QUALITY ENHANCEMENT AND SHELF-LIFE EXTENSION OF RED SHRIMP (ARISTEUS ANTENNATUS) DURING ICED STORAGE
Moawad, R. K.
Food Technology Dept., National Research Centre, Dokki, Cairo, Egypt.

ABSTRACT

Shrimp blackspot is a serious problem in shrimp processing. Melanosis occurs on most shrimp species and decreases the commercial value and consumer acceptance of the shrimp product. Therefore, our objective was to evaluate the effect of sodium metabisulphite dipping treatment (0-1.25% for one minute) on melanosis inhibition, shelf-life and quality attributes of red marine shrimp, harvested along the Alexandria, coast Egypt. After dipping, draining and packaging, shrimp samples were stored in ice for 8 days at 4-5°C. The results indicated that blackspot developed rapidly in control shrimp approaching unacceptable after 4 days storage in ice. The short shelf-life of control samples reflects high values of biochemical indices, microbial load and off-odor scores. On the other hand, utilizing the current recommended dip procedure of 1.25% Na2S2O5 for one minute, effectively retarded melanosis development, reduced the formation of nitrogenous compounds (TMA-N, TVB-N), slowed down the increase in TBC, pH, TBARS and off-odor scores associated with spoilage, and prolonged the shelf-life to seven days in iced storage. A one minute exposure in 1.25% sulfite solution is sufficient to delay blackening defects and maintain a high quality shrimp product.

Keywords: Shrimp blackspot, Melanosis, Shelf-life – Sensory quality.

INTRODUCTION

Shrimp are one of the most popular sea foods consumed in Egypt; they are valuable sources of high quality proteins, vitamins and minerals (King et al., 1990). In addition, shrimp contain very low lipid levels (Bragagnolo and Rodriguez-Amaya, 2001), and are rich in n-3 polyunsaturated fatty acids (Rosa and Nunes, 2003), which are considered anticholesterolomic (Krzynewek and Panunzio, 1989). On the other hand, about two-thirds of shrimp sterols are non-cholesterol sterols (Feeley et al., 1972). Therefore, the use of shrimp in diets is considered valuable, especially, if they replace foods of animal origin that are high in saturated fats.

Most consumer prefer fresh or "fresh-like" seafood products. However, shrimp muscle is one of the most rapidly deteriorating food products with limited shelf-life (Huidoboro et al., 2002). The harvest must be cooled down to the temperature of melting ice as quickly as possible before processing into other shrimp products therefore, most of the captures are marketed in boxes with ice. (Rahman et al., 2001).

Blackspot and microbial growth in fresh shrimp stored in ice are the main factors associated with quality deterioration, spoilage and economic loss (Zhuang et al., 1995). Psychrotrophic bacteria are the major group of microorganisms responsible for spoilage of fresh seafoods (Gram and Huss,
Shrimp contain a lot of non-protein nitrogenous compounds, easily metabolized by microorganisms (Cobb et al., 1976). One way to retard microbial growth is through antimicrobial agents. Sodium metabisulphite has been considered as antimicrobial food additives (Lueck, 1980). It (Na_2S_2O_5) has a reduction effect on total bacterial and H_2S producing bacteria growth in shrimp. (Pyle and Koburger, 1984). Thus, there could be advantages to treating fresh shrimp with such food additive before processing into other shrimp products (Cadun et al., 2005).

Discoloration due to melanosis is a serious problem in shrimp processing (Gokoglu, 2004). Shrimp black spot, an objectionable surface discoloration, occurs on most shrimp species and decreases the commercial value and consumer acceptance of the shrimp product (Montero et al., 2001). Melanosis is caused by the endogenous shrimp enzyme polyphenol oxidase (PPO), which oxidizes phenols to quinones, followed by non-enzymatic polymerization of the quinones to pigment of high molecular weight and very dark or black coloring. The enzyme PPO remains active throughout post-harvest processing unless the shrimp are frozen or cooked (McEvily et al., 1991). Melanosis defect initially occurs in appearance but increasingly spoils the flesh and therefore quality is lost (Yamagata and Low, 1995). Industry is therefore vitally interested in factors controlling these problems.

