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Effect of Modified Atmosphere Packaging and Vacuum Packaging Methods on Some Quality Aspects of Smoked Mullet (*Mugil cephalus*)

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Abstract: The effects of modified atmosphere packaging (MAP at 60% N_2; 35% CO_2 and 5% O_2) and under-vacuum packaging (UV) and cold storage at 4±1°C for 8 weeks on the quality aspects of traditional and liquid flavorings smoked whole and gutted mullet (*Mugil cephalus*) were the main objectives of this work. Some quality aspects of smoked mullet involved chemical, microbiological and sensory evaluation. Results showed that MAP reduced pH, total volatile basic nitrogen (TVB-N), trimethylamine nitrogen (TMA) and thiobarbituric acid (TBA) values especially in traditional smoked gutted fish compared with UV-packaged products and stored under cold conditions. However, the formation of biochemical attributes increased with time of storage. With respect to the microbiological load, both total viable count (TVC) and halophilic bacteria (HB) were higher in UV-liquid smoked fish than MAP-traditional smoked fish products. Vice versa was found in case of yeast and mold counts. In conclusion, MAP and UV methods for smoked mulled fish should be applied to obtain safe product.

Key words: Smoked fish · Modified atmosphere packaging (MAP) · Under-vacuum packaging (UV) · Cold storage

INTRODUCTION

Smoking is a centuries-old food preservation technique. However, the conventional smoking process is now being substituted by the use of smoke flavorings [1]. The shelf-life of smoked fish products depends largely on the initial bacterial contamination of the raw material; on the decrease of a_w in the tissues due to brining and pre-drying, on the activation of putrefactive micorflora due to the heat treatment, on the amount of smoke components that penetrate the product and on the temperature, air humidity and oxygen levels during storage[2].In addition, the shelf-life of cold smoked salmon was very variable (1-6 weeks) and was related to the initial Enterobacteriaceae load, which was dependant on hygienic conditions in the smoke house. High correlations existed between the remaining shelf-life and lactobacilli count, yeast count and total volatile base (TVBN) concentration [3]. Modified atmosphere pack (MAP) is a form of packaging involving the removal of air from the pack and the replacement with a single gas or mixture of gases. The gaseous atmosphere changes continuously during storage because of respiration of the packed product, biochemical changes and the slow permeation of gases through the packaging materials [4]. Vacuum pack (VP) is also a type of MAP system because air is removed from a pack and not replaced. VP is normally placed in a pack of low oxygen permeability, air is evacuated and the package sealed [5]. In addition, Modified atmosphere packaging (MAP) is an increasingly popular food preservation technique. Consumer demands for fresh and convenient foods free of chemical preservation has led to growth in the use of MAP and this technique may also reduce wastage and extend shelf-life of a range of seafood [5]. Besides, Vacuum packed cold-smoked is a product with wide range of consumption in Europe and thus of considerable economic importance for the seafood market [6]. Therefore, the main objectives of this work were to investigate the effects of modified atmosphere packaging (60%N_2; 35% CO_2 and 5% O_2) and

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under-vacuum packaging (UV) and cold storage at 4±1°C for 8 weeks on some quality aspects of traditional and liquid flavourings smoked whole and gutted mullet (*Mugil cephalus*). In addition, Chemical, microbiological and sensory evaluation were carried out each two weeks interval during cold storage.

MATERIALS AND METHODS

Materials

Fish: about 25 kg of mullet (*Mugil cephalus*) (average 200±50g) were obtained from El-Fayium Governorate, Egypt. They transferred to the laboratory using ice box. After that, they were immediately washed with tap water and divided into two lots; whole and gutted fish. All batches were salted using brine 20% NaCl concentration for 3 h at room temperature (32°C), washed carefully, drained for 3 h at 35°C. Traditional and liquid flavourings smoked whole and gutted mullet were done. Packaging materials: Polyamide/polyethylene (PA/PE) packaging rolls were obtained from Arab pharmaceutical packaging company, Cairo. The above packaging materials were used for preparation of packages of 30×20 cm. Modified atmosphere Packaging (MAP): Fish were divided into two groups. Each group contained whole and gutted fish. The first group was under-vacuum-packed and the second lot was modified atmosphere-packed in a Multivac model A 300 vacuum packaging machine (Bury, Lancs., UK). The gas ratio was 60% N_2; 35% CO_2 and 5% O_2, typical for packing fatty fish in MAP [7]. The final gas/sample ratio in all pouches was about 2:1 (v/w) for MAP conditions. All samples were stored in a refrigerator (4±1°C). Three fish were removed from each batch for each analysis. Sodium chloride: Salt fine refined table (EL-Nasr Co.) was purchased from local market, Nasr City, Cairo, Egypt. Sawdust: Beech wood sawdust was obtained from the local market. Liquid smoke: The liquid smoke condensate was produced by Namirei Co. LTD., Tokyo, Japan.

