Research on sustainability of fresh turkey meat packed in modified atmosphere

Bratulić[1], M., N. Cukon[2], L. Kozačinski[3], M. Ćustić[4], S. Hafner[5]

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Summary

For the needs of our research on sustainability of turkey meat packed in modified atmosphere, samples of fresh turkey meat were researched and they were: turkey fillet, steak, thigh, ground leg and turkey fillet treated with mixture of additives. The meat was packed in controlled conditions by using BIOGON OC 30 mixture with 70% O2 : 30% CO2 gas ratio. Meat samples were stored at temperatures from 4°C to 6°C. Microbiological and sensory research on packed meat was performed on the 1st, 4th, 8th and 12th day, and the research on turkey fillet treated with mixture of additives based on acetate, citrate and antioxidant (E 262, E331, E500, E301) on the 15th day as well. The results have shown that the meat packed in MAP with 70% oxygen share under optimal conditions can be kept safe for human nutrition in recommended shelf life of 8 days, in which meat samples are still within the allowed limits of parameters for evaluation of their safety. The recommended shelf life for turkey meat treated with mixture of additives based on acetate, citrate and antioxidant is up to 12 days.

Keywords: *fresh turkey meat, packaging, modified atmosphere*

Introduction

Due to demand for a product of good quality, packing fresh meat in modified atmosphere packaging (MAP) has become a significant method of preserving its quality. The European Union defines gases as argon, carbon dioxide, helium and other gases as allowed gases for procedures of modified atmosphere packaging (Plazonić, 2010). The real usage of these gases depends on producers and the food that is packed.

Fraqueza and Barreto (2009) researched the method of packing turkey meat in the mixture of argon gas and determined that this does not achieve better effects in comparison to decreased lipid oxidation of turkey meat. The same authors (2011) researched the effect of mixture of anaerobic gases with CO to growth of micro flora of spoilage, color and lipid oxidation of turkey meat stored at 0°C. They determined that the presence of CO in the mixture of gases with CO_2 affected the meat quality in the sense of light pink color that is acceptable to end users. Szalai et al. (2003) researched the effect of MAP to extension of shelf life of turkey breast fillets and chopped turkey breast. The mixture of 80% CO_2 and 20% N_2 extended the shelf life of turkey breast fillets up to the 20th day, whereas the mixture of 50% CO_2 and 50% N_2 was more suitable for extension of shelf life of chopped turkey breast. Dhananjayan et al. (2006) researched the bactericidal effect of MAP to turkey meat, whereas Orkusz et al. (2005) researched the sustainability and color of turkey meat packed in MAP and determined that turkey can be stored for 15 days in refrigerator conditions.

Živković et al. (2006) concluded that the increase of O_2 quantity affected the color of turkey meat, and the increase of CO_2 quantity affected the taste of turkey meat. Rajkumar et al. (2007) emphasize that vacuum packaging keeps the characteristic odor of turkey meat better. Fraqueza et al. (2008) estimated the shelf life of turkey meat of different categories packed in aerobic and modified atmosphere conditions, from the point of view of the relation between the quality and microorganisms in total volatile nitrogen. TVB-N did not show itself to be an appropriate indicator of meat spoilage. The effects of different ratios of O_2 and CO_2 in MAP to microbiological quality and color of meatballs were researched by Yilmaz et al. (2010). Ntzimani et al. (2008) determined lower quantities of biogenic amines during 30 days of storage of turkey in MAP (M1 30% CO_2:70% N_2 ; M2 -50% CO_2:50% N_2). Microbial count in meat in M2

[1] **Mario Bratulić, DVM**, Puris d.d. Pazin, Croatia;

[2] **Nenad Cukon, M.A., DVM** The Ministry of Agriculture, Fishing and Rural Development of the Republic of Croatia, Veterinary Directorate

[3] **Lidija Kozačinski, PhD**, Full Professor, University of Zagreb, Faculty of Veterinary Medicine, Department of Hygiene, Technology and Food Safety, Heinzelova 55, Zagreb, Croatia

[4] **Milena Ćustić, engineer**, Pula, Croatia

[5] **Silvija Hafner, B.Sc.**, Rijeka, Croatia

grew during storage and it was 7 log cfu/g after 22 days, while it was 26 days in M1. *Pseudomonas* spp and Enterobacteriaceae remained below detection level up to the 30th day of storage in M2.