A variety of compounds have been used to act as inhibitors for melanosis. The most widely used to these are sulphites, which interfere in the polymerization of the quinones, combining irreversibly with them, and forming colorless compounds (Embs and Markakis, 1965). There are several alternatives to sulphites, but according to Smith (1980) sulphite is the cheapest and easiest quite and effective method to prevent the occurrence of melanosis. In this respect, Chen et al., (1991) reported that, the number of chemicals that can actually be used in food systems to inhibit melanosis is limited by off-flavors, off-odors, toxicity, and economic feasibility. Recently, Gokoglu (2004) came to the conclusion that sodium metabisulphite was very effective than organic acids in preventing melanosis.

However, six types of sulphites are commonly used, of those sodium metabisulphite is the most used in the shrimp industry (Slattery et al., 1990). Current regulations prescribe a dip treatment of 1 minute exposure in 1.25% sodium bisulphate solution with an allowable sulfitie residual of 100 ppm, there is no evident risk for the general population when sulphites are used at permitted amounts (Federal Register, 1982, 1995). Due to the low residual sulfitie (SO_2) on the shrimp meat (29 ppm), the taste, texture, appearance and normal development of pink color upon cooking are unaffected by dipping in Na_2S_2O_5 solution for one minute (Slattery et al., 1990; Yamagata and Low, 1995).

Quality changes in shrimp during iced storage occur due to microbial activity and tissue enzymes (Cobb et al., 1976). The most commonly used methods for assessing spoilage of seafoods are pH, trimethylamine nitrogen (TMA-N), total volatile basic nitrogen (TVB-N) and lipid deterioration (TBARS), along with sensory and microbiological analyses (Cheuk et al., 1979, Ruiz-Capillas and Moral, 2001).
We have therefore thought it to be of scientific and practical interest to study the effect of sodium metabisulphite dipping treatment (1.25% for 1 minute) on melanosis inhibition and shelf-life of marine red shrimp stored in ice for 8 days at 4-5°C. Sensory odor inspection, microbial analysis and biochemical indices of shrimp samples under investigation were included and compared with control samples (dipped in distilled water for 1 minute). Proximate composition and energy value of raw fresh shrimp were also monitored.

MATERIALS AND METHODS

Shrimp source:
Live marine red shrimp (Aristeus antennatus) were purchased directly from fishing boats in Abi-kier, Alexandria, Egypt in December, 2004. Shrimp were killed immediately in crushed ice, then transferred to the laboratory within 3 hours. Heads on, shells-on whole shrimp were used to represent the most problematic product form. Shrimp were divided into 2 groups, each 2kg (72 pieces), and kept in crushed ice until treatment.

Samples treatment:
One group was dipped in a 1.25% solution of sodium metabisulphite (Na₂S₂O₅) for 1 minute with moderate agitation, at a ratio of approximately 300 grams shrimp per 1 liter solution (Otwell and McEvily 1991). The second group was dipped in 0% Na₂S₂O₅ (distilled water) for 1 minute. The dipping solutions were kept in an ice bath to maintain a temperature close to 0°C to avoid temperature differentials between the shrimp and solutions (Zhuang et al., 1996). Following draining at ambient temperature (20°C) for 3 minutes the shrimp were randomly packed into polyethylene bags, three pieces of whole shrimp / sample and stored in boxes containing crushed ice for 8 days. The samples were re-iced as necessary during storage. All boxes were housed in a refrigerator at 4-5°C to slow ice melting.

Analytical Methods:
For each sampling day, three samples were used / treatment. Sensory assessment (Odor score and extent of melanosis / blackening) were performed daily on the raw whole shrimp. Every other day, biochemical indices and microbiological analysis were evaluated on finely chopped and well mixed shrimp muscles after peeling and deveining.

Proximate analysis and energy value:
Moisture, protein, fat and ash contents of raw fresh shrimp samples were measured following the procedures proposed by AOAC (1995). The percentage results were the main value of two replicates. The energy value was calculated as mentioned in Rosa and Nunes (2003).

Biochemical indices:
P pH values were measured using Hanna, HI 9021 pH meter as described by Ruiz-Capillas and Moral (2001). Thiobarbituric acid reactive substances (TBARS) as mg malonaldehyde (MA)/kg flesh according to
Moawad, R. K.