Analytical Methods: Total volatile basic nitrogen (TVB-N) [8]. Trimethylamine nitrogen (TMA-N) [9], pH value and Thiobarbituric acid (TBA) [10] were determined. Concerning microbial load, Vacuum and modified atmosphere packaged (MAP) smoked mullet were analysed immediately upon opening of the packages. 10 g of fish muscles were suspended in 90 ml sterile saline (0.85% NaCl). Serial decimal dilutions were prepared and duplicate 1ml samples of appropriate dilutions were poured on selective agar plates. Plate count agar (PCA, Oxoid), PCA contained 10% salt for halophilic bacteria count and Potato-Dextrose Agar (PDA, Oxoid) for yeasts and molds count. They were then incubated for 2 days at 30°C. All microbial counts were converted to-10 logarithms of colony forming units per g (log_{10} CFU/g sample). Sensory evaluation: The investigated products were evaluated using a panel test of a point hedonic scale according to [11]. All data were expressed as mean values (n = 3). Statistical analysis: Data for sensory evaluation were statistically analyzed. One-way analysis of variance and least significant difference tests were conducted to test significance among treatment means [12]. Statistical comparison was based on three samples for each treatment for each specific storage time.

RESULTS

Some Quality Aspects

pH Value: The pH value of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage is shown in Fig. 1. The initial pH values of traditional-smoked whole and gutted fish were 5.38 and 5.21, respectively. The corresponding values of liquid–smoked whole and gutted fish were 5.58 and 5.29, respectively. The values of pH during cold storage for one week increased slightly in all products either packaged in UV or MAP but increase in case of MAP-products was negligible especially in gutted samples which extended up to the end of storage period. However, the pH values decreased in all products after two weeks of storage. With extend cold storage, the values of pH increased gradually up to the end of storage (8 weeks).

Total Volatile Basic Nitrogen (TVBN): Figure 2 shows the effect of packaging conditions and cold storage on TVB content in traditional and liquid smoked fish. TVB

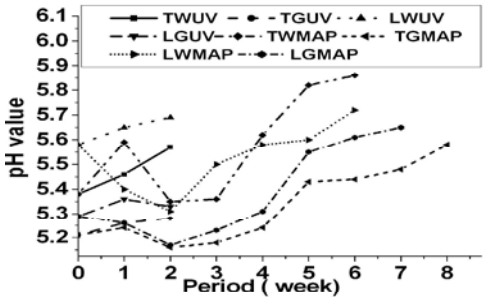

Fig. 1: The pH value of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

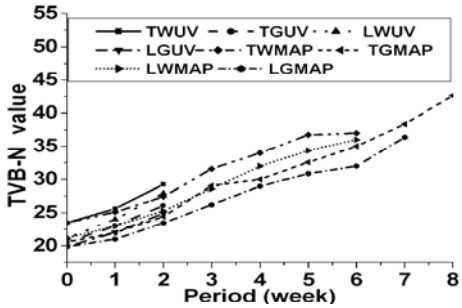

Fig. 2: Total volatile basic nitrogen (TVBN) content of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

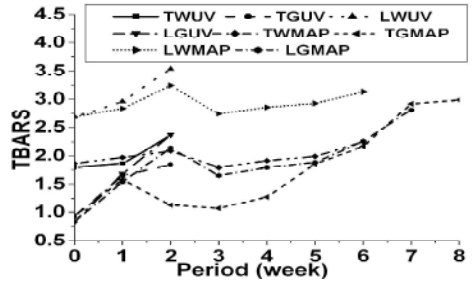

Fig. 4: Thiobarbituric acid reactive substances (TBARS) value of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

