Content is avaliable at SCOPUS

Meat Technology — Special Issue 64/2

www.meatcon.rs ▪ www.journalmeattechnology.com

UDK: 637.5:639.21
621.798-98-021.146.4

ID: 126558473

https://doi.org/10.18485/meattech.2023.64.2.66

Original scientific paper

Changes of sensory attributes of carp steaks (*Cyprinus carpio*) packaged in vacuum and modified atmosphere

Jelena Babić Milijašević[a], Milan Milijašević[a], Slobodan Lilić[a], Branka Borović[a], Jasna Đinović-Stojanović[a], Jelena Jovanović[a] and Mirjana Lukić[a]*

[a] *Institute of Meat Hygiene and Technology, Kaćanskog 13, 11 000 Belgrade, Serbia.*

ARTICLE INFO

Keywords:
Carp steaks
Sensory attributes
Shelf-life
Modified atmosphere packaging
Vacuum packaging

ABSTRACT

Consumers rate fish based on a number of parameters, the most important of which are the consumption safety, nutritional characteristics, taste, smell, color, texture, convenience for culinary processing and preservation. The shelf-life of fresh chilled fish can be extended by vacuum or modified atmosphere packaging. During the past decade, mixtures of gases with high concentrations of carbon dioxide and nitrogen have attracted the attention of researchers, who have been investigating packaging of fish. The aim of this research was to monitor changes of selected sensory parameters of common carp (*Cyprinus carpio*) steaks packaged in modified atmosphere and vacuum during storage at 3±0.5°C and to determine the shelf-life of the products. Sensory evaluation was conducted on 1, 4, 7, 9, 12 and 15 days of storage. Different gas mixtures as well as vacuum packaging did not significantly affect the changes in color and meat texture of carp steaks, and they remained characteristic until the end of the experiment. The freshness and acceptability of fish was most influenced by the average ratings of odor. The shelf-life of carp steaks packaged in the gas mixture consisting of 60% CO_2 and 40% N_2 (MAP1) was 12 days, while samples packaged in a mixture of gases with 40% CO_2 and 60% N_2 (MAP2) were acceptable for 9 days. The shelf-life of carp steaks packaged in vacuum was 7 days. The gas mixture consisting of 60% CO_2 and 40% N_2 proved to be the most suitable for packaging fresh carp steaks regarding the selected sensory characteristics of odor, meat texture, meat color and overall acceptability.

1. Introduction

The fact that fresh fish is a very perishable food (pH> 6.0; a_w> 0.98) has influenced the producers to focus on finding the optimal method for fish preservation. In recent years, however, consumers worldwide increasingly demand that they have fresh fish at all times, since it is fresh fish that has the most acceptable sensory attributes. This trend has led to the development of the effective concept of modified atmosphere packaging (MAP), thus ensuring a longer shelf-life of fish and preserving the basic parameters of its freshness (*Gimenéz et al., 2002*).

Consumers rate fish based on a number of parameters the most important of which are the consumption safety, nutritional characteristics, taste, smell, color, texture, convenience for culinary processing and preservation.

Changes in fish meat begin at the moment fish dies, or already at the time of the catch, and are the result of the activities of their own enzymes, the metabolism of microorganisms and the oxidation

***Corresponding author:** Jelena Babić Milijasević, *jelena.babic@inmes.rs*

Paper received Jun 16th 2023. Paper accepted Jun 30th 2023.
Published by Institute of Meat Hygiene and Technology — Belgrade, Serbia

of lipids. Changes in the sensory characteristics of the fish result from microbial development. The decomposition of food ingredients and the growth of microorganisms cause an unpleasant smell and taste as well as the production of visible pigmented or unpigmented colonies. The synthesis of polysaccharide extracellular materials and diffuse pigments results in sensory changes in the form of mucus formation and discoloration (*Gram & Huss, 1996*). On the other hand, chemical changes such as auto oxidation or enzymatic hydrolysis of fats may cause the rise of unpleasant smell and taste or, in the latter case, the activity of tissue enzymes may lead to unacceptable softening of the fish meat.

