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Belgrade-Serbia

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MEAT AND MEAT PRODUCTS – PERSPECTIVES OF SUSTAINABLE PRODUCTION

Belgrade, June 10th-12th, 2013

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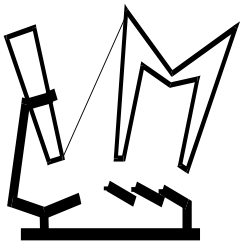

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SENSORY EVALUATION OF SELECTED QUALITY PARAMETERS DURING STORAGE OF COLD SMOKED TROUT PACKED IN VACUUM AND MODIFIED ATMOSPHERE

Nataša Pavlićević[1], Milan Ž. Baltić[2], Mirjana Dimitrijević[2], Vesna Đorđević[3], Radmila Marković[2], Milorad Mirilović[2]

[1] Veterinary Speciality Institute "Subotica", Subotica, Serbia
[2]Faculty of Veterinary Medicine, Belgrade, Serbia
[3]Institute of Meat Hygiene and Technology, Belgrade, Serbia

Abstract – Sustainability of cold smoked fish products, can be defined as the period of time between the packing of food and which the product is safe for the consumers' health and, its organoleptic characteristics nutritional value are invariable and acceptable for consumers. This demand is largely achieved by packing fish product in vacuum or in modified atmosphere. The aim of our study was to show the changes of selected sensory characteristics of cold smoked trout packed in a vacuum and modified atmosphere. In experiment, two groups of trout are formed. The first group was vacuumed (group I) and the second one is packaged in a gas mixture with 90% CO_2 and 10% N_2 (group II). Average scores of color intensity of group I was identified with statistically significant higher scores. Average scores of odor and taste of the smoke and overall acceptability of group II were significantly higher. Results of experiment show advantages and some potential disadvantages of packing cold smoked trout in modified atmosphere.

Key words – color intensity, odor and taste of the smoke, overall acceptability.

I. INTRODUCTION

Sustainability of food, and therefore cold smoked fish products, can be defined as the period of time between the packaging of food and the time in which the product is primarily safe for the consumers' health and, in which, its organoleptic characteristics (odor, taste, appearance, and texture) and nutritional value are invariable and acceptable for consumers [1, 2].

The modern consumer is looking for high-quality food that has kept the sensory characteristics and nutritional value of the raw material from which it is produced, and that it is also safe for his health [3]. This demand is largely achieved by packing product in vacuum or in modified atmosphere. Apart from satisfying the requirements of consumers, in this way the producers win, too - not only do they manage to keep, but in this way, they are also able to expand the market [4].The basic principle of packaging is to avoid contamination, delay fault, permit some enzyme reactions that could improve the softness, reduce the loss of weight and where applicable, to ensure preservation of the organoleptic properties of the product [5, 6, 7, 8, 9].

Food can be easily rotten in air, due to the loss of moisture, reaction of oxygen, as well as the growth and reproduction of aerobic microorganisms, bacteria and yeasts. This leads to a change in the texture, color, odor, taste and nutritional value of food. These changes make foods unacceptable for human consumption and often unsafe to the health of consumers. The main goal of packaging food in vacuum and in modified atmosphere is the removal of oxygen from the food, since it allows for the growth of aerobic microorganisms (bacteria, yeasts and molds), and to prevent oxidative reactions depleting vitamins, pigments, lipid components, reducing the quality and nutritional value of the product [7]. When packing in a vacuum, removing the air in the packaging impermeable to oxygen, anaerobic / microaerophilic

conditions are created, increasing the CO_2 content and reducing the pH of the product. Oxygen remained in the container turns into the carbon dioxide due to respiration of the local tissue and bacterial activity. These changed conditions inhibit the growth of aerobic bacteria and allow for the growth of facultative anaerobes. Regular vacuuming prolongs sustainability, but it drains the food. That is why the food packaging in a mixture of gases, i.e. modified atmosphere, or MAP (Modified Atmosphere Packaging) is a leading technology of packaging of the 21st century, which basically functions as vacuum packing, with the only the difference that, in the vacuum packing, the inner milieu that inhibits microorganisms develops within the package, while in MAP, the gas mixture is initiated to create the same conditions [10, 11]. However, the packaging of fish products in vacuum or modified atmosphere cannot improve the quality of the product [12]. Therefore, it is important that the materials used for packaging are of high quality and good manufacturing practice and the cold chain are mandatory in order to maintain the quality and extend the sustainability of food packaged in modified atmosphere [1].

