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RESEARCH ARTICLE

Effectiveness of Peroxyacetic Acid as Disinfectant to Physico-chemical, Microbial and Organoleptic Characteristics of Fresh *Pangasius* Fillet during Chilling Storage

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Abstract

Pangasius fillet is a good source of amino acids, low residue levels of heavy metals and polychlorinated biphenyls, high amounts of saturated fatty acids, low amounts of polyunsaturated fatty acids, low cholesterol levels. However, it is highly perishable. During the processing of *Pangasius* fillets, washing could reduce the microbial loads on the fish fillets as much as possible. Objective of this study focused on the efficacy of different concentrations of peroxyacetic acid (PAA) to the firmness (N), peroxide value (meq/kg), total plate count (cfu/g), sensory score of fresh *Pangasius* fillet during 20 days of preservation at cooling temperature. Our results showed that 75ppm PAA was appropriate to maintain physico-chemical, microbial and sensory characteristics of fresh *Pangasius* fillet during storage.

Keywords: *Pangasius fillet, Peroxyacetic, Firmness, Peroxide value, Total plate count, Sensory score.*

Introduction

The intensive development has resulted in the rapid expansion of *Pangasius hypoththalmus* aquaculture in Vietnam [1]. Different *Pangasius* products marketed around the world such as portions, steaks, fillets and also added value products. Fresh, frozen and thawed fillets are the most popular forms sold in seafood supermarkets in US, EU countries [2]. Customers prefer to skinned and boneless frozen fillets [3].The processing of frozen *Pangasius* fillets including cutting of the gills, filleting, skinning, trimming, sorting, tumbling, cooling, packaging and freezing. The digestible protein of Pangasius fillet is rich in essential amino acids [4].

Moreover, it also contains high amouts od polyunsaturated fatty acids, which have beneficial health effects in the prevention of cardiovascular diseases [5]. Regarding to the shelf life of fishery products, rapid deterioration of fish is caused mainly by spoilage microorganisms leading to decreased shelf life and economic loss. The enzymatic and chemical reactions are often responsible for the initial loss of quality while microbial activity is responsible for subsequent spoilage [6, 7].

During filleting, endogenous bacteria from the raw material, processing environment, manual manipulation may contaminate the clean fish flesh [8, 9]. During processing, an intervention of washing step is used to reduce or eliminate the microbial loads on the food products as much as possible. Chemical sanitizers are usually implemented in the seafood processing industry against harmful bacteria on contact surfaces to improve food hygiene. Bacteria are the primary origin that has caused food-borne diseases and spoilage of products [10].

The major groups of the sanitizers are iodophors, quaternary ammonium compounds, peroxy compounds, chlorine compounds, acid-anionic, phenols, ozone and carboxylic acid. Quaternary ammonium compounds pose little toxicity or safety risks. They require a relatively long contact time and are often applied as foam. Among the chemical sanitizers used in food industry, chlorine and peroxyacetic acid are considered the most popular and traditional sanitizer [11, 12] Chlorine based sanitizers are popularly applied in food processing sector. Chlorination can dramaticaly infect aquatic life and form chlorinated hydrocarbons having carcinogenic and mutagenic characteristics [13]. Meanwhile peroxyacetic acid (PAA) decomposes rapidly, remains minimal residue and changes to relatively harmless naturally-occurring substances [14]. Peroxyacetic acid ($C_2H_4O_3$) is an aqueous mixture of acetic acid and hydrogen peroxide. It is emerging as better alternative to the chlorine sanitizers. Peroxyacetic acid disinfects by oxidizing of the outer cell membrane of vegetative bacterial cells, endospores, yeast and mold spores.

It works by focusing on the cell wall and cell membrane and oxidizing the H-S and S-S bonds in the cell's enzyme. Microbes are then unable to function and die [15]. It has been proven to be useful in removing biofilms. PAA has been considered as a powerful oxidant capable of producing water quality advantages comparable to those expected with ozone application [16]. Puposes of our study demonstrated the effectiveness of peroxyacetic acid as disinfectant to physico-chemical, microbial and organoleptic characteristics of fresh pangasius fillet during chilling storage.

