

Full Length Research Paper

Changes in chemical, microbiological and sensory properties of marinated seafood salad during storage period

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This study aimed to determine changes in chemical, microbiological and sensory properties of marinated seafood salad that contains squid, surimi, mussel, shrimp and octopus, during the storage period of five months. According to results of microbiological analyses, all raw materials and production process were fitted into hygienic rules. The acetic acid/salt ratio of all raw materials was in the acceptable limits. Results of the study showed that, TBA value is important in the evaluation of the shelf life of salads. It observed that TBA value was getting higher in parallel with the storage time. Although bacterial load of marinated seafood salads were in the consumption limits, sensory analyses showed that sensory quality of the salads was getting decrease while TBA value was getting higher at the end of 5th month at 4°C.

Key words: Marinated seafood salad, chemical, microbiological, sensory properties.

INTRODUCTION

The marinating process is one of the oldest methods of preservation of fish and other sea products (Giuffrida et al., 2007). Marinades are solutions, including sugar, spices, oil, acids (from vinegar, fruit juice, wine) and they are used to improve tenderness, juiciness, flavour and aroma and to extend shelf life of meat, poultry, seafood and vegetables (Cadun et al., 2005).

Marinades are semi preserves; acid, usually acetic acid and salt are added to the fish to retard the action of bacteria and enzymes, resulting in a product with a characteristic flavour and an extended but limited shelf life (McLay, 1972). A combination of acetic acid and salt is used in order to preserve the raw materials. The aim is not only to prevent microorganism growth but marination is also used to tenderise or to change taste, textural and structural properties of raw material (Gökoğlu et al., 2004).

In Turkey, there are limited studies about marination (Cadun et al., 2005). Existing studies are generally done on marinated fish (Varlık et al., 1993; Aksu et al., 1997). Although marination technology is well developed, there is no information about marinated seafood salad in Turkey. The study was, therefore, aimed to determine the

changes in microbiological, chemical and sensory properties of marinated seafood salad during the storage period in Turkey.

MATERIALS AND METHODS

Squid, surimi, mussel, shrimp and octopus were obtained from a private seafood processing plant in Mudanya / Bursa Province of Turkey, and these were used in the production of marinated seafood salad. Raw materials were boiled at 85°C for 5 min and frozen at -40°C by IQF (Individual Quick Freezing) technique and stored at -18°C.

All raw materials were defreezing and analysed based on their microbiological loads. Then, all the materials were marinated, separately. 13.5% acetic acid (Merck KGaA Darmstadt, Germany) was used for acidity and diluted to 4% with brine (pH = 3.5). Saccharin was used as sweetener (40 g/ 100 kg). The marinating processes were realized at 4°C and for 10 h with 4% of acetic acid and 4% of salt. The temperature of marination room was at 12 ± 1°C.

After the marination, it was observed that the concentration of 4% salt caused the breaking into piece of the mussels and hardening of the octopuses. As a result, the concentration of salt was increased to 6% for mussels and decreased to 2% for octopuses. After

Table 1. Results of microbiological analysis and pH values of raw materials and seafood salad.

Analysis	Raw materials					Seafood salad
	Squid	Surimi	Mussel	Shrimp	Octopus	
TMAB count (cfu/g)	<10	<10	<10	<10	<10	<10
TCB count (MPN/g)	<3	<3	<3	<3	<3	<3
<i>E. coli</i> (MPN/g)	<3	<3	<3	<3	<3	<3
<i>S aureus</i> (cfu/g)	<10	<10	<10	<10	<10	<10
<i>Salmonella</i> spp. (cfu/25 g)	Not found	Not found	Not found	Not found	Not found	Not found
<i>V. parahaemolyticus</i> (cfu/25g)	-	-	Not found	-	-	-
<i>V. cholerae</i> (cfu/25g)	-	-	Not found	-	-	-
Yeast-Mould (cfu/g)	<10	<10	<10	<10	<10	<10
pH	3.87	3.92	3.45	3.94	3.89	3.91

marination of raw materials has been completed, pH values of each have been measured. Seafood salads were prepared by mixing of marinated materials and these salads were waited for 30 min. Seafood salads were packaged into 200 g plastic bags by using 65% marinated material and 35% olive oil. These packages were stored at 4°C. During the storage period, chemical, microbiological and sensory quality analysis of the marinated seafood salad samples were performed on the day 1 and 7 and on the months 1, 2, 3, 4 and 5.