Spoilage of fish and fish products can be defined as any change in the fish meat which makes the product unusable for human consumption. How long will smoked fish products be sustainable, or how much time is needed to bring about the first signs of spoilage (sensory changes) depends on several factors. Spoilage of fish and therefore cold smoked fish products is the result of three processes: (i) decomposition of tissue as a result of enzyme action from the flesh of fish (autolysis of cells), (ii) the growth of microorganisms, and (III) oxidation reactions which produce evaporative compounds of low molecular weight [13]. Therefore, as the parameters of quality of smoked fish, the microbiological as well as chemical and sensory quality parameters are monitored.

These are the sensory methods used to assess appearance, texture, color, odor and taste of fish and fish products, by human senses and often, for the quality monitoring of cold smoked fish products these sensory indicators are monitored [6]. Especially when it comes to smoked food, the importance of sensory characteristics double increases, due to the specificity which smoke gives to this type of food, appealing to consumers. Numerous data in the literature are related to the research which aim was to monitor the changes of the most important sensory characteristics of fish and fish products during storage. The results show that fish and fish products packed in a mixture of gases and vacuum, maintain their sensory characteristics longer and the spoilage in them occurs later than it is the case with fish and fish products kept in the air with, according to the sensory evaluation, slight advantage in terms of sustainability mainly being determined in samples packed in a mixture of gases in relation to the samples packaged in a vacuum. Therefore, the aim of our study was to show the changes of selected sensory characteristics of cold smoked trout packed in a vacuum and modified atmosphere and to point out to the potential advantages or disadvantages of one of the two types of packeges.

II. MATERIALS AND METHODS

Rainbow trout *(Oncorhynchusmykiss)* is used for (average weight 1 kg). Fresh whole trout's were obtained from the fishery Bočac (owner-ship company "Tropic", Banja Luka, Republic of Srpska, Bosnia & Herzegovina) and transported to the fish processing plant in special refrigerated vehicles at 4 ^{o}C. The fish was subsequently headed. After that trout's were rinsed in potable water and then wet salted for 24 h in brine solution (9% salt) containing rosemary (*Quantum satis)* in a temperature-controlled room (4 °C). After salting, before smoking, fishes were drained for one hour at 20 °C in smoking chambers. The smoking was performed in automated smoke chambers at the temperature of 28 °C during the period of 8 hours. Subsequently, fish were cooled (at 2 °C, for 10 h) and then sliced (each slice 0.5 cm thickness; 75 g). During the slicing, both the skin and the rib bones were removed. Upon completion of the manufacturing process, two groups of samples were formed. The first group was vacuumed (group I) and the second one is packaged in a gas mixture with 90% CO_2 and 10% N_2. In packaging of smoked trout fillets in

modified atmosphere the Multivac device was used (Multivac C350, D-87787 Wolfertschwenden, Germany). Packing material was foil OPA/EVOH/PE (oriented polyamide/ethylene vinyl alcohol / polyethylene, UPM - Kymene, Walki Films, Finland) with low gas permeability (permeability degree to O_2 5 cm^3/m^2/day at 23 °C for N_2 1 cm^3/m^2/day at 23 °C for 23 $cm^3/m+$/day CO_2 at 23 °C and water vapor 15 g/m^2/day at 38 °C). Packages are filled with ready-made mixtures of gases of the producer Messer Tehnogas. Ratio of gas/sample in the package was 2:1. Smoked trout fillets from both groups were stored for 42 days at 3°C, and were subjected to a sensory analysis (at 0, 7th, 14th and 21st, 28th, 35th and 42th days of storage) by a panel of eight trained evaluators. Selection of evaluators was performed according to ISO 8586-1:1993 and 8586-2:2008 standards.Sensorial evaluation was performed by quantitative descriptive analysis (ISO 6564/1985). Evaluating paper included evaluation three parameters of quality. Each property was evaluated by a scale from 1 to 5. Marks indicated level of property expression (sensation of odor and taste to smoke and color intensity) as well as to evaluation of total acceptability. The results were statistically analysed (mean value, standard deviation, standard error, coefficient of variation and confidence interval for a variance) and statistical significance calculated (t-test and analysis of variance at 0.05) using FigurePad Prism 4.0 statistical package.

