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Effect of dandelion polysaccharides on the retardation of the quality changes of white shrimp

Hong-Bin Wang*

School of Marine Science and Technology, Huaihai Institute of Technology, 59 Cangwu Road, Xinpu 222005, China

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ABSTRACT

Dandelion polysaccharides (DPs) have antibacterial and antioxidant activities. In this study, investigated were the effects of the DPs on preservation of white shrimp (*Penaeus vannamei*) during refrigerated storage. Shrimp samples were untreated or soaked in the DPs solution, and then they were stored under refrigerated conditions. Samples were taken periodically and evaluated for total viable count, pH value, total volatile basic nitrogen, and overall acceptability score. Treatment of the DPs effectively retarded bacterial growth and pH increasing, reduced total volatile basic nitrogen, and increased overall acceptability score of white shrimp (*P. vannamei*) during refrigerated storage. The results show that the DPs treatment could prolong shelf life for up to 10 days.

1. Introduction

Shrimp is an important seafood with considerable nutritional and economic value in many countries worldwide [1]. It is a perishable product and it is important to extend its shelf life.

Several studies have been conducted to extend the shelf life of shrimp, especially by using natural extract or phenolic compounds [2–7]. Application of natural additives to maintain the quality of shrimps could be safer compared to synthetic additives [7].

Dandelion (*Taraxacum officinale*) is a perennial herb of the family *Asteraceae* (*Compositae* family) [8]. Dandelion polysaccharides (DPs) have antibacterial and antioxidant activities [9]. Therefore, it was of our interest to investigate the DPs on the retardation of quality changes of white shrimp (*Penaeus vannamei*) stored at refrigerated conditions during 10 days.

2. Methods and materials

2.1. Materials

Live white shrimps, with similar properties, were purchased from a local market, Xinpu, China. Dried dandelion leaves were purchased from a local pharmacy in Xinpu, China. Cellulase, with an enzymatic activity of 30,000 U/g, was purchased from Beijing Shengshi Jiaming Technology Development Co. Ltd. (Beijing, China). All other chemicals were of reagent grade.

2.2. Preparation of DPs

The DPs were prepared according to the method described by Wang [10]. Briefly, dandelions were dried in a hot air oven (JK-OOI-240A, China) at 45 °C until a constant weight was observed. The dried dandelions were pulverized, sifted through a 60 mesh sieve, extracted with organic solvents (light petroleum, acetone and methanol) in a Soxhlet apparatus, and then soaked in distilled water to yield a 1% (w/v) suspension. The pH of the suspension was adjusted to 4.51, and 4000 U/g of cellulase was added. The reactor was maintained in a thermostatic water bath at 54.87 °C for 46.11 min. The extract was filtered through a Whatman GF/A filter paper and concentrated to approximately 20% (w/v). The proteins were removed using the Sevag method, and the extract was precipitated by adding 3 volumes of absolute ethanol, followed by filtration using a Whatman GF/A filter paper, and freeze drying.

2.3. Dipping and refrigerated storage conditions of shrimps

Dipping solutions of the DPs were 1%, 2%, and 3%, respectively. The shrimps were shocked with crushed ice first and dipped into the three dipping solutions fully immersed for 5 min. Residual solutions on the shrimps were dripped off for 1 min, and the shrimps were kept at 4 °C until the excess of water was drained. Then these shrimps were placed on plastic-coated wire racks inside plastic containers at 4 °C for 10 days.

* Tel.: +86 518 85895427; fax: +86 518 85895428.
E-mail address: whbhhit@sina.com

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2.4. Analytical methods

2.4.1. DPs characterization

Ash, moisture, total sugar and protein contents of the samples were determined according to standard methods [11].

2.4.2. Microbiological analysis

For determining total viable count (TVC), minced white shrimp samples were homogenized with sterile phosphate-buffered saline solution to prepare sample suspensions. Pour-plate method using plate count agar was used to determine the total plate counts in samples. The inoculated agar plates were incubated at 30 °C for 48 h before counting the colonies [12].

2.4.3. pH measurement

The pH values were measured according to the method described by Duan, Cherian, and Zhao with a digital pH meter (Model number PHS-3C Digital Precision PH Meter, Leici, Shanghai, China) [13].

2.4.4. Total volatile basic nitrogen (TVB-N)

For determination of TVB-V, the shrimps were homogenized using a blender. A 10 g sample was washed into the distillation flask and 1 mg magnesium oxide was added with a drop or two of silicone antifoam solution. Samples were boiled and distilled into 10 mL of 0.1 N HCl solutions in a 500 mL conical flask with added Tashiro-indicator (Riedel-de Haen, Seelze, Germany). After distillation, the contents of conical flask were titrated with 0.1 N NaOH [14].