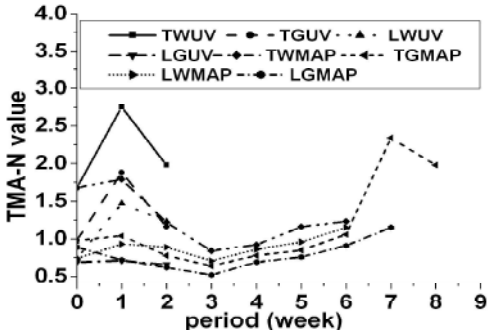

Fig. 3: Trimethylamine nitrogen (TMAN) content of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

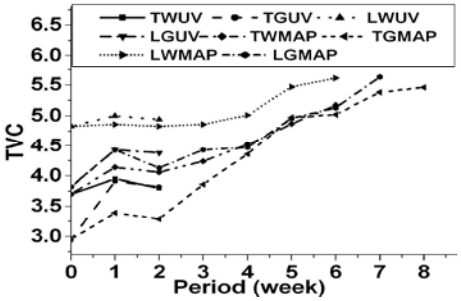

Fig. 5: Total viable count (TVC)of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

initially of traditional-smoked whole and gutted fish were 23.46 and 20.54 mg\100g flesh, respectively. The corresponding values of liquid–smoked whole and gutted fish were 21.17 and 19.85mg\ 100 g flesh, respectively. With respect cold storage, TVB increased in all products in particularly in traditional-smoked whole fish and UV–packaged when compared to similar product in case of liquid- smoked whole fish and MAP–packaged under the same conditions. The same trend was observed in case of gutted fish products. In addition, the increment of TVB was attributed mainly with increase of storage period up to 8 weeks at 4±1°C.

Trimethylamine Nitrogen (TMAN): The effect of packaging conditions and cold storage on TVB content in traditional and liquid smoked fish is presented in Fig. 3. The initial values of TMA in traditional-smoked whole and gutted fish were 1.68 and 0.98 mg\100 g flesh, respectively. The corresponding values of liquid–smoked whole and gutted fish were 0.74 and 0.69 mg\ 100 g flesh, respectively. After one week of storage at 4±1°C, its value was increased and then decreased after 3 week in all treatments. TMA content increased after four week up to 8 week in all samples. Although liquid-smoked gutted samples and MAP-packaged contained low TMA value but it was rejected before that smoked by traditional smoke.

Thiobarbituric Acid (TBA): The effect of packaging conditions and cold storage on TBA value in traditional and liquid smoked fish is shown in Fig. 4. Original values of TBA in traditional-smoked whole and gutted fish were 1.79 and 0.93 mg MA\kg flesh, respectively. The corresponding values of liquid–smoked whole and gutted fish were 2.68 and 0.98 mg MA\kg flesh, respectively. These values of TBA increased in all treatments up to 3 week of cold storage in particularly liquid-smoked whole

and gutted fish products and then decreased after 4 week. After that, its value increased gradually up to 8 week at 4±1°C.

Total Viable Count (TVC): The effect of packaging conditions and cold storage on TVC content in traditional and liquid smoked fish are illustrated in Fig. 5. Initial TVC of traditional-smoked whole and gutted fish were 3.70 and 2.95 $\log_{10}$ cfu/g flesh, respectively. The corresponding counts of liquid–smoked whole and gutted fish were 4.83 and 3.82 $\log_{10}$ cfu/g flesh, respectively. After two weeks, TVC reduced in all products and then gradually increased up to 8 weeks. However, the increment in TVC in MAP-smoked fish products was lower than that packaged by using UV conditions.

Halophilic Bacterial Count (HBC): The effect of packaging conditions on HBC content in traditional and liquid smoked fish during cold storage are showed in Fig. 6. HBC initially of traditional-smoked whole and gutted fish were 3.45 and 3.24 $\log_{10}$ cfu/g flesh, respectively. The corresponding values of liquid–smoked whole and gutted fish were 4.10 and 3.58 $\log_{10}$ cfu/g flesh, respectively. These counts of HB increased in all products after two weeks and then reduced after three weeks under the same conditions of storage. With respect to extend cold storage, THB increased especially in case of UV-smoked products compared with MAP-smoked fish products.

Yeasts and Molds Count (YMC): Figure 7 shows the effect of packaging conditions on YMC content in traditional and liquid smoked fish during cold storage. YMC originally of traditional-smoked whole and gutted fish were 3.39 and 2.78 $\log_{10}$ cfu/g flesh, respectively. The corresponding values of liquid–smoked whole and gutted fish were 3.15 and 2.65 $\log_{10}$ cfu/g flesh, respectively.