III. RESULTS AND DISCUSSION

Results of our study showed that the average scores of all parameters (overall acceptability, the intensity of sensations of taste and odor of smoke, the intensity of color) in both groups of trout fillets were decreasing during storage (Fig.1, Fig. 2, Fig 3).

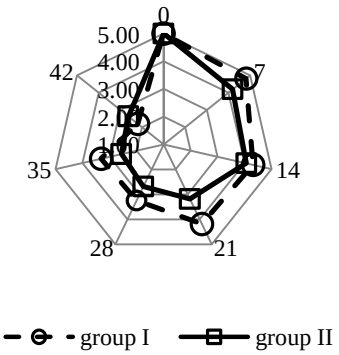

Figure 1 Change in average sensory evaluation of color intensity in both group of cold smoked trout during storage

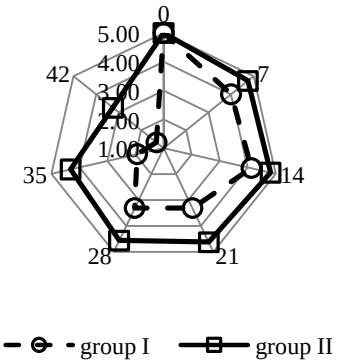

Figure 2 Change in average sensory evaluation of the intensity of sensations of taste and odor of smoke in both group of cold smoked trout during storage

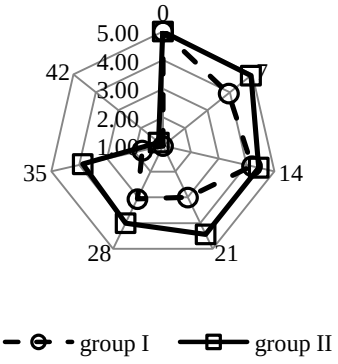

Figure 3 Change in average sensory evaluation of the overall acceptability in both group of cold smoked trout during storage

Comparing the average scores of color intensity of I and II group was identified with statistically significant higher scores of color intensity of

cold smoked fillets packed in vacuum compared to fillets packed in a mixture of gases throughout the storage period (Table 1).

Table 1 Statistical relevance of difference (t-test) between average sensory evaluations of color intensity in both groups of cold smoked trout during storage

Days of storage	Group I	Group II
	$\overline{X} \pm S_d$	$\overline{X} \pm S_d$
0	5.00±0.00	5.00±0.00
7	4.81^a±0.37	4.19^b±0.26
14	4.31^a±0.26	4.06^b±0.18
21	4.19^a±0.26	3.19^b±0.37
28	3.25^a±0.27	2.69^b±0.26
35	3.31^a±0.26	2.56^b±0.32
42	2.19±0.26	2.63±0.52

Means±S_d followed by different letters differ significantly ($p<0.05$).