The shelf-life of fresh chilled fish can be extended by vacuum or modified atmosphere packaging (MAP) (*Pastoriza et al., 1996*; *Siverstvik et al., 2002*; *Stamatis & Arkoudelos, 2007*; *Milijašević et al., 2010*). The most commonly used gases in modified atmosphere packaging technology are carbon dioxide (CO_2), oxygen (O_2) and nitrogen (N_2) (*Martinez et al., 2006*). During the past decade, mixtures of gases with high concentrations of CO_2 and N_2 have attracted the attention of researchers, who have been investigating packaging of fish. The shelf-life of fresh chilled fish is relatively short and at temperatures of +2 ± 2 °C, it is about 2 to 3 days. It has been confirmed that packaging of fish in modified atmosphere significantly extends the shelf-life of product (*Masniyom et al., 2002*; *Stamatis & Arkoudelos, 2007*; *Provincial et al., 2010*).

The aims of this research were to monitor changes of selected sensory parameters of common carp (*Cyprinus carpio*) steaks packaged in modified atmosphere and vacuum during storage at 3±0.5°C and to determine the shelf-life of the products.

2. Materials and methods

2.1. Sampling

Common carp (*Cyprinus carpio*) of average body weight 2.50±0.30 kg were obtained from a fishpond where a semi-intensive rearing system was used. Fish were transported live to the fish slaughtering and processing facility, where they were stunned, slaughtered and scaled, and carcasses were cut into steaks 2 cm thick and 220 g average weight. Three sample groups of carp steaks were formed. One group of steaks were vacuum packaged and were used as the control. The other two sample groups were packaged in modified atmospheres with different gas ratios: MAP1: 60% CO_2+40% N_2 and MAP2: 40% CO_2+60% N_2. The machine used for packaging was Variovac (Variovac Primus, Zarrentin, Germany), and the material used for packaging was foil OPA/EVOH/PE (oriented polyamide/ethylene vinyl alcohol/polyethylene, Dynopack, Polimoon, Kristiansand, Norway) with low gas permeability (degree of permeability for O_2 – 3.2 cm^3/m^2/day at 23°C, for N_2 – 1 cm^3/m^2/day at 23°C, for CO_2 – 14 cm^3/m^2/day at 23°C and for steam 15 g/m^2/day at 38°C). The ratio of gas:fish steaks in the packages was 2:1. All fish steaks were stored in the same conditions at 3°C±0.5°C and on days 1, 4, 7, 9, 12 and 15 of storage, sensory testing was performed.

2.2. Sensory evaluation

The sensory evaluation was performed by six trained panelists. Prior the sensory evaluation, samples were taken out from the refrigerator and remained at room temperature for 15 min. For each day of examination, each assessor was provided with portion of carp steaks. The samples were evaluated for overall acceptability, with regard to odor, meat color, and meat texture using a 1–7 intensity score scale, with 7 corresponding to the most liked sample, and 1 corresponding to the least liked sample. The product was defined as unacceptable when a score of less than 3 points was recorded by at least of 50% of the panelists.

2.3. Statistical analysis

The mean values and standard deviations were calculated by using column statistics with the processing of 6 values for each analyzed group. Significant differences between groups were calculated using one-way ANOVA analysis by Tukey's comparative test in the program Microsoft Office Excel (2016). Differences were evaluated as significant at $p<0.05$.

3. Results and discussion

The results of the sensory evaluation of carp steaks are presented in Table 1.

At the beginning of the storage period, meat color, texture, odor and overall acceptability were evaluated with very high scores in all groups of carp steaks. Average scores of color acceptability decreased during the experiment and this was most pronounced in samples packaged in vacuum. Nevertheless, the color of fish meat was acceptable during the entire storage period in all groups of samples.