Karpin'ska-Tymoszczyk (2011) researched the effect of using antioxidant in turkey meat in vacuum packaging by comparing the results with the turkey meat packed in MAP (VP and MAP-20% CO_2 /80% N_2). The research by Remm et al. (2011) of microbiological and sensory quality of ground turkey meat packed in MAP showed that a roughly minced meat had weaker sensory characteristics.

Packing fresh turkey meat in MAP has been researched a lot in the past years, but all the effects in the sense of sustainability of fresh turkey meat are still not known. Subsequently, by this research we join the need of researching sustainability of fresh turkey meat in MAP.

Material and methods

Industrial samples of fresh, portioned and chopped meat which were taken from 20-week-old Nicholas turkey cocks, 19.6 kg on average. After cooling, carcasses of 14.82 kg on average were cut, with the temperature in the deep breast of 1.2°C. After further processing, standard turkey cuts were prepared for packing and they were: turkey fillet, steak, thigh, ground leg and turkey fillet treated with mixture of additives based on Na acetate, Na citrate and antioxidant.

The meat was packed in controlled conditions by using BIOGON OC 30 mixture with 70% O_2 : 30% CO_2 gas ratio on Multivac R570 machine for thermoforming plates within the regular production process which is carried out routinely in an industrial plant. High barrier films were used in packing. Lower transparent film of 500 microns for thermoforming based on APET with a polyethylene layer for welding which shows a good transparency, has high firmness and excellent behavior at thermoforming, and top film PET/EVE 80 LAF (80 microns), which has polyethylene/EVOH/polyethylene structure with anti-fog effect. Meat samples were stored in a refrigerator at 4 to 6±1°C. Bacteriological and organoleptic research on packed meat was performed on the 1st, 4th, 8th and 12th day, and the research on turkey fillet treated with mixture of additives based on acetate, citrate and antioxidant (E 262, E331, E500, E301) on the 15th day since packing as well.

Five samples of each product were prepared for researches. The samples were analyzed in an accredited laboratory, and there were performed sensory and bacteriological researches which were interpreted according to the Regulation on microbiological criteria for foodstuffs. A sensory panel determined the odor, appearance and changes on the packed product. HRN ISO methods were used in microbiological research of the products in determining the count of aerobic mesophilic bacteria, species *Staphylococcus aureus, L. monocytogenes, E. coli,* then sulphite-reducing clostridia *Salmonella* spp and *Enterobacteriaceae*.

Table 1 **Results of bacteriological research of turkey meat samples on the 4th day of storage in MAP**

MEAT PART	T/°C	AMB	S/25g	S.a.	E.C.	E	SRC	L.m.
BREAST	4.1	104	0	0	0	0	0	0
STEAK	6.0	7.0x104	0	0	0	0	0	0
GROUND MEAT	4.7	4.2x104	0	0	0	0	0	0
THIGH	5.0	1.2x105	0	0	0	0	0	0
BREAST WITH ADDITIVE	2.9	8.0x104	0	0	0	0	0	0

* AMB = aerobic mesophilic bacteria; S = *Salmonella* spp., S.a.= *Staphylococcus aureus;* E.c.= *Escherichia coli*; E= *Enterobacteriaceae*; SRC = sulphite-reducing clostridia; L.m. = *Listeria monocytogenes*

Table 2 **Results of bacteriological research of turkey meat samples on the 8thday of storage in MAP**

MEAT PART	T/°C	AMB/g	S/25g	S.a. /g	E.C. /g	E/g	SRC/g	L.m. /g
BREAST	1.8	104	0	0	0	0	0	0
STEAK	4.3	1.7x105	0	0	0	0	0	0
GROUND MEAT	3.4	105	0	0	0	0	0	0
THIGH	3.4	7.0x105	0	0	0	0	0	0
BREAST WITH ADDITIVE	1.6	4.0x105	0	0	0	0	0	0

* AMB = aerobic mesophilic bacteria; S = *Salmonella* spp., S.a.= *Staphylococcus aureus;* E.c.= *Escherichia coli*; E= *Enterobacteriaceae*; SRC = sulphite-reducing clostridia; L.m. = *Listeria monocytogenes*