Opinion is that the color of smoked fish products is of primary importance, which determines the consumer's choice of a particular type of food [14]. This is shown by tests conducted on the market of the European Union countries; too, showing that for the consumers, one of the most important indicators of the quality of smoked fish products is the expression of red color [15]. The same opinion is shared by Johnston et al. [16], while Lakshmanan et al. [17] emphasized that the loss of color as one of the most important parameters of the quality of cold smoked salmon, greatly reduces the price of of this product on the market. According to the research of Torrissen et al. [18], consumers in Germany and France, as the main indicator of the quality of smoked fish stress the prominence color. Pronounced discoloration that characterized the samples packed in a mixture of gases during the storage may be due to the action of CO_2. Poli et al. [19] point out that the loss of color of fish packed in a mixture of gases can be a result of denaturation of muscle proteins and pigment proteins, due to the formation of carbonic acid. Torriero [20] emphasizes that dissolving carbon dioxide in the tissues, while packing the fish in a mixture of gases, leads to acidification and decrease in pH value of meat, and such changes in the pH value of meat can cause changes in the color of the product. Goktepe and Moody [11], in their studies came to similar data. The color of smoked fish packed in a mixture of gases was losing the intensity and patterns were fading, compared to the fish kept in the air. Such a conclusion was also made, on the basis of their examinations, Masniyom et al. [21] and Hong et al. [22] who investigated the sensory characteristics of fresh sea bass and mackerel packed in a mixture of gases and air. Choubert and Baccaunaud [23] observed that salmon trout has a more distinct color when packed in a gas mixture having a lower content of CO_2, in combination with nitrogen, compared to the packaging in a mixture of gases with higher CO_2 content. Discoloration of salmon meat, as a result of the loss of pigment, was also noted by Partmann [24], in the salmon packed in a mixture of gases containing 100% CO_2 and Barnett et al. [25] who examined the salmon packed in a gas mixture with 90% CO_2.

Comparing the average scores of intensity of odor and taste of smoke of I and II group of trouts it was found that the scores were significantly higher in relation to the intensity of odor and taste of the smoke for cold smoked fillets packed in a mixture of gases compared to fillets packed in vacuum during the entire storage period (Table 2).

Table 2 Statistical relevance of difference (t-test) between average sensory evaluation of intensity of sensations of taste and odor of smoke in both group of cold smoked trout during storage

Days of storage	Group I	Group II
	$\overline{X} \pm S_d$	$\overline{X} \pm S_d$
0	5.00±0.00	5.00±0.00
7	4.00^a±0.27	$4.75^b \pm 0.27$
14	4.13^a±0.35	4.81^b±0.26
21	3.31^a±0.46	4.63^b±0.69
28	3.31^a±0.26	4.56^b±0.18
35	1.94^a±0.50	4.31^b±0.26
42	1.31^a±0.26	3.25^b±0.27

Means±S_d followed by different letters differ significantly ($p<0.05$).

High sensory scores of the intensity of odor and taste of the smoke of the cold smoked trout packed in a mixture of gases, throughout the whole storage period was characteristic of the

group of trout packed in a mixture of gases. The very cause of such a phenomenon remains unexplained, and therefore very interesting as a subject of future research. We believe that the increased CO_2 in the samples of group II significantly favored the intensity of odor and taste of the smoke. It is possible that the dissolved carbon dioxide, with a consequent lowering of pH in the samples, accelerated or initiated some of the reactions responsible for the formation of odor and taste of smoke.

Comparing the average scores of overall acceptability of group I and II of the trouts, it was found that statistically significant higher scores for overall acceptability were assigned to cold smoked fillets packed in a mixture of gases compared to fillets packed in a vacuum, on day 7, 21, 28, 35 of testing (Table 3).

Table 3 Statistical relevance of difference (t-test) between average sensory evaluations of overall acceptability in both groups of cold smoked trout during storage

Days of storage	Group I	Group II
	$\overline{X} \pm S_d$	$\overline{X} \pm S_d$
0	5.00±0.00	5.00±0.00
7	3.94^a±0.18	4.94^b±0.18
14	4.19±0.26	4.44±0.32
21	3.00^a±0.38	4.44^b±0.18
28	3.06^a±0.32	4.00^b±0.27
35	1.75^a±0.27	3.88^b±0.23
42	1.00±0.00	1.19±0.26

Means±S_d followed by different letters differ significantly ($p < 0.05$).