Vyncke (1975). Total volatile basic nitrogen (TVB-N) as mgN/100g flesh as mentioned by Pearson (1981). Trimethylamine nitrogen (TMA-N) as mgN/100g flesh according to the method recommended by the AMC (1979). All analyses were performed at least in duplicate.

Microbiological analysis:
Total bacteria counts (TBCs) of the representative samples were determined according to the method described by Harrigan and Margaret (1996). The bacterial counts were expressed as mean log_{10} CFU/g sample.

Sensory Evaluation:
(1) Melanosis development:
Melanosis formation was evaluated according to the melanosis scale (Table 1) published by Otweel and Marshall (1986). Raw shrimp samples from each treatment were evaluated daily for degree of melanosis by 10-member panel. A score of 0 indicates high quality product and a score of 8 or greater represent severe melanosis defects approaching unacceptable.

<table>
<thead>
<tr>
<th>Table 1. Scale for melanosis evaluation</th>
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<tbody>
<tr>
<td><strong>Melanosis Scores</strong></td>
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<tr>
<td>----------------------</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>4</td>
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<td>6</td>
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<tr>
<td>8</td>
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<tr>
<td>10</td>
</tr>
</tbody>
</table>

2) Odor changes:
Odor inspection of the whole raw shrimp either control or treated by sodium metabisulphite was performed daily by 10-member panel according to the method recommended by Nielsen (1995). Odor characteristic of the shrimp was scored on a scale of 0-10, with 10 representing seaweedy fresh marine odor and 0 distinct putrefied shrimp odor and lots scoring less than 4 were rejected.

**RESULTS AND DISCUSSION**

Proximate composition and energy value:
It is well recognized that uncontrolled variables, such as the geographical location of shellfish, season of the year, sex, feeding habits and reproductive status affect the nutrient composition of shrimp, especially marine species (King et al., 1999).

Data on moisture, protein, fat and ash contents, expressed as grams (g) per 100g edible portion, of the raw marine red shrimp are presented in Table 2. The proximate analyses are within the normal limits for the species and season and are in agreement with those found in the shellfish literature (King et al., 1990; Bragagnolo and Rodriguez-Amaya, 2001; Rosa and Nunes, 2003).
Table 2 also reveals that shrimp are characterized by a high protein (21.7%) and ash (2.1%) contents and very low fat content (0.43%). Added to these merits is the low energy value based on protein and fat contents of raw red marine shrimp. (96.54 K calorie/100g = 403.92 kj/100g), the moisture / protein ratio (3.41) also reflect good quality of shrimp meat (Pearson, 1981). These results confirmed the findings obtained by Huidobro et al., (2002); Rosa and Nunes (2003); Cadun et al., (2005). Based on proximate analyses and energy value of red marine shrimp (Table 2), consumption of shrimp is therefore being encouraged.

Table 2: Proximate composition and energy value of raw fresh marine red shrimp (% wet weight basis).

<table>
<thead>
<tr>
<th>Constituents</th>
<th>On fresh wet basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %</td>
<td>74.05</td>
</tr>
<tr>
<td>Protein %</td>
<td>21.7</td>
</tr>
<tr>
<td>Fat %</td>
<td>0.43</td>
</tr>
<tr>
<td>Ash %</td>
<td>2.10</td>
</tr>
<tr>
<td>Moisture/ Protein ratio</td>
<td>3.41</td>
</tr>
<tr>
<td>Caloric value*</td>
<td></td>
</tr>
<tr>
<td>K calorie /100g</td>
<td>96.54</td>
</tr>
<tr>
<td>KJ / 100g</td>
<td>403.92</td>
</tr>
</tbody>
</table>

*Caloric value = g. protein x 4.27 + g. fat x 9.02 (1 K calorie = 4.184 K.J)

Quality changes during iced storage:

pH Changes:

pH values of shrimp samples as affected by sulphite dipping treatment and iced storage for 8 days are illustrated in Fig.1, from which it is apparent that the initial pH value of control shrimp was 6.72, while treated shrimp exhibit slightly higher pH value (6.78). From the same results illustrated in Fig 1, it is clear that, pH values for control red shrimp stored in ice increased progressively throughout the experiment and reached figures of 6.91, 7.23, 7.48 and 7.80 after 2, 4, 6 and 8 days, respectively. However, increases in pH are related to the accumulation of basic substances, such as ammonia and trimethylamine (TMA) produced by microbial development in shrimp muscle (Chang et al., 1983). Fig 1 also reveals that sulphite treated shrimp samples showed lower pH values throughout the experiment reached figure of 7.30 after 8 days of iced storage. The lower pH values for treated samples could be explained in the basis of antimicrobial property of sodium metabisulphite (Lueck, 1980).