Results and discussion

On day 0 in our research, the samples of fresh turkey meat and chopped ground leg were controlled before packing, where temperatures of meat before gasification ranged between 3.2°C for turkey breast to 1.2°C for turkey breast steak, and the temperatures after gasification were 4.6°C for turkey breast and 4.7°C for ground turkey leg. Total aerobic mesophilic bacteria in fresh cooled meat was 10^3 cfu/g for turkey thigh, 2.3 x 10^4 cfu/g for ground leg, 3.7 x 10^4 cfu/g for turkey breast to 4.2 x 10^4 cfu/g at the most in turkey breast steak. Turkey breast with added additives had a growth of 12% after injecting and tumbling. On the 4th day

Table 3 **Results of bacteriological research of turkey meat samples on the 12th day of storage in MAP**

MEAT PART	t/°C	AMB/g	S/25g	S.a. /g	E.c. /g	E/g	SRC/g	L.m. /g
BREAST	3.7	**>106**	0	0	0	0	0	0
STEAK	4.2	**>106**	0	0	0	**105**	0	0
GROUND MEAT	3.0	**>106**	0	0	**>103**	**105**	0	0
THIGH	3.7	**>106**	0	0	0	**105**	0	0
BREAST WITH ADDITIVE	3.9	9.0X105	0	<102	<102	<104	0	0

* AMB = aerobic mesophilic bacteria; S = *Salmonella* spp., S.a.= *Staphylococcus aureus;* E.c.= *Escherichia coli*; E= *Enterobacteriaceae*; SRC = sulphite-reducing clostridia; L.m. = *Listeria monocytogenes*

Table 4 **Results of bacteriological research of turkey breast samples with additive on the 15th day of storage in MAP**

TURKEY BREAST	T/°C	AMB/g	S/25g	S.a. /g	E.c. /g	E/g	SRC/g	L.m. /g
SAMPLE 1	0.6	**106**	0	**1.3x103**	2.0x102	**3.0x104**	0	0
SAMPLE 2	1.1	**>106**	0	**103**	6.0x102	**3.0x104**	0	0
SAMPLE 3	1.2	**>106**	0	**1.2x103**	5.0x102	**2.0x104**	0	0
SAMPLE 4	0.6	**106**	0	**1.1x103**	2.0x102	**2.8x104**	0	0
SAMPLE 5	1.2	**>106**	0	**1.2x103**	5.0x102	**2.0x104**	0	0
m	0.9	**>106**	0	**1.1x103**	4.3x102	**2.6x104**	0	0

* AMB = aerobic mesophilic bacteria; S = *Salmonella* spp., S.a.= *Staphylococcus aureus;* E.c.= *Escherichia coli*; E= *Enterobacteriaceae*; SRC = sulphite-reducing clostridia; L.m. = *Listeria monocytogenes*

of the research it was determined in sensory research that there were no changes in the samples, and microbiological research (Table 1) shows that the samples were within the allowed parameters and there was no significant increase in aerobic mesophilic bacteria, except in the sample of thigh (1.2 x 10^5 cfu/g). Color and odor remained characteristic for turkey meat.

After 8 days of storage, sensory research determined that the color of turkey did not change and it was characteristic for the kind of meat. The results indicate that the gas mixture with 30% CO_2 had a favorable effect, which has also been determined by Fraqueza and Barreto (2011). The effect on color and taste in MAP is emphasized by Živković et al. (2006), who determined that after packing, the increase in O_2 quantity affected the color and the increase in CO_2 quantity affected the taste of turkey meat. A remark of untypical odor of turkey meat was made for two of five observed samples of turkey thigh. In bacteriological research (Table 2) , total aerobic bacterial count was highest in turkey thigh. Modified atmosphere packaging extended the usual sustainability of turkey meat and, according to Plazonić (2010), MAP prolongs the shelf life of perishable food, decreases microbial growth, and the product keeps its shape and appearance, vitamins, taste and fat, as well as natural color. Church and Parsons (1995) also list that it keeps the product more sustainable, which includes a prolonged distribution. On the contrary, Szalai et al. (2003) consider that the extension of shelf life of products of fresh turkey meat in MAP should be in the content of 80% CO_2 and 20% N_2 up to the 20th day, whereas the mixture of gases in the content of 50% CO_2 and 50% N_2 was more suitable for extending the shelf life of chopped turkey breast.

