

Catfish Preservation using *Porphyra Yezoensis* Composites Preservatives

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Abstract: This study aims to preserve fresh catfish meat by using *Porphyra yezoensis* extract, chitosan and lactic acid Nisin. The composite preservative obtained by sensory evaluation can effectively maintain the color, odor and texture of fresh catfish meat, as well as inhibit bacterial growth. Results show that treatment using a preservative solution (*Porphyra yezoensis* extract 10%, Nisin 0.2% and chitosan 15%) extended the shelf life of the fresh catfish meat from 12 h to 24 h when stored at room temperature and from 6 d to 9 d when stored at 4°C. These results provide a practical method of preserving fresh catfish meat.

Keywords: Catfish, composite preservative, *porphyra yezoensis* extracts

INTRODUCTION

Fishes are rich in essential amino acids. They contain 24 eicosapentaenoic acid, 26 docosahexaenoic acid, vitamins, minerals and lecithin (Lall and Tibbetts, 2009). They are an important source of high-quality protein for human. However, they easily discolor, stale and rot during storage, processing and marketing because of their high moisture and protein content, soft organization and high bacteria-carrying capacity. Therefore, they should be promptly treated with appropriate preservation measures after capture to extend the preservation time. Commonly used preservation methods include cryogenic preservation, chemical preservation, modified atmosphere packaging and irradiation preservation (Mahmoud *et al.*, 2006). Recently, with the increased awareness of environmental protection and preservation technology development, the security of chemical preservation gradually raised concerns. The use of some natural and non-toxic biological preservatives as raw materials for preservation technology has attracted interest. These preservatives are currently used in aquatic product processing, storage, transportation and consumption. Several studies have focused on improving the use of biological preservatives for aquatic preservation.

Porphyra yezoensis extracts reportedly contain antibacterial substances that inhibit *Escherichia coli* and other bacteria in food (Jiang *et al.*, 2007). Chitosan acts as an efficient antibacterial agent and a superior film-forming polymer widely used in food preservation (Du *et al.*, 2009; Wang *et al.*, 2013). Nisin is an efficient, safe, nutritious and natural food preservative that can effectively kill Gram-positive bacteria causing food spoilage (Abdullah *et al.*, 2010; Chollet *et al.*, 2008;

Davies *et al.*, 1997; Mahadeo and Tatini, 1994; Rose *et al.*, 1999). This study aims to use *P. yezoensis* extract, chitosan and nisin to prepare a composite preservative of raw fish and provide a theoretical basis for the comprehensive use of *P. yezoensis* in fish preservation.

MATERIALS AND METHODS

Materials: Catfishes, each weighing about 2 kg, were purchased from the farmers' market (Xinpu, Jiangsu, China). Dried *P. yezoensis* was obtained from the supermarket (Xinpu, Jiangsu, China). Raw chitosan from shrimp shells was purchased from Nantong Biochemical Co. (Jiangsu, China). The molecular weight and degree of deacetylation were calculated at 41×10^4 Da and 93.5%, respectively. Nisin was supplied by Lanzhou Weiri Biological Engineering Co., Ltd. Tea polyphenols were provided by Suzhou XinKaiheng Chemical Trading Co., Ltd. All materials used were of food grade.

Preparation of the composite preservatives: *P. yezoensis* was soaked in water bath at 40°C for 48 h, homogenated and centrifuged at $4000 \times g$ for 30 min to yield *P. yezoensis* extracts. The preservatives were prepared by mixing the weed extracts with varying volumes of distilled water.

Pretreatments of catfish: The catfishes were descaled, gutted, their heads and tails removed and cut into small pieces (approximately 50 g per piece).

