

RESEARCH ARTICLE

Chemical Quality Attributes of Refrigerated Mudskipper (*Pseudapocryptes elongatus*) under Vacuum and Modified Atmosphere Packaging

Minh Phuoc Nguyen

Faculty of Biotechnology, Ho Chi Minh City Open University, Ho Chi Minh City, Vietnam.

Abstract

Modified atmosphere and vacuum packaging were believed as emerging innovative technologies for food preservation. They changed food environment by withdrawing O₂ or replacing the atmosphere inside the package by a mixture of gases. Mudskipper (*Pseudapocryptes elongatus*) has huge potential for coastal aquaculture development and is an alternative to shrimp farming in the Mekong Delta. Mudskipper fishes were refrigerated and stored at 4°C for 21 days under vacuum and modified atmosphere packaging. These samples were analyzed the changes of major chemical parameters such as total volatile base (TVB-N, mg TVB/g), trimethylamine (TMA, mg TMA/g), thiobarbituric acid-reactive substances (TBARS, mg malondialdehyde/kg) during preservation. Results revealed that vacuum packaging could maintain chemical quality attributes for 15 days; meanwhile modified atmosphere packaging could extend the chemical quality indicators for 20 days. It's obviously presumed that modified atmosphere packaging should be an alternative technology for seafood storage.

Keywords: Mudskipper, Vacuum, Modified atmosphere packaging, Total volatile base, Trimethylamine, thiobarbituric acid-reactive substances.

Introduction

Mudskipper fishes (*Pseudapocryptes elongatus*) have been widely distributed in the brackish water in intensive or semi-intensive farms. They are euryhaline, air-breathing and amphibious species [1]. It is remarkably euryhaline and able to survive in high salinities, feeding mainly on pennate diatoms [2]. They can absorb and refresh different pollutants released into the coastal environment by industrial, agricultural, domestic and transportation activities [3]. They are considered as potential bio-indicator in environmental monitoring and assessments [4].

Their muscle can have high nutritional components such as the essential amino acids, vitamins and minerals [5, 6]. This species is believed as an alternative species to shrimp farming in rainy season. Aquaculture of *P. elongatus* in the Soc Trang province (Vietnam) has developed rapidly owing to high demand and high commercial value [7, 8]. Fish in general and mudskipper fish in particular were highly perishable owing to action of autolysis and hydrolytic

enzymes [9]. Fish was affected by bacteriological putrefaction; the quality loss was attended by a decline in commercial value [10]. Total volatile base (TVB-N), trimethylamine (TMA), thiobarbituric acid-reactive substances (TBARS) were key indicators for spoilage estimation as well as for fish freshness. They were originated from degradation of protein and non-protein nitrogen constituents which were mainly created by metabolism of fish spoilage bacteria and endogenous enzymes [11].

Vacuum packaging was utilized for long-term preservation and shelf-life extension of fish. Growth of aerobic spoilage bacteria would be prevented under low oxygen concentration [12, 13]. Modified atmosphere packaging changed the gaseous environment and keep products in gas-barrier films [14]. Elevated CO₂ levels retarded the growth of spoilage and pathogenic bacteria due to an extension in the lag phase and their reduced growth rate in the logarithmic phase [15, 16]. Modified atmosphere packaging (MAP) combined with low storage temperatures was

an effective strategy to prolong shelf life fishery products [17, 21]. Our study monitored the changes of some chemical attributes of chilled mudskipper fishes during storage under vacuum and modified atmosphere packaging. In 5 day-intervals, they were periodically sampled to examine total volatile base (TVB-N, mg TVB/g), trimethylamine (TMA, mg TMA/g), thiobarbituric acid-reactive substances (TBARS, mg malondialdehyde/kg) during 25 days of storage.

Materials and Method

Sample

Mudskipper fishes were collected from Vinh Chau district, Soc Trang province, Vietnam. They must be reared following Viet GAP without antibiotic residue to ensure food safety. After collecting, they must be kept in ice chest below 4°C and quickly transferred to laboratory for experiments. Chemical substances such as 2-thiobarbituric acid, malondialdehyde tetrabutylammonium, Trichloroacetic acid formaldehyde, K₂CO₃, HCl were all analytical grade originated from Sigma Chemical Co., Riedel-de Haen, Fluka.

Researching Method

Mudskipper fishes were washed and sanitized under washing tank having 25 ppm peracetic acid with air bubble blowing to remove foreign matters. They were chilled at 4°C and packed either in vacuum or modified atmosphere packing (45% CO₂, 5% O₂, 50% N₂). These samples were stored for 25 days to monitor the changes of chemical quality indicators by analyzing the total volatile base (TVB-N, mg TVB/g), trimethylamine (TMA, mg TMA/g), thiobarbituric acid-reactive substances (TBARS, mg malondialdehyde/kg) in 5 day-interval. The total volatile base (TVB-N, mg TVB/g) and trimethylamine (TMA, mg TMA/g) were evaluated by FAO [22]. A Thiobarbituric acid-reactive substance (TBARS, mg malondialdehyde/kg) was

measured by 1, 1, 3, 3-tetraethoxypropane [23].