Marinated seafood salad samples were analysed. Each analysis was done in triplicates and results were recorded as the arithmetic means of the values.

Chemical analysis

The following chemical analyses were determined in marinated seafood salad:

1. pH values, Salt (%) (Ludorff and Meyer, 1973),
2. Thiobarbituric Acid (TBA) mg
3. Malonaldehyde/kg (Varlık et al., 1993),
4. Total Volatile Base-Nitrogen (TVB-N) mg N/100 g (Schormüller, 1968)

Microbiological analysis

Twenty five grams of seafood salad was aseptically weighed and transferred into 225 ml of sterile buffered peptone water (Oxoid CM509) and homogenized by Stomacher 400 Lab Blender (Seward Medical, UK) for 2 min. Samples were diluted as 10^{-1} with 0.1% sterile peptone water. The other dilutions were prepared from this main dilution. The following analyses were determined:

1. Total Aerobic Mesophilic Bacteria (TMAB) Count (Swanson et al., 1992);
2. Total Coliform Bacteria (TCB) Count (Anonymous, 1983);
3. *Escherichia coli* (*E. coli*) (Andrews, 1992);
4. *Staphylococcus aureus* (*S. aureus*) (Elliot et al., 1995);
5. *Salmonella* spp. (Andrews and Hammack, 2003),
6. *Vibrio parahaemolyticus* (*V. parahaemolyticus*), *Vibrio cholerae* (*V. cholerae*) (Elliot et al., 1995);
7. Yeast-Mold (Y-M) Count (Mislivec et al., 1992).

Sensory analysis

Sensory evaluation of marinated seafood salad was performed by

five previously trained panellists, who were asked to evaluate appearance, odour, flavour and texture by using a form. Each feature has different evaluation point (appearance max. 5; odour max. 1; flavour max. 6 and texture max. 3). According to the scoring table, a total score of sensory attributes of 15 means first quality (best quality), scores from 14.9 to 13 indicated second quality; scores from 12.9 to 11.0 indicated third quality and scores from 10.9 to 6.0 indicated fourth quality (Schormüller, 1968).

Statistical analysis

Experiments were done by using a randomised block design and statistical evaluation of the data were done by descriptive analysis. Results were expressed in mean values and standard deviations.

RESULTS AND DISCUSSION

The results of microbiological analysis of all the dissolved raw materials were shown in Table 1. Initial quality of raw materials, considering their freshness, microbiological load and physical damage, is an important factor which influences the quality of the end product (Fuselli et al., 1994). The results of the microbiological analysis showed that the boiling process of all the raw materials was adequate to reduce the microbiological loads. All the counts did not exceed the maximum limits of microbiological criteria for frozen seafood materials given by Turkish Manual of Seafood Quality Control Limits (Anonymous, 2001).

pH values of raw materials and marinated seafood salad were shown in Table 1. pH value of marinated seafood salad was found to be 3.91 after packaging. Generally, food poisoning and spoilage bacteria may only growth above the 4.8 pH (McLay, 1972), therefore pH value of marinated products should not be more than 4.8 (Rehbein and Oehlenschlager, 1996). pH values of our samples were below 4.8. It was supported by other chemical and sensory analyses (Ludorff and Meyer, 1973; Schormüller, 1968; Varlık et al., 1993).

TBA value is one of the best indicators of rancidity especially in marinated seafood products. When TBA

Table 2. Chemical changes of marinated seafood salad during the storage period (mean± standard deviation).

Physical and chemical analysis	Storage period						
	1st day	7th day	1st month	2nd month	3rd month	4th month	5th month
pH	3.91 ± 0.007	3.97 ± 0.007	3.88 ± 0.02	3.70 ± 0.02	3.61 ± 0.019	3.42 ± 0.02	3.2 ± 0.03
Salt (%)	3.2 ± 0.126	3.1 ± 0.167	2.8 ± 0.178	2.4 ± 0.228	1.7 ± 0.141	1.5 ± 0.167	1.2 ± 0.185
TBA (mg malonaldehyde/kg)	2.13 ± 0.004	2.15 ± 0.012	2.21 ± 0.016	2.31 ± 0.007	2.67 ± 0.015	3.80 ± 0.012	4.92 ± 0.024
TVB-N (mg N/100 g)	8.12 ± 0.011	8.25 ± 0.005	9.16 ± 0.015	10.65 ± 0.032	12.51 ± 0.02	13.82 ± 0.037	15.77 ± 0.015

Table 3. Microbiological quality changes of marinated seafood salad during storage period.