Table 1. Sensory evaluation of carp steaks packaged under different conditions during the storage period. MAP1: 60% CO_2+40% N_2 and MAP2: 40% CO_2+60% N_2

Sensory parameter	Packaging conditions	Storage time (days)					
		1	4	7	9	12	15
Odor	MAP1	7.0±0.0^a	7.0±0.0^a	6.8±0.4^a	5.1±0.2^a	3.6±0.4^a	1.3±0.4
	MAP2	7.0±0.0^a	7.0±0.0^a	6.6±0.5^a	3.7±0.5^b	1.2±0.3^b	ne
	Vacuum	7.0±0.0^a	6.5±0.5^b	4.7±0.6^b	1,0±0.0^c	ne	ne
Meat texture	MAP1	7.0±0.0^a	6.9±0.2^a	6.1±0.4^a	5.3±0.6^a	4.6±0.4^a	3.8±0.3
	MAP2	7.0±0.0^a	7.0±0.0^a	6.3±0.4^a	5.2±0.8^a	3.7±0.5^b	ne
	Vacuum	7.0±0.0^a	6.8±0.4^a	5.0±0.3^b	3.5±0.5^b	ne	ne
Meat color	MAP1	7.0±0.0^a	6.8±0.4^a	6.4±0.5^a	5.8±0.3^a	5.2±0.4^a	4.5±0.4
	MAP2	7.0±0.0^a	6.7±0.5^a	6.5±0.4^a	5.9±0.5^a	5.0±0.3^a	ne
	Vacuum	6.8±0.4^a	6.9±0.2^a	4.8±0.2^b	4.6±0.6^b	ne	ne
Overall acceptability	MAP1	7.0±0.0^a	7.0±0.0^a	6.5±0.5^a	4.8±0.4^a	4.1±0.2^a	1.2±0.3
	MAP2	7.0±0.0^a	7.0±0.0^a	6.2±0.4^a	4.6±0.5^a	2.2±0.4^b	ne
	Vacuum	7.0±0.0^a	6.2±0.4^b	4.5±0.3^b	1.5±0.4^b	ne	ne

Legend: Same lowercase letters in a column indicate no significant differences ($p>0.05$)
ne: not evaluated

Numerous studies in the European Union showed that the color of food products, specially fish, is a main parameter that influences consumer decisions to buy a particular type of food (*Espe et al., 2004*).

In our research, textural changes were detected in common carp muscle during the storage and was most evidenced in samples packaged in vacuum. Although the average texture scores were lower over time, at the end of the experiment, texture was rated as acceptable in all groups.

During the entire storage period, the average scores of the odor of carp steaks decreased in all experimental groups. Our results showed that odor changes were most pronounced in the vacuum packaged fish. The carp steaks packaged in a modified atmosphere consisting of 60% CO_2 and 40% N_2 received high odor scores, and they had an effect on high ratings of overall acceptability, considering that odor is the most significant sensory attribute in the evaluation of freshness and acceptability of fish as food. The odor of carp steaks packaged in MAP1 was evaluated as unacceptable on day 15 of the experiment, while in samples packaged in MAP2, odor was judged as unacceptable on day 12. The odor of vacuum packaged samples was evaluated as unacceptable on day 9.

The results of numerous studies indicate that samples of fish packaged in various gas mixtures have always shown higher sensory estimates of overall acceptability and, hence, a longer shelf-life in comparison with the fish stored primarily in the air, but also vacuum packaged fish. The results of the present study showed that the highest average rates of overall acceptability, which also proved to be significantly higher ($p< 0.05$), were established for carp steaks packaged in an atmosphere consisting of 60% CO_2 and 40% N_2. Carp steaks with somewhat smaller average ratings of overall acceptability were packaged in a mixture of gases with 40% CO_2 and 60% N_2; the lowest average ratings of overall acceptability were those of vacuum packaged samples. Statistically significantly higher sensory ratings during storage were established by *Masniyom et al., 2002* for samples of sea bass fillets packaged in various mixtures of gases in relation to fish stored in air. Similar results were obtained by *Goulas and Kontominas, 2007*, who examined modified atmosphere packaged and vacuum packaged mackerel. Such results can also be a confirmation of *Murcie et al., 2003*, who found that food packaged in a modified atmosphere retains a better appearance in comparison with vacuum packaged food.