Preservation of fresh catfish meat: Fresh fish meat pieces were soaked in the composite preservative for 1 min, drained, placed in a glass dish, sealed with a

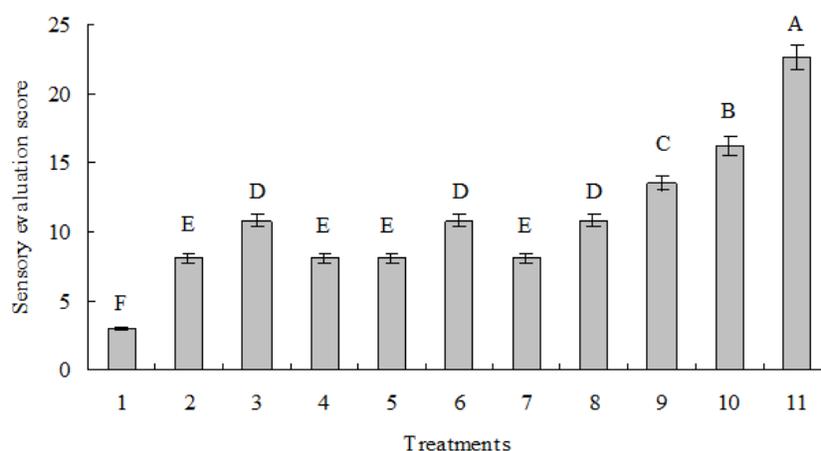


Fig. 1: Effect of *Porphyra yezeensis* extract with or without its synergists on preservation of catfish meat (1, Control; 2, 5% *Porphyra yezeensis* extract; 3, 10% *Porphyra yezeensis* extract; 4, 15% *Porphyra yezeensis* extract; 5, 0.1% Nisin; 6, 0.2% Nisin; 7, 0.3% Nisin; 8, 5% Chitosan; 9, 10% Chitosan; 10, 15% Chitosan; 11, 10% *Porphyra yezeensis* extract + 0.2% Nisin + 15% Chitosan). Bars represent the standard deviation (n = 3). Different letters on the bars indicate significant differences (p<0.05)

plastic wrap and allowed to stand at room temperature (25°C) for 36 h and at 4°C for varying periods (0, 3, 6, 9, 12 and 15 d).

Sensory evaluation: Pieces of catfish meat were evaluated by 18 panelists aged between 20 and 25 years from the Department of Food Science and Technology on the 9-point hedonic scale, where 9 = like extremely; 7 = like moderately; 5 = neither like nor dislike; 3 = dislike moderately; 1 = dislike extremely (Meilgaard *et al.*, 1990). All panelists evaluated the color, odor and texture of the meat. The total sensory evaluation score ranged between 27 (the highest score) and 3 points (the lowest score).

Microbiological analysis: Microbiological analysis was conducted as described in the study by Nirmal and Benjakul (2009b) with slight modifications Catfish meat (25 g) was placed in a Waring blender (JJ-2, Wuxi Woshin Instruments Co., Ltd., Wuxi, China) containing 225 mL of 0.85% saline water. After homogenization, appropriate dilutions were prepared and spread on a plate count agar medium containing 0.5% sodium chloride to determine the total viable counts. Total viable counts of mesophilic bacteria were determined by incubating the agar plates at 35°C for 2 d.

RESULTS

Effect of *P. yezeensis* extract without or with its synergists on the preservation of catfish meat: The effect of *P. yezeensis* extract alone or in combination with its synergists on the sensory score of catfish meat is shown in Fig. 1. *P. yezeensis* extracts with and

without additives, including Nisin or chitosan, exhibited preservation effects on catfish meat. When *P. yezeensis* extract was solely used as catfish meat inhibitor, the maximum sensory score (10.8) obtained was 10% (Fig. 1). Nisin with a concentration of 0.2% reached its optimal preservation effect on catfish meat (10.8). Chitosan with a concentration of 5, 10 and 15% obtained 10.8, 13.5 and 16.2 of sensory scores of catfish meat, respectively. The preservation effect increased with the increase in chitosan concentration. However, chitosan solutions above 15% are not suitable for preserving aquatic animals because of their high viscosity. Therefore, chitosan with 15% concentration was considered optimal for the preservation of catfish meat. When 15% *P. yezeensis* extract as well as Nisin with 2% concentration and chitosan with 15% concentration were combined, the maximum sensory score of catfish meat (22.6) was obtained. Therefore, 10% (w/v) *P. yezeensis* extract combined with 0.2% Nisin and 15% chitosan was used for further study.