Material and Method

Material

Pangasius fishes were collected from Dong Thap province, Vietnam. After collecting, they must be kept live and conveyed to laboratory by boat for experiments. The live fishes were then filleted and washed under tap water. Peroxyacetic acid (PAA) was supplied from Van Dai Phat Co. Ltd.

Researching Procedure

Fillets were divided into 5 groups (P0: non-treated with PAA; P1: treated with 25ppm PAA; P2: treated with 50 ppm PAA; P3: treated with 75 ppm PAA; P4: treated with 100 ppm PAA). All samples were kept in cooling store at temperature 4^{o}C for 20 days. In every 5 days interval, samples were analyzed the firmness (N), peroxide value (meq/kg), total plate count (cfu/g), sensory score.

Physico-chemical, Sensory and Statistical Analysis

Firmness (N) was evaluated by penetrometer. Peroxide value (meq/kg) was determined by procedure following Shon, J. and Chin, K.B. [17]. Total plate count (cfu/g) was quantified by 3M-Petrifilm. Sensory score was evaluated by a group of panelist using 9 point-Hedonic scale. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Firmness (N) of Raw Pangasius Fillet during 20 Days of Chilled Storage

Raw Pangasius fillets were treated by different concentration of PAA (P0: non-treated with PAA; P1: treated with 25ppm PAA; P2: treated with 50 ppm PAA; P3: treated with 75 ppm PAA; P4: treated with 100 ppm PAA). During 20 days of cool storage, quality attributes of these samples were evaluated. Our results were elaborated in Table 1. It's obviously seen that 75ppm PAA was adequate to maintain texture of fish fillet.

Table 1: Firmness (N) of of raw Pangasius fillet during 20 days of chilled storage

Samples	P0: Control	P1: 25 ppm	P2: 50 ppm	P3: 75 ppm	P4: 100 ppm
0 days	3.15±0.02^a	3.15±0.02^a	3.15±0.02^a	3.15±0.02^a	3.15±0.02^a
5 days	2.48±0.04^c	3.01±0.03^b	3.04±0.04^{ab}	3.11±0.02^a	3.14±0.00^a
15 days	2.03±0.02^c	2.82±0.01^b	2.91±0.02^{ab}	3.06±0.03^{ab}	3.12±0.02^a
20 days	1.49±0.01^d	2.11±0.00^c	2.83±0.01^b	3.01±0.01^{ab}	3.09±0.01^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

The soft texture can be explained by various bacterial species which affect the fish protein structure. They make the fish texture easy susceptible and fragile due to their action on tissues of the fish components consequently disrupting the cells and producing toxins additionally [18, 19].

Peroxide Value (meq/kg) of Raw Pangasius Fillet during 20 days of Chilled Storage

Oxidative rancidity can occur even in low-fat fishes, depending on the fatty acid composition. It can also occur during raw, refrigerated and frozen storage [20, 22].

PAA treatment has effected in retarding the production of primary lipid oxidative degradation. Fatty fish are highly sensitive to lipid oxidation during preservation. This is one of the most key reasons of spoilage in fish products which rendered by formation of poisonous components and gradual limited nutrition value [23]. Malondialdehyde (MDA) is a secondary product from lipid oxidation [24]. This leads to a greater risk of dyslipidemia, insulin resistance and high blood pressure, which are considered important components in the pathogenesis of the metabolic syndrome, mainly in obese adolescents [25]. Low temperatures don't prevent lipid oxidation due to the action of endogenous lipoxygenases even under frozen conditions [26].