In this respect, Huidobro et al., (2002) reported that the initial pH value of shrimp muscle was 6.93, thereafter it reached 7.29 after 4 days of iced storage. A pH of 7.4 for zero-day of storage was reported by Flores and Crawford. (1973). They also mentioned a pH of 8.4 after 8 days of iced storage. Rahaman et al., (2001) came to the conclusion that pH value of brackish water prawn increased from 6.63 to 7.28 during 10 days of iced storage. Recently, Gokoglu, (2004) reported that the initial pH value of shrimp muscle was 7.1 and reached 7.5, 7.7 and 7.95 after 2.4 and 6 days of refrigerated storage at 4°C.
The pH of shrimp and prawn has been suggested as a good index of freshness (Cadun et al., 2005). It was reported that pH of shrimp muscles increased with time and temperature (Shamshad and Co-Workers, 1990), and they noted a relationship between pH and acceptability. On the basis of sensory evaluation the pH value above 7.3 was found unacceptable for consumption or spoiled (Rahaman et al., 2001). On the other hand, Cheng and Lain, (1979) reported that pH 7.8 was a critical margin for acceptability. According to these criteria, our shrimp samples treated with sodium metabisulphite were of good quality throughout the storage, whereas the control samples were of good quality up to 4 days (Fig.1).

![Graph showing pH changes over days](image)

**Fig. 1:** Changes in pH values of control and Na$_2$S$_2$O$_5$- treated red shrimp during ice storage.

**Trimethylamine nitrogen (TMA-N) changes:**

Crustaceans contain considerable trimethylamine oxide (TMAO), which is broken down to trimethylamine (TMA) by psychotropic bacterial enzymes (Yamagata and Low, 1995). Changes of TMA-N values of control and Na$_2$S$_2$O$_5$- treated ice- stored red shrimp were compared (Fig.2). The TMA-N of control shrimp increased from 0.45 mg/100g on 0-day to 1.89, 4.35, 6.13 and 8.24 mgN/100g on day 2, 4, 6 and 8 of ice storage; respectively. Similar trend of changes in TMA-N of control shrimp was observed by Gokoglu (2004), who reported that TMA-N of control shrimp increased from 0.05 to 9.1 mgN/100g during 6 days of refrigerated storage at 4°C.

6100
Fig. 2: Changes in TMA-N (mgN/100g) values of control and Na$_2$S$_2$O$_5$-treated red shrimp during ice storage.

Fig. 2 also reveals that, for Na$_2$S$_2$O$_5$-treated shrimp, the TMA-N values of the 0-day, 2, 4, 6 and 8 days were 0.43, 1.17, 2.67, 4.00 and 5.76 mgN/100g, respectively. However, the lower TMA-N values of sulphite-treated shrimp could be due to the antibacterial effect of Na$_2$S$_2$O$_5$ (Pyle and Koburger, 1984). The present study confirmed the findings of Yamagat and Low (1995), who reported that the TMA-N levels of control shrimp were higher than those of the sulphite treated shrimp under the same conditions. In this respect, Huidobro et al., (2002) pointed out that TMA-N levels increased from 0.47 mgN/100 g after 1 day to 2.91 mgN/100 g after 4 days of ice-stored shrimp pre-treated with sulphite.

TMA-N is well documented as a product of bacterial spoilage (Gram and Huss, 1996), a level of 5mgN/100 is the limit of acceptability of shrimp (Cobb et al., 1976; Gokoglu, 2004). Consequently control shrimp samples under investigation were of acceptable quality up to 4 days as compared to 7-8 days for sulphite-treated shrimp (Fig.2). This was also seen in the pH study (Fig.1).