Effect of composite preservatives on the sensory scores of catfish meat: Changes in the sensory scores of catfish meat without and with treatment stored at room temperature (25°C) are presented in Fig. 2. Color, odor and texture of catfish meat were evaluated to obtain sensory scores at 0, 12, 24, 36, 48 and 60 h. At 0 h, no obvious differences in sensory scores were observed among all samples. After storage for 12 h, decreases in the sensory scores of the control samples were noticeable (p<0.05). At 12 h, the sensory scores of catfish meat treated with *P. yezeensis* extract composite preservatives increased compared with the control (p<0.05). After storage for 36 h, the sensory scores of

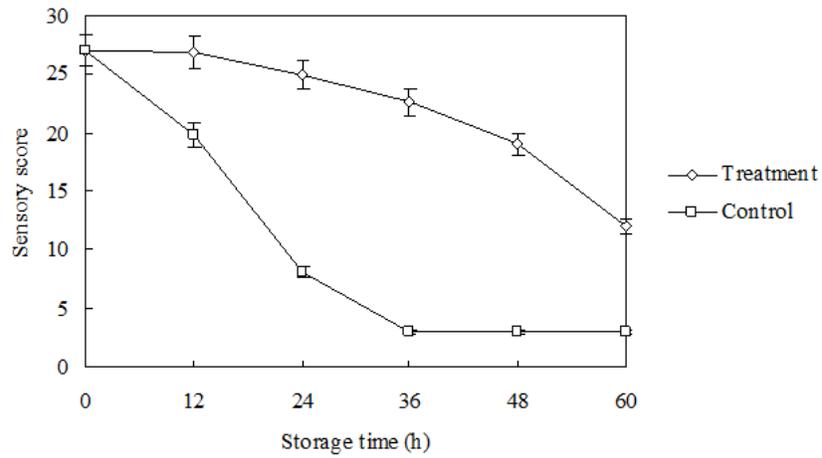


Fig. 2: Effect of composite preservatives on sensory score of the catfish meat stored at room temperature (25 °C). Bars represent the standard deviation (n = 3)

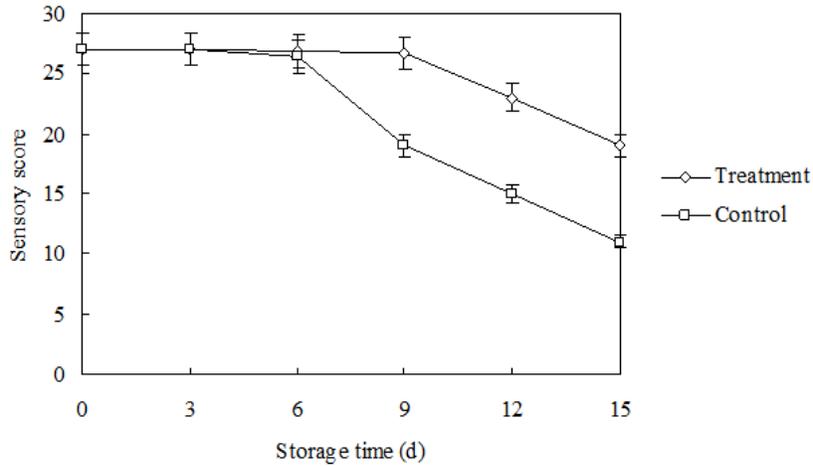


Fig. 3: Effect of composite preservatives on sensory score of the catfish meat stored at 4°C. Bars represent the standard deviation (n = 3)

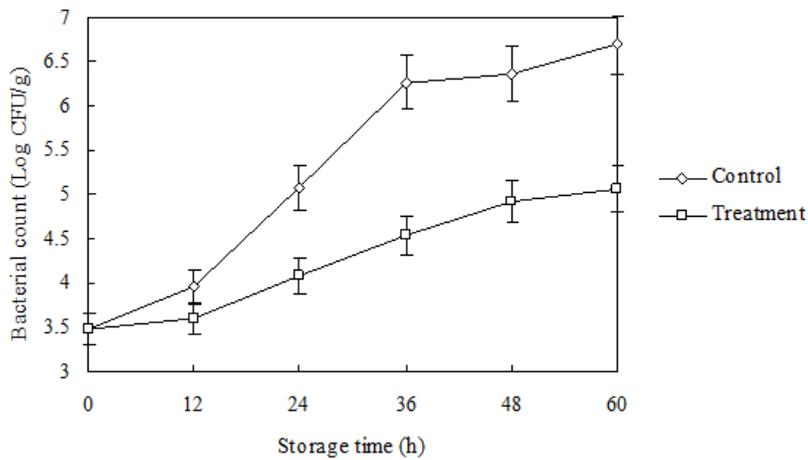


Fig. 4: Effect of composite preservatives on bacterial count in the catfish meat stored at room temperature (25°C). Bars represent the standard deviation (n = 3)