Table 2: Peroxide value (meq/kg) of raw Pangasius fillet during 20 days of chilled storage

Samples	P0: control	P1: 25 ppm	P2: 50 ppm	P3: 75ppm	P4: 100ppm
0 days	0.04±0.00^{a}	0.04±0.00^{a}	0.04±0.00^{a}	0.04±0.00^{a}	0.04±0.00^{a}
5 days	0.51±0.02^{a}	0.31±0.02^{ab}	0.25±0.02^{b}	0.11±0.03^{bc}	0.09±0.03^{c}
15 days	0.94±0.01^{a}	0.59±0.01^{b}	0.37±0.01^{bc}	0.15±0.02^{c}	0.12±0.01^{c}
20 days	1.39±0.00^{a}	0.63±0.03^{b}	0.55±0.02^{bc}	0.19±0.04^{c}	0.17±0.00^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Total Plate Count (cfu/g) of Raw Pangasius Fillet during 20 days of Chilled Storage

Peroxyacetic acid propably reduced the pH of fish which is considered as an adverse effect for microorganism proliferation [27, 28]. PAA was evaluated at 10, 20, 50 and 150 ppm at contact times of 10, 20 and 240s on *Pangasius* fillet. Washing with PAA wash water resulted in a reduction of *Escherichia coli* on Pangasius fish which ranged from 0.4-1.4 log CFU/g [29]. Peroxyacetic acid was efficient to kill sessile *L. monocytogenes* populations, while sodium hypochlorite was only partially effective to kill attached *L. monocytogenes* [30].

Table 3: Total plate count (10^4 cfu/g) of raw Pangasius fillet during 20 days of chilled storage

Samples	P0: control	P1: 25 ppm	P2: 50 ppm	P3: 75ppm	P4: 100ppm
0 days	4.18±0.04^{a}	3.25±0.02^{b}	2.16±0.00^{c}	1.26±0.03^{d}	0.04±0.03^{e}
5 days	5.94±0.01^{a}	3.49±0.00^{b}	2.57±0.02^{c}	1.54±0.02^{d}	0.16±0.02^{e}
15 days	7.16±0.02^{a}	4.03±0.04^{b}	2.96±0.01^{c}	1.77±0.03^{d}	0.73±0.01^{e}
20 days	8.95±0.01^{a}	4.27±0.01^{b}	3.12±0.00^{c}	2.15±0.01^{d}	0.91±0.03^{e}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Sensory Score of Raw Pangasius Fillet during 20 Days of Chilled Storage

Pangasius meat has high nutritive qualities and excellent sensory properties. Tender flesh, sweet taste; absence of fishy odour and spines, delicate flavour and firm texture when cooked are the attributes that favour consumer preference for *Pangasius* [31]. This finding thoroughly revealed that fillet samples treated with 75ppm PAA could maintain their sensory characteristics in effective manner.

Table 4: Sensory score of raw Pangasius fillet during 20 days of chilled storage

Samples	P0: control	P1: 25 ppm	P2: 50 ppm	P3: 75ppm	P4: 100ppm
0 days	8.23±0.03^{a}	8.23±0.03^{a}	8.23±0.03^{a}	8.23±0.03^{a}	8.23±0.03^{a}
5 days	7.08±0.02^{c}	7.68±0.00^{bc}	7.95±0.01^{b}	8.04±0.02^{ab}	8.11±0.01^{a}
15 days	6.12±0.01^{c}	7.21±0.01^{b}	7.67±0.00^{ab}	7.83±0.03^{ab}	7.92±0.00^{a}
20 days	5.37±0.04^{d}	7.04±0.03^{c}	7.43±0.00^{b}	7.62±0.01^{ab}	7.81±0.04^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Conclusion

The good nutritional quality of *Pangasius* fillet is reflected in its proximate composition. While washing with peroxyacetic acid is important in respect of fillet sanitation, it also plays a vital role in maintaining the microbial quality of the washing water. We have successfully identified the efficacy of PAA treatment to physico-chemical, microbial and organoleptic characteristics of fresh pangasius fillet during chilling preservation.

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