Total volatile basic nitrogen (TVB-N) changes:

TVB-N production is the combined result of tissue enzymes and microbial activity (Cheuk et al., 1979). Changes in TVB-N of control and treated shrimp samples during iced storage are shown in Fig.3, from which it is apparent that the initial average TVBN value for control sample was 17.4 mgN/100g flesh. TVB-N level detected in red shrimp samples are close to others referred in fresh shrimp samples (Huidobro et al., 2002; Gokoglu, 2004). At the beginning of iced storage, TVB-N showed slightly higher value in control samples than sulphite-treated samples.
Fig. 3 also reveals that during iced storage TVB-N value of all samples gradually increased with a higher rate in control shrimp than in sulphite-treated shrimp. Similar trend of changes was obtained by Gokoglu (2004), who reported that TVBN value increased from 18.29 mg/100g to more than 30 mg/100g after 4 days of refrigerated storage. Also, Yamagata and Low (1995), pointed out that control banana shrimp showed higher TVB-N values than sulphite - treated samples during 8 days of iced-storage. Rahaman et al (2001) came to the conclusion that TVB-N of brackish water prawn increased from 5.88 mg/100g to 32.76 mg/100g after 10 days of iced storage.

![Graph](image)

**Fig. 3:** Changes in TVB-N(mgN/100g) values of control and Na$_2$S$_2$O$_5$-treated red shrimp during ice storage.

Fig. 3 showed differences levels of TVB-N according to storage time and sulphite treatment. However, a level of 30 mgN/100g has been considered the upper limit above which fishery products are considered unfit for human consumption (Cobb *et al.*, 1976; Connell, 1995). As shown in fig. 3 control shrimp kept in ice were acceptable for 4 days compared to 8 days for treated samples. The general lower pH, TMA-N and TVB-N values in treated samples as compared to control samples, indicated that Na$_2$S$_2$O$_5$ treatment slowed spoilage in red shrimp samples. These results confirmed the findings reported by Yamagata and Low (1995) for banana shrimp treated with bisulphate and stored in ice for 8 days.

Thiobarbituric acid reactive substances (TBARS) changes:

TBARS analysis is an important quality index, indicating fat oxidation. The TBARS values of red shrimp samples as affected by sulphite treatment and iced-storage for 8 days are shown in Fig. 4. From which it is apparent that, the initial TBARS for control and treated shrimp were 0.46 and 0.42 mg MA/Kg; respectively. These values are in line with those obtained by Cadun
et al., (2005). TBARS values of both samples gradually increased during iced storage reached figures of 1.08, 1.84, 2.34 and 3.7 mg MA/Kg in control samples after 2, 4, 6 and 8 days; respectively. On the other hand, treated shrimp exhibit lower values of TBARS being 0.78, 1.23, 1.90 and 2.40 under the same conditions; respectively. Sodium metabisulphite from its multi functions properties inhibits shrimp pigments from oxidation and consequently reduces TBARS values (Fig.4).

Concerning TBARS of shrimp samples, it is worth mentioning that, fish and fish products of good quality will have TBARS values less than 2 mg MA/kg, while consumption limits should be less than 5 mg MA/Kg (Bonnel, 1994; ES. 2005). However, shrimp samples well below the acceptability limits. Treated samples were of good quality up to seven days, whereas control samples exhibit good quality up to 4 days (Fig.4). Generally, the lower TBARS values in all samples (Fig.4) is related to low fat content of shrimp samples (Table 2). The results of TBARS confirmed the findings of Rahaman et al., (2001) who reported that shrimp samples exhibit acceptable peroxide values during 10 days of iced-storage.

Fig. 4: Changes in TBARS mg MA /Kg flesh of control and Na₂S₂O₅-treated red shrimp during ice storage.