High scores of overall acceptability of trout fillets of II group were followed by high scores of odor and taste intensity of the smoke, which is not surprising given that the primary significance as to the parameter of quality of cold-smoked fish is given to the odor and taste of the smoke [26][27]. Although high average scores of intensity of odor and taste of the smoke in the samples of group II, had effect to the high scores of overall acceptability throughout the storage period, so they have had a positive impact on the acceptability of the product, however, such a phenomenon could have had some adverse effects on product quality . Actually, the intense odor and taste of the smoke may mask signs of spoilage and thus affect the relationship between bacteriological status and occurrence of signs of spoilage [28].

IV. CONCLUSION

Given the significance of the parameters of color expression of smoked fish products, the impact of CO_2 on the color, can be considered as a undesirable aspect of packing cold smoked trout in an atmosphere rich in carbon dioxide, compared to packaging in a vacuum. The intensity of odor and taste of smoke in the samples packed in a mixture of gases is the parameter that positively affects the overall acceptability of the final product. Certainly, the further research in this area, i.e. the impact and interaction of carbon dioxide with the smoke fractions responsible for the formation of the odorand taste of the smoke, would be of great importance for the study of quality of smoked products and the possibility of favoring this desirable sensory characteristics by applying different technological methods, which would increase the attractiveness and consumption of cold-smoked fish products. However, taking into account the most important aspect of the quality of certain food, and it is the safety for the consumers health, it should be noted that the intense odor and taste of the smoke in the samples of the group of fillets packed in a mixture of gases can hide certain changes that would indicate the presence of possible pathogens within the product and thus jeopardize the safety of the product. From these results of the examinations, it can be concluded that it is necessary to conduct further research to determine the best relationship between the characteristics of the production processes, the sustainability of the finished product and end user satisfaction.

REFERENCES

1. McMillin, K.,W. (2008). Where is MAP going? A review and future potential of modified atmosphere packaging hor meat. Meat Science 80: 43-65.
2. Sørheim, O., Aune, T., Nesbakken, T. (1997). Tecnologiacl, hygienic and toxicological aspects of carbon monoxide used in modified - atmosphere packaging of meat. Trends in Food Science & Technology 8: 307-312.
3. Bøknæs, N., Jensen, K.N., Guldager, H.S., Østerberg, C., Nielsen, J., Dalgaard, P. (2002).