Sensory Analysis: The scores for overall acceptability score decreased with increase of storage time for all treatment samples. The results (Fig. 8) showed that MAP condition improved sensory properties and shelf life of samples products compared with UV conditions. Sensory score changed during cold storage period depending mainly on packing condition , fish form and smoking method in addition high scores had been given based on the flowing order MAP–traditional smoked gutted fish flowed by liquid smoked gutted fish, traditional smoked whole fish and liquid smoked whole fish products respectively. The samples had very good quality and no

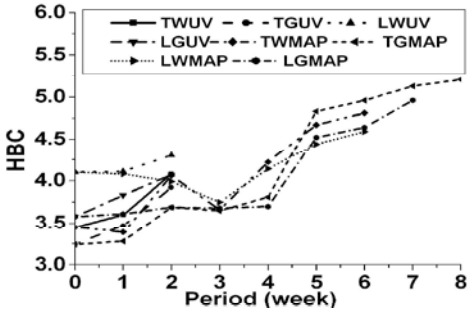

Fig. 6: Halophilic bacterial count (HBC)of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

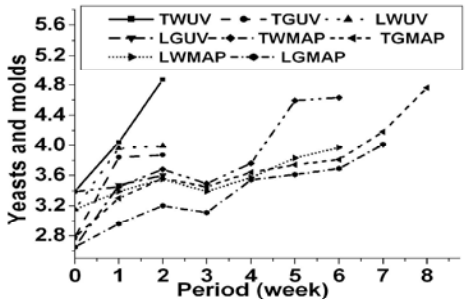

Fig. 7: Yeasts and Molds count (YMC)(HBC)of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

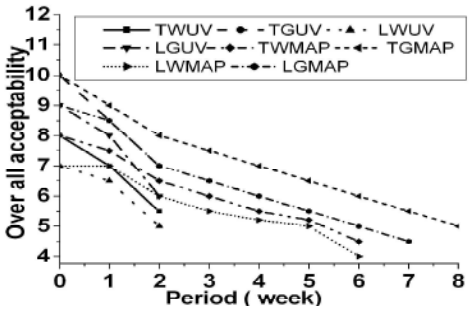

Fig. 8: Over all acceptability of traditional and liquid smoked fish and packaged under vacuum (UV) and modified atmosphere packaging (MAP) conditions during cold storage

significant deference up to 35 days for MAP traditional and liquid smoked fish samples. The score of samples were found to below 4.5 after 42 days for MAP traditional whole smoked fish and MAP liquid whole smoked fish.

DISCUSSION

Smoked fish is a delicious product and packaging conditions are limited factor to limit shelf-life. In this work, the values of pH and TVB were similar with those mentioned by [6] who reported that TVB content of cold-smoked Atlantic fish was 22.4 mg\ 100 g flesh. On the other hand, it was reported that TVBN values ranged between 27 and 32 mg/100g raw fish and 120-134 mg/100 g freshly smoked fish sample [12]. Beside, TMA in our products were lower value than those reported (4.7 mg\100 g flesh) by [6] in cold-smoked Atlantic fish. In other work, the highest concentration of TMA was obtained from sardine stored in air, followed by sardine stored in VP and the lowest in MAP [13]. In generally, TVB increased in traditional-smoked fish products when compared to similar products in case of liquid-smoked fish and MAP–packaged. In addition, the increase in TMA was attributed mainly with increase of storage periods. Concerning TBA values indicated that smoking conditions and packaging conditions prevented high lipid oxidation. On the other hand, the differences in TVC are due to smoking method and fish form investigated With respect to the effect of cold storage. TVC increased in all treatments in particularly in case of UV-liquid fish samples compared with UV-traditional fish samples either in whole or gutted fish samples. Similar findings were found in MAP-smoked fish samples under the same conditions at the first week of storage. Bacteria grew most quickly in sardine stored in air, followed by those in VP and the lowest counts were with MAP [14]. Furthermore, YMC had been taken the same trend of HBC for smoked products studied. Sensorial analysis showed that no significant deference up to 15 days for UV conditions traditional and liquid smoked fish samples. These results are in agreement with those reported by [15].

In conclusion, MAP could be improved some quality aspects and increased the shelf-life of traditional and liquid smoked mullet fish products especially gutted fish compared with UV packaging under the same conditions of cold storage.

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