4. Conclusion

Different gas mixtures as well as vacuum packaging did not significantly affect the changes in meat color and meat texture of carp steaks, and they remained characteristic until the end of the experiment. The freshness and acceptability of fish was most influenced by the average ratings of odor, so based on the results of the present study, it can be concluded that the shelf-life of carp steaks packaged in the gas mixture consisting of 60% CO_2 and 40% N_2 (MAP1) was 12 days, while samples packaged in a mixture of gases with 40% CO_2 and 60% N_2 (MAP2) were acceptable for 9 days. The shelf-life of carp steaks packaged in vacuum was 7 days.

The gas mixture consisting of 60% CO_2 and 40% N_2 proved to be the most suitable for packaging fresh carp steaks regarding the selected sensory characteristics of meat color, meat texture, odor and overall acceptability.

Disclosure statement: No potential conflict of interest was reported by authors.

Funding: The research results shown in this paper were financed by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, and based on the Agreement on the implementation and financing of scientific research work by the Grant No. 451-03-47/2023-01/200050 from 03.02.2023.

References

Espe M., Kiessling A., Lunestat B., Torrissen O. & Røra, A. B. (2004). Quality of cold smoked salmon collected in one French hypermarket during a period of 1 year. *Lebensmittel- Wissenschaft & Technologie*, 37, 627–638.

Gimenéz, B., Roncalés, P. & Beltrán, J.A. (2002). Modified atmosphere packaging of filleted rainbow trout. *Journal of the Science of Food and Agriculture*, 82, 1154–1159.

Goulas, A. E. & Kontominas, M. G. (2007). Effect of modified atmosphere packaging and vacuum packaging on the shelf-life of refrigerated chub mackerel (*Scomber japonicus*): biochemical and sensory attributes. *European Food Research and Technology*, 224, 545–553.

Gram, L. & Huss, H. H. (1996). Microbiological spoilage of fish and fish products. *International Journal of Food Microbiology*, 33, 121–137.

Martinez, L., Djenane, D., Cilla, I., Beltran, J. A. & Roncales, P. (2006). Effect of varying oxygen concentrations on the shelf life of fresh pork sausages packaged in modified atmosphere. *Food Chemistry*, 94, 219–225.

Masniyom, P., Benjakul, S. & Visessanguan, W. (2002). Shelf-life extension of refrigerated seabass slices under modified atmosphere packaging. *Journal of the Science of Food and Agriculture*, 82(8), 873–880.

Milijašević, M., Babić, J., Baltić, M., Spirić, A., Velebit, B., Borović, B. & Spirić, D. (2010). The influence of different gas mixtures on the changes of certain microbiological and chemical parameters in carp's (*Cyprinus carpio*) cuts packed in modified atmosphere. *Meat Technology*, 51 (1), 66–70.

Murcia M. A., Martinez-Tome M., Nicolas M.C. & Vera A. M. (2003). Extending the shelf-life and proximate composition stability of ready to eat foods in vacuum or modified atmosphere packaging. *Food Microbiology*, 20, 671–679.

Pastoriza L., Sampedroo G., Hherrera J. J. & Cabo M. L. (1996). Effect of carbon dioxide atmosphere on microbial growth and quality of Salmon slices. *Journal of the Science of Food and Agriculture*, 72, 348–352.

Provincial, L., Gil, M., Guille´n, E., Alonso, V., Roncales, P. & Beltran, J. A. (2010). Effect of modified atmosphere packaging using different CO_2 and N_2 combinations on physical, chemical, microbiological and sensory changes of fresh sea bass (*Dicentrarchus labrax*) fillets. *International Journal of Food Science & Technology*, 45, 1828–1836.

Stamatis, N. & Arkoudelos, J. S. (2007). Effect of modified atmosphere and vacuum packaging on microbial, chemical and sensory quality indicators of fresh, filleted *Sardina pilchardus* at 3°C. *Journal of Science of Food and Agriculture*, 87, 1164–1171.