2.4.5. Color measurement

The color of shrimps was measured by using a CR-400 Minolta chromometer instrument. Color was determined in three zones (head, body, and tail) on the shrimp. Triplicate measurements were taken at each shell zone using CIE Lab L^*(lightness), a^* (redness) and b^* (yellowness) system.

2.4.6. Sensory evaluation

Sensory evaluation of shrimp samples was performed by a group of six trained people on each sampling day. Panelists were asked to evaluate overall acceptability of shrimp samples. A rating was assigned for the parameter on a 1-to-9 descriptive hedonic scale, with 9 as the highest-quality sample. A sample scored below 5 for a sensory attribute was considered unacceptable [1].

2.5. Statistical analysis

All data are presented as mean ± S.D. *t*-Test was used to compare the means of two groups of the rat study. Statistical significance at the 95% and 99% probability levels were set at $p < 0.05$ and $p < 0.01$, respectively. Microsoft Excel (Microsoft Corporation, USA) was used for statistical analysis.

3. Results and discussion

3.1. Characterization of DPs

The product samples contained 1.3% ash, 1.9% moisture, and 95.2% total sugar, respectively, and were water-soluble, which was consistent with the results of the previous study [10].

3.2. Effect of DPs on TVC in white shrimp during refrigerated storage

The antibacterial effect of DPs against bacteria in shrimp during storage is shown in Fig. 1. The initial TVC in shrimp was approximately 4.5 log CFU/g (not treatment group). The TVC for the control group significantly ($p < 0.05$) increased up to 6.3 CFU/g over 10 days of storage, while TVC for the treatment group only increased slightly. The TVC for the treatment group was lower than that for the control group during the entire storage.

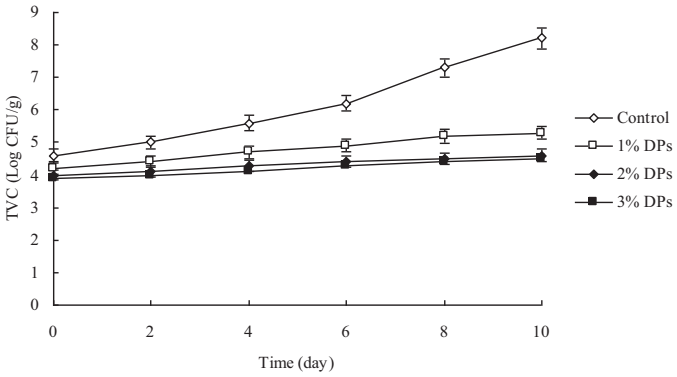

Fig. 1. Effect of dandelion polysaccharides (DPs) on the total viable count (TVC) of white shrimp (*Penaeus vannamei*) during refrigerated storage. Bars represent the standard deviation ($n = 3$).

3.3. Effect of DPs on pH in white shrimp during refrigerated storage

The pH of the fresh shrimps at the beginning of storage was measured as 7.26. The changes of pH of all the samples are presented in Fig. 2. The pH of all the groups decreased during the initial 2 days of storage. After then, the pH increased till the end of storage. It was reported that shrimp pH of 7.7 or less indicated prime quality, 7.70–7.95 showed poor but acceptable quality and 7.95 or greater represented unacceptable quality [15]. The pH for the control and 1% DPs treatment exceeded 7.7 after 6 and 10 days of storage, respectively, while that for 2% and 3% DPs treatments did not exceeded 7.7 at the end of 10 days of storage. The increased pH could be related to the formation of volatile amines from microbial activity and enzymatic ammonia production during refrigerated storage.

3.4. Effect of DPs on TVB-N content in white shrimp during refrigerated storage

TVB-N is an important indicator of chemical spoilage. The increase in TVB-N was due to the activities of spoilage bacteria and endogenous enzymes [16]. The changes in TVB-N values as

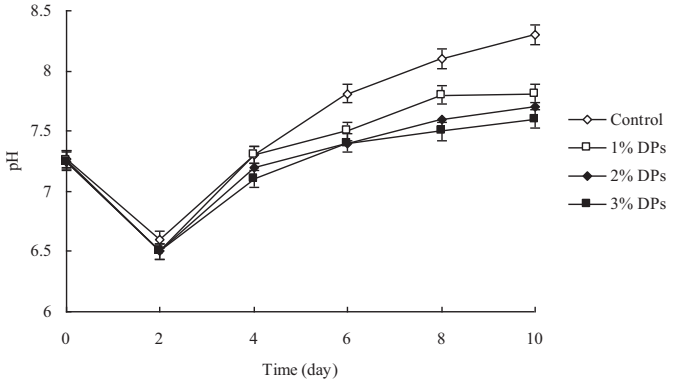

Fig. 2. Effect of dandelion polysaccharides (DPs) on pH in white shrimp (*Penaeus vannamei*) during partially refrigerated storage. Bars represent the standard deviation ($n = 3$).