Bacterial Analysis:
Total bacteria counts (TBC) in control and sulphite – treated shrimp sample are presented in Fig.5. the results indicated that initial counts of TBC in raw fresh control red shrimp was 4.13 log CFUg⁻¹. The lower initial value of TBC showing that a correct handling was performed after catching and that products were microbiologically of high quality. Counts of TBC, around 4.5-5.24 log CFUg⁻¹, in shrimp stored at O°C on the day of catch have been reported (Rahman et al., 2001; Cadun et al., 2005). In relation to this, Chang et al., (1983) refer that shrimp initially presenting 10⁵ CFUg⁻¹ and 18mg TVBN/100g are of good but not of prime quality.
Fig. 5 also demonstrates that microbial load decreased to 3.62 log CFUg\(^{-1}\) just after the shrimp were dipped in 1.25% Na\(_2\)S\(_2\)O\(_5\) for one minute. In this respect, Pyle and Koburger (1984) reported that microbial numbers were reduced immediately by as much as 50% after dipping shrimp in a sodium bisulphate solution. Huidobro et al (2002) also reported that the initial TBC of raw fresh shrimp sample pre-treated with sulphite was 2.7 log CFUg\(^{-1}\). Sodium metabisulphite has been considered as an antimicrobial food additives (Lueck, 1980).

![Graph showing TBC log CFUg\(^{-1}\) over days for control and treated shrimp](image)

**Fig. 5: Changes in TBC log CFUg\(^{-1}\) of control and Na\(_2\)S\(_2\)O\(_5\)-treated red shrimp during ice storage.**

Fig. 5 further shows that TBCs of control shrimp samples markedly increased during iced storage reaching figures of 5.24, 6.08, 7.58 and 8.73 log CFUg\(^{-1}\) after 2, 4, 6 and 8 days of iced storage, respectively. These results confirmed the findings obtained by (Zhuang et al., 1996; Rahman et al., 2001). On the other hand, treated shrimp samples exhibit quite low TBCs that reached figures of 4.35, 4.90, 5.67 and 6.82 log CFUg\(^{-1}\) after 2, 4, 6 and 8 days of iced storage, respectively, similar results were achieved in shrimp samples pre-treated by sulphite (Pyle and Koburger, 1984; Huidobro et al., 2002).

Concerning the shelf-life of crustaceans, in general 10\(^8\)-10\(^8\) bacteria/g is defined as an onset of spoilage population for shrimp (Simpson et al., 1997). Thus, the shelf-life of control shrimp was 4 days compared to 7 days for sulphite-treated shrimp stored in ice (Fig.5). The results of microbiological quality confirmed the results of biochemical indices previously discussed in red shrimp samples and also confirmed the findings achieved by Gokoglu (2004).
Sensory Evaluation:

(1) Melanosis development:

Blackspot occurs on most shrimp species and decreases the commercial value and consumer acceptance (Montero et al., 2001). Mean melanosis scores of control and sulfite-treated shrimp stored in ice for 8 days are given in Table 3. From which it is apparent that, blackspot developed rapidly in control samples exceeding the target limit score of 4 after 3 days storage time. A score of 4 for extent of melanosis in 3-4 days has also been reported for shrimp (Otwell and Marshall, 1986; Otwell et al., 1992; Montero et al., 2001). However, melanosis is caused by the endogenous shrimp enzyme PPO, which oxidizes phenols to quinines, followed by non-enzymatic polymerization of the quinones to pigment of high molecular weight and very dark or black coloring (Lee-Kim et al., 1997).

Concerning melanosis scores, it is worth mentioning that a score of 4 or less indicated high quality product with minimal melanosis. A score between 4 and 10 was considered indicative of shrimp with measurable quality defects. A score of 8 or greater represented severe defects, approaching unacceptable (Otwell and Marshall, 1986; McEvily et al., 1991).

Data presented in Table 3 further shows that control samples exhibit slight melanosis noticeable on some shrimp in the head and gill region, for the first 2 days of storage. On the third day, control samples developed slight blackening (4.3) noticeable on most shrimp (30-40% of shrimp surface affected). By day 4, over 75% of shrimp heads were dark with moderate blackening (6) in the tail and body (50-60% of shrimp surface affected). On the 5th day, control samples exhibit heavy blackening (8.4) on most shrimp (60-80% of shrimp surface affected and, consequently were considered unacceptable. After 6 days of iced-storage control samples showed extremely heavy blackening (9.3) on all shrimp (80-100% of shrimp surface affected), the entire shrimp was very poor quality. At the end of storage time, control samples showed very poor quality (10), indicating advanced stage of proteolysis. In this respect, Gokoglu (2004) reported that control shrimp were judged unacceptable (based on melanosis scores) after 4 days compared to 6 days for sulfite – treated shrimp.

