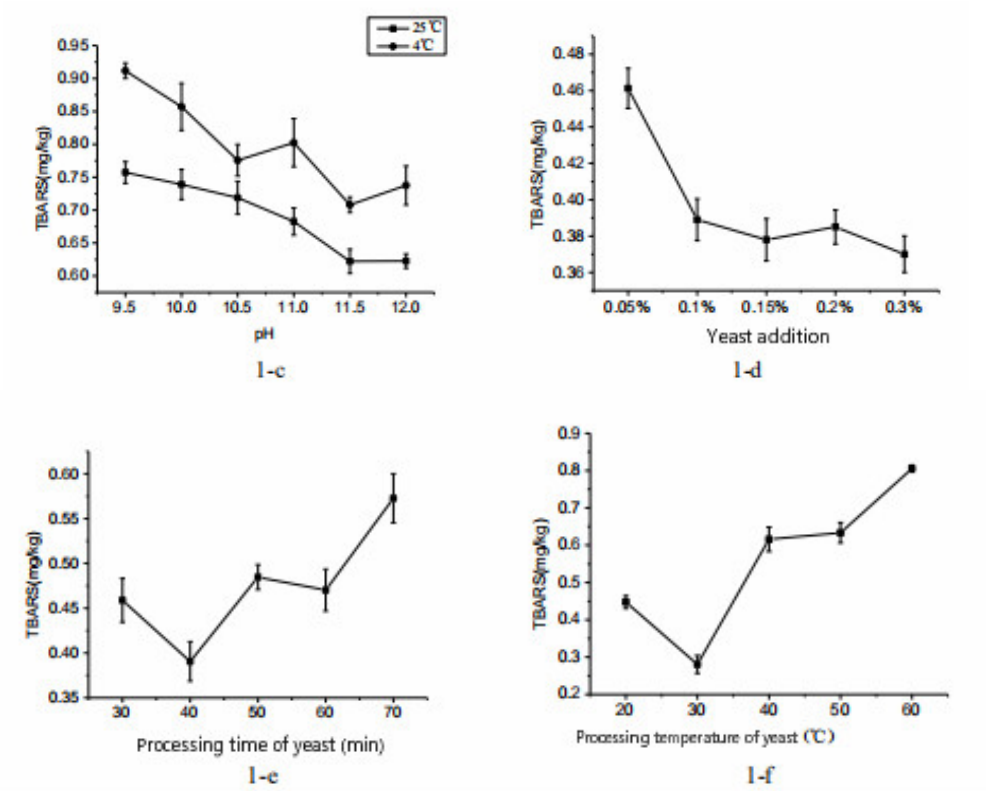


Figure 1. Effect of different deodorization methods on TBARS value.

2.3 Effect of different deodorization methods on protein loss rate

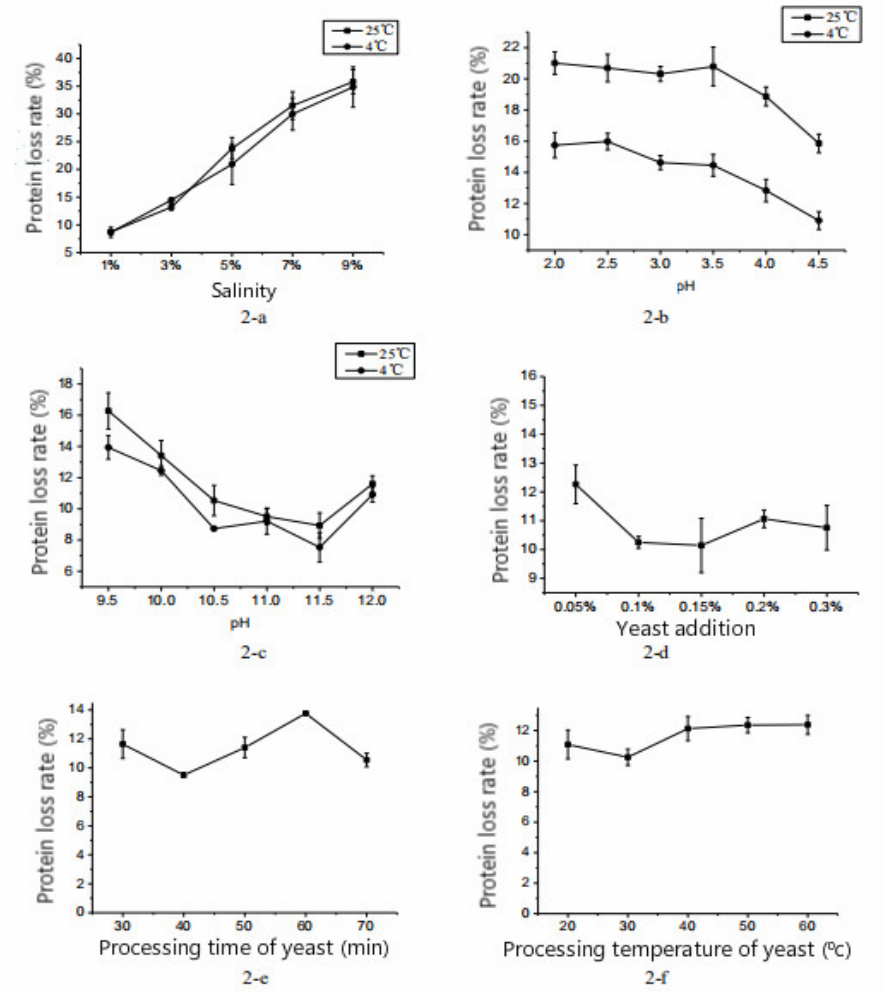


Figure 2 Effect of different deodorization methods on protein loss rate

See Figure 2-a for the effect of deodorization by salt dissolution on protein loss rate. With the increase of salt concentration, the protein loss rate showed a gradually rising trend. Temperature had no obvious effect on the protein loss rate. When the concentration was 9%, the protein loss rate was the highest, reaching 48.15%. The research by Weng Liping *et al.* shows that the salt dissolution method causes a large loss of water-soluble protein and the removal effect of nonpolar fishy smell substances is poor[16], which is consistent with the research results of this experiment.