Thawed chilled barents cod fillets in modified atmosphere packaging - application of multivariate data analysis to select key parameters in good manufacturing practice. *Lebensmittel-Wissenschaft und-Technologie* 35: 436-443.
4. Cutter, C.N. (2002). Microbial control by packaging: A review. *Critical Reviews in Food Science and Nutrition* 42(2):151-161.
5. Dainelli, D., Gontard, N., Spyropoulos, D., Zondervan-van den Beuken, E., Tobback, P. (2008). Active and intelligent food packaging: legal aspects and safety concerns. Review in Trends in Food Science & Technology 19:99-108.
6. Kerry, J.P., O'Grady, M.N., Hogan, S.A. (2006). Past, current and potential utilization of active and intelligent packaging systems for meat and muscle-based products: A review. Meat Science 74:113-130.
7. Hill, D.S. (2003). Present trends in food technology, Chapter 1 in Pests of Stored Foodstuffs and Their Control. Kluwer Academic Publishers.
8. Murcia, M.A., Martínez-Tomė, Nicolás, M.C., Vera, A.M. (2003). Extending the shelf-life and proximate composition stability of ready to eat foods in vacuum or modified atmosfere packaging. Food Microbiology 20: 671-679.
9. Vermeiren, L., Devlieghere, F., van Beest, M., de Kruijf, N., Debevere, J. (1999). Developments in the active packaging of foods. Review in Trends in Food Science & Technology 10: 77-86.
10. Radetić, P., Milijašević, M., Jovanović, J., Velebit, B. (2007). Pakovanje svežeg mesa u modifikovanoj atmosferi - trend koji traje. Tehnologija mesa 48:99-108.
11. Goktepe, I. and Moody, M.W. (1998). Effect of modified atmosphere packaging on the quality of smoked catfish. Journal of Muscle Food 9:375-389.
12. Özogul, Y., Özogul, F. (2004). Effects of slaughtering methods on sensory, chemical and microbiological quality of rainbow trout (*Onchorynchus mykiss*) stored in ice and MAP. European Food Research Tecnology 219:211-216.
13. Arashisar, Ş., Hisar, O. Kaya, M. Yanik, T. (2004). Effects of modified atmosphere and vacuum packaging on microbiological and chemical properties of rainbow trout (*Oncorynchus mykiss*) fillets. *International* Journal of Food Microbiology 97:209-214.
14. Schubring (2008). Use of "filtered smoke" and carbon monoxide with fish. Journal of Consumer Protection and Food safety, 3:31-44.
15. 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, Lebensm.-Wiss. u.-Technol. 37:627-638.
16. Johnston, I. A., Alderson, R., Sandham, C., Dingwall, A., Mitchell, D., Selkirk, C., Nickell, D., Baker, R., Robertson, B., Whyte, D., Springate, J. (2000). Muscle fibre density in relation to the color and texture of smoked Atlantic salmon (*Salmo salar L.*). Aquaculture, 189:335–349.
17. Lakshmanan, R., Miskin, D., Piggott, J.R. (2005). Quality of vacuum packed cold-smoked salmon during refrigerated storage as affected by high-pressure processing. Journal of the Science of Food and Agriculture 85:655–661.
18. Torrissen, O., J., Bencze-Røra, A., M., Nortvedt, R., Espe, M., Jørgensen, L., Sørensen, N., K., Olsen, S., O. (2000). In: Program & Abstract. Atlantic salmon-qality and market responses (pp. 75). The Ninth International Symposium on Nutrition & Feeding in Fish. May 21-25, 2000, Miyazaki, Japan.
19. Poli, B.M., Messini, A., Parisi, G., Scappini, F., Vigiani, V. Giorgi, G., Vincenzini, M. (2006). Sensory, physical, chemical and microbiological changesin European sea bass (*Dicentrarchus labrax*) fillets packed under modified atmosphere/air or prepared from whole fish stored in ice. International Journal of Food Science and Technology 41: 444–454.
20. Torrieri, E., Cavella, S., Villani, F, Massi, P. (2006). Influence of modified atmosphere on the chilled shelf life of gutted farmed bass (*Dicentrarchus labrax*). Journal of Food Engineering 77:1078-1086.
21. 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 82:873-880.
22. Hong, L.C., Leblanc, E. L., Hawrysh, Z. J., Hardin, R. T. (1996). Quality of Atlantic Mackerel (*Scomber scombrus L.*) Fillets during Modified Atmosphere Storage. Journal of food science Vol. 61, No. 3: 646-650.
23. Chouberta, G., Baccaunaud, M. (2006). Colour changes of fillets of rainbow trout (*Oncorhynchus mykiss W.*) fed astaxanthin or canthaxanthin during storage under controlled or modified atmosphere. *Lwt-food Science and Technology* 39:1203–1213.
24. Partmann, W. (1981). Investigations on the storage of packaged rainbow trouts (*Salmo gairdneri, R.*) in air and in carbone dioxide. Die Fleischwirtschaft 61:625–629.
25. Barnett, H. J., Stone, F. E., Roberts, G. C., Hunter, P. J., Nelson, R. W., & Kwok, J. (1982). A study

in the use of a high concentration of CO_2 in a modified atmosphere to preserve fresh salmon. Marine Fisheries Review 44:7–11.
26. Jónsdóttir, R., Ólafsdóttir, G., Chanie, E., Haugen, J.E. (2008). Volatile compounds suitable for rapid detection as quality indicators of cold smoked salmon (*Salmo salar*). *Food Chemistry*, 109, 184-195.
27. Ólafsdóttir, G., Kristbergsson, K. (2006). Electronic-Nose Technology: Chapter 5. Application for Quality Evaluation in the Fish Industry in Odors in Food industry, Springer US.
28. Lyhs, U. (2002). Lactic acid bacteria associated with the spoilage of fish products, Academic dissertation, Faculty of Veterinary Medicine, University of Helsinki

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