Microbiological analysis	Storage period						
	1st day	7th day	1st month	2nd month	3rd month	4th month	5th month
TMAB count (cfu/g)	<10	<10	<10	<10	<10	<10	<10
TCB count (MPN/g)	<3	<3	<3	<3	<3	<3	<3
<i>E. coli</i> (MPN/g)	<3	<3	<3	<3	<3	<3	<3
<i>S. aureus</i> (cfu/g)	<10	<10	<10	<10	<10	<10	<10
<i>Salmonella</i> spp. (cfu/g)	Not found	Not found	Not found	Not found	Not found	Not found	Not found
Yeast-mould (cfu/g)	<10	<10	<10	<10	<10	<10	<10

value exceeds 4 mg malonaldehyde/kg, rancidity begins. Consumable limits has been determined as 8 mg malonaldehyde/kg (Conell, 1980; Erdem et al., 2005; Schormüller, 1968). As seen in Table 2, initial TBA value of marinated seafood salad was 2.13 ± 0.004 mgmalonaldehyde/kg and increased to 4.92 ± 0.024 mg malonaldehyde/kg at month 5 and rancidity begun. There was a difference between the initial and last period of storage of TBA values that was also confirmed by sensory analysis. Similar results were obtained by Erdem et al. (2005), Tomek et al. (1992) and Yapar (1998).

TVB-N is used for the determination of the spoilage level during the storage period (Cobb and Venderzont, 1975; Kietzmann et al., 1969; Oehlenschlager, 1981). A level of 35 mg/100 g has been upper limit above which fish products

are considered to be unfit for human consumption (Ludorf and Meyer, 1973; Schormüller, 1968). In marine fish, TVB-N values of 15 to 20 mg N/100 g show good quality, whereas TVB-N values of 50 mg N/100 g show poor quality (Conell, 1980).

Crustaceans may have high TVB-N values peculiar to themselves (Oehlenschlager, 1997). Initial TVB-N value of marinated seafood salad was 8.12 ± 0.011 mg N/100 g and increased to 15.77 ± 0.015 mg N/100 g at the end of storage period (Table 2). Although there was a significant difference between the initial and end values of TVB-N, marinated seafood salads were still rated as “good quality”.

The results of microbiological analysis of marinated seafood salad during the storage period are given in Table 3. The results of microbiological analysis show that there was no

bacterial growth during storage period. It concluded that, the acetic acid/salt ratio was enough to protect the product and production process was realized on hygienic rules.

The results of the sensory analysis have been given in Table 4. Sensory analyses were realised by trained panellists. According the results, there was no first class product. Seafood salads were determined as “second quality” from first day to first month and as “third quality” at second month. Sensory analysis of the months 3, 4 and 5 of marinated seafood salads were evaluated as “fourth quality”.

According to the results of TBA analyses rancidity begins at 5th month of storage due to fat oxidation. Also, results of sensory analyses, marinated seafood salads were accepted as “bad quality” after 3rd months. Although, according to

Table 4. Sensory evaluations of marinated seafood salads during the storage period.

Sensory evaluation	Storage period						
	1st day	7th day	1st month	2nd month	3rd month	4th month	5th month
Appearance	4.7	4.7	4.6	4.4	3.9	3.7	3.2
Odour	1	1	0.9	0.9	0.8	0.6	0.4
Flavour	5.2	5.2	5.2	4.9	4.3	3.2	2.2
Texture	2.7	2.7	2.4	2.2	1.9	1.5	0.9
Total	13.6	13.6	13.1	12.4	10.9	9.0	6.7
Quality class*	2	2	2	3	4	4	4

*; 2: Good quality; 3: consumable; 4: bad quality.

results of sensory analyses, the quality class of marinated seafood salad has been indicated as 4 (bad quality) during 3rd to 4th months, total score has been decreased from 10.9 to 6.7.

The results of the study showed that microbiological quality of the marinated seafood salad is not enough to keep the quality of the product. Even there no bacterial load was observed, TBA value has increased and sensory evaluation score of the product has decreased. It is important to take into consideration of TBA value and sensory analyses while determining the shelf life of marinated seafood salads.

When a food product is evaluated as “non-consumable” by the results of sensory analyses, it cannot accept as “consumable” even technical quality parameters into acceptable limits. Thus, bacteriologic and chemical analysis should be supported by sensory analyses.

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