Figs. 2-b and 2-c show the effect of acid-base deodorization on protein loss rate. When the fish was treated with acid method, the protein loss rate showed a fluctuating downward trend. 4 degree celsius protein loss rate was lower than 25 degree celsius, while 4 degree celsius and pH2.5 protein loss rate was the lowest, 12.83%; Alkaline deodorization also showed a fluctuating downward trend, but the overall protein loss rate was lower than that of acid method and salt dissolution method. When the pH was 11.5 and 4℃, the protein loss rate was the lowest, which was 8.93%". It may be that the protein dissolves under acidic conditions due to its acid-soluble and alkali-precipitation characteristics, so the loss rate is relatively higher.

2.4 Comparison of volatile flavor compounds before and after different deodorization methods

A total of 66 kinds of volatile flavor substances were detected by GC-MS, of which 48 kinds were detected before deodorization. After different deodorization treatments, the kinds of volatile flavor substances were reduced. 39 kinds and 33 kinds were detected by salt solution method (25℃ and 4℃), and 39 kinds and 33 kinds by acid method (25℃, 4℃) detected 35 and 31 species respectively, alkaline method (25 ℃ and 4 ℃) detected 31 and 27 species respectively, yeast method detected 31 species.

Aldehydes play an important role in the odor characteristics of aquatic products, especially some aldehydes with relatively low molecular weight have low threshold values, which usually produce some pungent odor, and may come from the decomposition of peroxy compounds formed after oxidation of unsaturated fatty acids[16]. Before deodorization, the content of aldehydes reached 35.09mg/kg, accounting for 26.82% of the total volatile components. valeraldehyde, hexanal, octanal and nonanal were detected, among which hexanal content was the highest, reaching 22.37mg/kg. Hexaldehyde has green grass smell and fishy smell, and is one of the substances causing fishy smell of fish. In addition, unsaturated aldehydes such as 2- hexenal, 2,4- heptadeenal and the like have also been proved to be typical fishy smell substances[17] of various fishes. After different deodorization treatments, the types and contents of aldehyde substances detected are significantly reduced, of which yeast method is the best, only hexanal (4.65mg/kg) and octanal (0.78 mg/kg) are detected after deodorization; The types and contents of aldehydes detected after deodorization by alkaline method are lower than those detected by acid method. After removing fishy smell by salt solution method, the content of aldehyde substances decreased, but the species did not change significantly compared with that before removing fishy smell. The deodorization effect is more obvious at 25℃ than at 4℃.Ketones have eucalyptus, fat and burnt flavor, with a high threshold value, but have an enhancement effect on fishy smell[18]. After deodorization treatment, the types and contents of ketones decreased.

The content of alcohol substances before deodorization is up to 15.21mg/kg. The possible reason is that yeast produces small molecule alcohol substance in the process of deodorization by fermentation, or uses fishy smell substance as substrate to convert original macromolecular substance into small molecule alcohol. Hydrocarbon is the volatile substance with the highest content, of which alkane has a higher threshold and makes little contribution to fishy smell. However, some olefin compounds can form aldehydes or ketones under certain conditions, which is also a potential factor[19] for fishy smell.

3. Conclusion

In this paper, comparing the effects of different deodorization methods, it is found that among the three deodorization methods, salt solution method has the worst deodorization effect. TBARS value is high and protein loss rate is high, deodorization effect at 25℃ is slightly better than 4 ℃; Alkali deodorization is better than acid deodorization, in which pH 11.5 and 25℃ have better deodorization effect and lower protein loss rate. Yeast has the best deodorization effect, with low protein loss rate, low TBARS value and low fishy smell value. The deodorization effect is best when the deodorization temperature is 30℃, deodorization time is 40min and yeast addition amount is 0.2%". A total of 66 kinds of volatile flavor substances were detected by GC-MS method, of which 48 kinds were detected

before deodorization. After different deodorization treatments, the kinds of volatile flavor substances can be reduced. 39 and 33 kinds will be detected by salt dissolution method (salt concentration 9%), temperature 25 and temperature 4 ,respectively. 35 and 31 kinds were detected by acid method (pH 4.5, temperature 25 and temperature 4 “), and 31 kinds can be detected by alkali method (pH11.5), 31 and 27 species were detected at 25 and 4 temperatures respectively, and 31 species were detected by yeast method. Volatile substances mainly include aldehydes, ketones, hydrocarbons, alcohols and amines, etc. Hexaldehyde, octanal, nonanal, 1- octene -3- alcohol, etc. What contribute much to fishy smell are the main volatile substances, and the content is obviously reduced after deodorization treatment. The types and contents of volatile substances after deodorization by yeast method are the least, which are consistent with the previous physical and chemical indexes. By comprehensive comparison, yeast method is a better deodorization method and has certain application potential and value in the deodorization process before sturgeon meat processing.

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