On the other hand, the results in Table 3 indicated that Na$_2$S$_2$O$_5$ had a strong effect on delaying melanosis development in shrimp. This could be explained in the basis that sulphites can inhibit PPO activity also, sulfites interfere in the polymerization of the quinones, combining irreversibly with them and forming colorless compounds (Embs and Markakis, 1965). However, the bisulphate – dipped samples exceeded the target limit score of 4 after 6 days of storage (Table 3). These results confirmed the findings obtained by Otwell and McEvily (1991).

Referring to Table 3, it is quite clear that sulfite – treated shrimp had developed slight melanosis in the head and body after 6 days of storage. By day 7, though, only moderate blackening was observed for the whole shrimp. At the end of the trial period treated shrimp were rejected because of reddening in the gut region (an indicative of advanced spoilage) as well as to the higher melanosis score (8.0). However, blackening occurrence in treated samples in the late period of storage could be due to oxidation of sulphites.
Moawad, R. K.

(Lee-Kim et al., 1997). These results coincide with those obtained by Yamagata and Low (1995); Gokoglu (2004) who reported that Na$_2$S$_2$O$_5$ treated shrimp stored in ice has extended shelf-life compared to untreated control.

Table (3): Melanosis score of control and sulphite-treated shrimp during iced-storage

<table>
<thead>
<tr>
<th>Iced-Storage (Day)</th>
<th>Control</th>
<th>Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.2 ± 0.15</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>3.5 ± 0.12</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>4.3 ± 0.19</td>
<td>2.1 ± 0.14</td>
</tr>
<tr>
<td>4</td>
<td>6.0 ± 0.27</td>
<td>2.8 ± 0.29</td>
</tr>
<tr>
<td>5</td>
<td>8.4 ± 0.30</td>
<td>3.6 ± 0.29</td>
</tr>
<tr>
<td>6</td>
<td>9.3 ± 0.26</td>
<td>4.8 ± 0.44</td>
</tr>
<tr>
<td>7</td>
<td>10.0 ± 0.00</td>
<td>6.1 ± 0.22</td>
</tr>
<tr>
<td>8</td>
<td>10.0 ± 0.00</td>
<td>8.0 ± 0.51</td>
</tr>
</tbody>
</table>

(All values reflect the mean and standard deviation, n = 10)

(2) Odor Changes:

Product odor has become a major factor in grading and evaluation the quality of fish and shelf fish (Nielsen, 1995). Mean scores for sensory assessment of odor during iced storage of control and treated shrimp are shown in Table 4. From which it is clear that mean odor scores decreased as the time of storage progressed. However, control shrimp stored in ice retained their characteristic fresh seaweed odor for the first 2 days of storage. On the third day of ice storage the odor score of control samples slightly decreased indicating loss of fresh odor intensity, in other words control samples exhibit a weak marine odor. By day 4, control samples developed a slight ammonical and fishy odor, which could be attributed to the reaction between TMA and shrimp fat (Yamagata and Low, 1995). On the 5th day of iced storage a distinct ureal odor was detected in control samples, accordingly samples were considered unacceptable. After 6 days of storage control samples exhibit severe off-odor and it probably coincides with the onset of spoilage and the logarithmic phase of microbial growth (Fig.5). Thereafter, the odor score sharply decreased indicating very poor quality.

Table 4 also reveals that, the Na$_2$S$_2$O$_5$ – treated shrimp stored in ice retained their characteristic fresh seaweed odor for the first 4 days storage.

Table 4: Odor score for control and sulphite-treated red shrimp during iced-stORAGE.