Statistical Analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Changes of the Total Volatile Base (TVB-N) during Storage

A total volatile base (TVB-N) was used as quality indicator of bacteria spoilage and to estimate the remaining quality and shelf-life of sea foods [24]. It was toxic biogenic amines formed in fish during storage [25]. In our research, changes of TVB contents in the chilled mudskipper fishes stored under different conditions were mentioned in table 1. It's obviously noticed that vacuum packaging had ability to maintain TVB-N values until 15 days; meanwhile the modified atmosphere packaging (45% CO₂, 5% O₂, 50% N₂) could prolong the TVB-N values for 20 days.

In another report, TVB in sea bass (*Dicentrarchus labrax*) preserved by modified atmosphere packaging (60% CO₂) was higher than those of samples stored at ambient condition [26]. A gas mixture including of 90% CO₂ and 10% N₂ was appropriate for limitation of TVB-N to preserve fresh trout and carp cuts [11]. Fletcher et al [27]. Reported that TVB-N increased over time regardless of fish: CO₂ ratio. Özogul et al [28]. Mentioned that TVB-N correlated strongly with total viable count. A strong correlation between quality decomposition of MAP seafood and accelerated TVB-N was proven [29].

Table 1: Changes of the total volatile base (TVB-N, mg TVB/g) during storage

Packaging	5 days	10 days	15 days	20 days	25 days
Vacuum	0.08±0.03 ^d	0.17±0.00 ^c	0.29±0.02 ^{bc}	0.41±0.01 ^b	0.74±0.02 ^a
Modified atmosphere	0.06±0.00 ^c	0.14±0.03 ^{bc}	0.23±0.03 ^b	0.30±0.01 ^{ab}	0.38±0.03 ^a

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

Changes of trimethylamine (TMA) during Storage

TMA was normally generated from trimethylamine oxide (TMAO), possibly reduced by endogenous bacteria enzymes.

TMA was related to the smell of the decayed seafood and was considered as an indicator of bacterial decomposition [24]. In our research, changes of TMA contents in the chilled mudskipper fishes stored under different conditions were mentioned in Table 2. It's clearly noticed that vacuum packaging had ability to maintain TMA values until 15 days; meanwhile the modified atmosphere packaging (45% CO₂, 5% O₂, 50% N₂) could prolong the TMA values for 20 days. The decomposition of TMAO into TMA derived

from Gram-negative bacteria, the low TMA emission in the preserved samples by modified atmosphere packaging was owing to prevention of aerobic, including TMA-producing bacteria by CO₂-enriched air [30]. In another report, TMA was limited if pearlspot (*Etroplus suratensis* Bloch) were stored at 60% CO₂ [31]. Emborg et al [32]. Demonstrated that the formation of biogenic amines was limited in fresh MAP salmon.

Table 2: Changes of the trimethylamine (TMA, mg TMA/g) during storage

Packaging	5 days	10 days	15 days	20 days	25 days
Vacuum	0.03±0.03 ^d	0.11±0.01 ^{cd}	0.18±0.00 ^c	0.37±0.02 ^b	0.46±0.01 ^a
Modified atmosphere	0.02±0.01 ^c	0.07±0.00 ^{bc}	0.11±0.02 ^b	0.15±0.00 ^{ab}	0.19±0.03 ^a

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

Changes of thiobarbituric Acid-reactive Substances (TBARS) during Storage

Owing to high percentage of polyunsaturated fatty acids contained in fish flesh, they easily caused oxidative reaction [33]. In our research, changes of TBARS contents in the chilled mudskipper fishes stored under different conditions were mentioned in table

3. It's obviously noticed that vacuum packaging had ability to maintain TBARS values until 15 days; meanwhile the modified atmosphere packaging (45% CO₂, 5% O₂, 50% N₂) could prolong the TBARS values for 20 days. Modified atmosphere packaging limited microbial proliferation and slow down chemical changes improving the shelf life of rainbow trout fillets at least twice [34].

Table 3: Changes of thiobarbituric acid-reactive substances (TBARS, mg malondialdehyde/kg) during storage

Packaging	5 days	10 days	15 days	20 days	25 days
Vacuum	9.37±0.02 ^e	17.82±0.00 ^d	24.53±0.03 ^c	28.66±0.01 ^b	34.79±0.02 ^a
Modified atmosphere	7.42±0.01 ^c	11.48±0.02 ^{bc}	15.20±0.00 ^b	17.29±0.02 ^{ab}	19.54±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 ($\alpha = 5\%$)

Conclusion

Mudskipper fish (*P. elongatus*) aquaculture has developed rapidly to supply the high demand of domestic consumers because there's more awareness of its nutritional benefits and of the health concerns associated with other meat products. The shelf life of

fresh refrigerated fish can be prolonged by vacuum packaging or modified atmosphere packaging. The oxygen elimination decreased lipid oxidation, the rancidity accumulation, proliferation of aerobic microorganisms. Modified atmosphere packaging should be exploited as an alternative for controlling the formation of biogenic amines in stored fish.

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