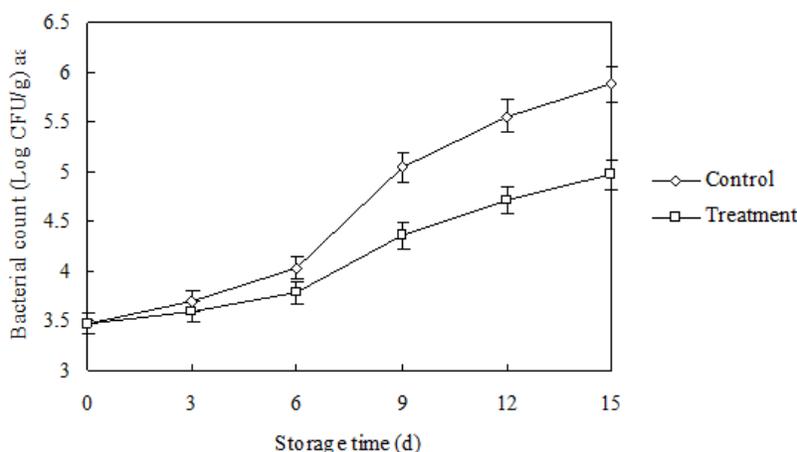


Fig. 5: Effect of composite preservatives on bacterial count in the catfish meat stored at 4°C. Bars represent the standard deviation (n = 3)

the control samples reached their lowest degrees, whereas those of the samples treated with *P. yezoensis* extract composite preservatives remained high (22.6).

Changes in the sensory scores of catfish meat without and with treatment stored at 4°C are shown in Fig. 3. The shelf life of the control samples was 6 d, whereas that of the treated samples was 9 d.

Effect of composite preservatives on bacterial count in catfish meat: Changes in bacterial counts of catfish meat during room temperature storage in the presence of composite preservatives are shown in Fig. 4. The bacterial counts in the control increased steadily for 60 h. Despite the increase in the bacterial counts of the catfish meat treated with composite preservatives, these counts were significantly lower than that of the control ($p < 0.05$). This result indicated the antimicrobial activity of composite preservatives toward bacteria in catfish meat. Changes in bacterial count of catfish meat with and without treatments when stored at 4°C were similar to those when stored at room temperature (Fig. 5).

DISCUSSION

The main problems in the preservation of fish include the following:

- Prevention of microorganism growth that cause abnormal odor, organizational structure, or generation of hazardous substances
- Prevention of oxidation that cause odor and color changes

Therefore, preservatives often contain antibacterial and antioxidant components. The results showed that Nisin, *P. yezoensis* extract and chitosan exhibited preservation effects on fresh catfish meat. The

composite preservative made of these components showed better preservation.

The three components exhibit antibacterial ability only in the early preservation stage. When the bacterial count increased rapidly, their antibacterial effects were not apparent. The preservation effect of Nisin could be ascribed to its antibacterial effect. It decreases with the increase in water-soluble protein in the product, which may reduce the binding chance of Nisin and microorganisms because of the binding of Nisin and protein. *P. yezoensis* extract exhibits a higher antimicrobial activity compared with Nisin. It largely contributes in maintaining the natural color and flavor of the product and inhibiting growth of bacteria in fresh fish. This advantage may be attributed to the synergistic effect of the antibacterial substance, antioxidants in the extract and the natural flavor of the extract. Chitosan can effectively inhibit the growth of microorganisms and maintain the natural color, flavor and organizational structure of the product. This effect is attributed to the synergy between the antibacterial and superior film-forming effect of chitosan. A single substance cannot sufficiently preserve fish. As new preservative materials are developed, the synergy between composite preservatives can provide research direction.

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