<table>
<thead>
<tr>
<th>Iced-Storage (Day)</th>
<th>Control</th>
<th>Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.0 ± 0.58</td>
<td>9.0 ± 0.45</td>
</tr>
<tr>
<td>2</td>
<td>8.3 ± 0.37</td>
<td>8.6 ± 0.43</td>
</tr>
<tr>
<td>3</td>
<td>7.1 ± 0.29</td>
<td>8.1 ± 0.48</td>
</tr>
<tr>
<td>4</td>
<td>5.4 ± 0.34</td>
<td>7.8 ± 0.33</td>
</tr>
<tr>
<td>5</td>
<td>4.0 ± 0.47</td>
<td>1.1 ± 0.27</td>
</tr>
<tr>
<td>6</td>
<td>3.0 ± 0.36</td>
<td>6.6 ± 0.35</td>
</tr>
<tr>
<td>7</td>
<td>1.8 ± 0.35</td>
<td>5.7 ± 0.27</td>
</tr>
<tr>
<td>8</td>
<td>1.0 ± 0.53</td>
<td>4.3 ± 0.31</td>
</tr>
</tbody>
</table>

(All values reflect the mean and standard deviation, n = 10)
The odor changed to slightly ammonical and slightly fishy on day 7. At the end of the trial period treated shrimp developed a distinct ureal odor that makes samples unacceptable. These results are in agreement of those obtained by Yamagata and Low (1995) in banana shrimp pre-treated with sulphites and stored in ice for 8 days.

Conclusions:
This study has demonstrated the effectiveness of sodium metabisulphite as an agent in delaying melanosis development in red shrimp. Its antimicrobial effect was confirmed. Based on biochemical indices, microbiological and sensory analyses, a one minute dip into 1.25% \( \text{Na}_2\text{S}_2\text{O}_5 \) solution is sufficient to delay blackspot and maintain a high quality shrimp product for at least 7 days storage in ice compared to only 4 days for control samples.

REFERENCES

Moawad, R. K.


6109
اطالة مدة حفظ الجمبري الأحمر وتحسين جودته أثناء التخزين في الثلج

روبيل كامل معرض المركز القومي للبحوث - قسم الصناعات الغذائية - الدقى - مصر

البَعَقُ السَوداء التي تنترس سريعاً في معظم أنواع الجمبري أثناء حفظه في الثلج تقلل من قيمته التجارية وتخفض من قابلية المستهلك على ممارسة المنتجات - لذا أجري هذا البحث بفرض تأثير غمر الجمبري الأحمر في محلول تركيزه 1.25% صوديوم ميتا-بي-سولفيفت لمدة دقيقة واحدة ثم التصفية والتعبئة وحفظ في الثلج لمدة 8 أيام داخل الثلاجة (4-6 م) على خصائص جودة الجمبري ودمن حفظه في الثلج وكذا منع الأسوداء الحادي.

أكدت النتائج أن الأسوداء يحدث سريعاً في عينات الدكتور (المغمورة في ماء مقطور لمدة دقيقة واحدة) مما يجعلها غير قابلة بعد 4 أيام من الحفظ في الثلج (حسب التقييم الحسي لدرجة الأسوداء). وترجع سبب الحفظ القصيرة إلى ارتفاع قيم درجات التحلل الكيمياوي وإلى زيادة الحمل الميكروبي الذي يؤثر بدوره في سرعة تكوين المركبات المؤلمة عن الرائحة غير المرغوبة والدامة على حدوث تحلل وفساد في عينات الجمبري.

وعلي جانب آخر فإن غمر الجمبري في محلول 1.25% صوديوم ميتا-بي-سولفيفت لمدة دقيقة واحدة حسب التوصيات الحديثة أظهرت بوضوح طهوره البُعَق السوداء وقلة من تكوين المركبات القاعدية الكليّة الطبيعة وكذا تتزوجين ثلاثة الأيمين. وأيضًا أظهرت النتائج أنها تمكنت من تقليل درجة الملوحة في الحمل الميكروبي وقلة من الارتفاع الحادث في درجة تركيز أيون الأيدروجين (أكس الأيدروجيني) ومحمض البيروباربلورين.

كما أظهرت نتائج التقييم الحسي تأثير ظهور الرائحة غير المرغوبة المصاحبة لفساد الجمبري وعليه تم تمثيل فترة الصلاحية في العينات المعالمة والمحفوظة في الثلج إلى سبعة أيام و هذا يعني أن غمر الجمبري لمدة دقيقة واحدة في محلول 1.25% صوديوم ميتا-بي-سولفيفت كان كافياً لتقليل ظهور عوامل الفساد في عينات جودة عالية لمدة طويلة (7 أيام).

6110