After the 12th day there was determined a change from typically light pink to grey color, and highly unpleasant odor with ground turkey leg and thigh with bones. There was determined an increase in aerobic mesophilic bacteria (>10^6 cfu/g) and enterobacteria, whereas the count of *E. coli* and enterobacteria exceeded the allowed values in samples of chopped meat (Table 3). Microbiological spoilage of samples was confirmed by sensorial changes. In the research by Yilmaz et al. (2005) on the 7th day of packaging in vacuum and 100% CO_2 ,total bacterial count was 6.3 log cfu/g.

It is important to emphasize that aerobic mesophilic bacterial count was within the allowed limits in the sample of treated turkey breast with additive based on Na acetate, which indicates to efficiency of additive mixture. On the other hand, during the research of the treated turkey breast on the 15th day (Table 4), a significant increase in aerobic mesophilic bacterial count was recorded in three out of five samples, and the count of *S. aureus*, *E. coli* and enterobacteria exceeded the maximum allowed quantities. The change of color to light grey and a very untypical odor for turkey meat were also determined, which differs from the research findings by Orkusz et al. (2005) who did not determine changes on the 15th day of storage. The results of our research indicate that the recommended shelf life of injected turkey meat should be up to 12 days, when the samples are still within the allowed limits of parameters for evaluation of health safety.

Conclusion

Turkey meat packed in MAP in industrial conditions with high content of oxygen of 70% can be kept safe for human nutrition in recommended limit of 8 days in storing conditions which are in accordance

Untersuchungen der Erhaltbarkeit von frischem Putenfleisch gepackt in der modifizierten Atmosphäre

Zusammenfassung

Zu Zwecken unserer Untersuchungen hinsichtlich Erhaltbarkeit von Putenfleisch gepackt in der modifizierten Atmosphäre wurden Musterproben des frischen Putenfleisches untersucht, u.zw: Putenfilet, Schnitzel, Hinterkeule, gehackte Keule, sowie Putenfilet behandelt mit Additivmischung. Das Fleisch wurde in kontrollierten Bedingungen gepackt, unter Anwendung der fertigen Mischung BIOGON OC 30 mit Gasverhältnis 70 % O2 : 30 % CO2. Die Fleischmuster wurden auf Temperatur von 4° C bis 6° C gelagert. Mikrobiologische und sensorische Untersuchung wurde am 1., 4., 8., und 12. Tag durchgeführt, und für das behandelte Fleisch mit Additivmischung auf Basis von Azetat, Zitrat und Antioxidans (E262, E331, E500, E301) auch am 15. Tag. Die Resultate haben gezeigt, dass Putenfleisch gepackt in MAP mit Sauerstoffanteil von 70 % in optimalen Lagerbedingungen, für Nahrungszwecke der Menschen in der empfohlenen Frist von 8 Tagen als richtig gesehen werden kann. Die empfohlene Frist für das behandelte Fleisch mit Mischung von Azetat, Zitrat und Antioxidans beträgt bis zu 12 Tagen.

***Schlüsselwörter**: frisches Putenfleisch, Packen, modifizierte Atmosphäre*

Ricerca della sostenibilità di carne tacchina confezionata nell'atmosfera modificata

Sommario

A causa della nostra ricerca della sostenibilità di carne tacchina confezionata nell'atmosfera modificata, sono stati ricercati i campioni di carne tacchina fresca, come segue: filetto di tacchino, petto, sopracoscia, fuso di tacchino e filetto trattato con la miscella di aditivi. La carne è stata confezionata nelle condizioni controllate, con uso contemporaneo di una miscella già preparata BIOGON OC 30 con interrelazione di gas del 70% di O2 e del 30% di CO2. I campioni di carne sono stati immagazinati sulla temperatura tra 4°C e 6°C. La ricerca microbiologica e sensorica è stata fatta il primo, il quarto, l'ottavo ed il dodicesimo giorno, e per il filetto tacchino trattato con la miscella di aditivi a base di acetati, citrati e antiossidanti (E 262, E331, E500, E301) è stata fatta il quindicesimo giorno. I risultati hanno rivelato che la carne tacchina, confezionata nel MAP con la percentuale di ossigeno del 70% può essere mantenuta nelle condizioni ottimali di immagazinamento e sostenersi accettabile per l'alimentazione umana nell'ambito di 8 giorni raccomandati, in cui i campioni di carne continuano essere nei limiti di parametri per la valutazione di correttezza igienica. La raccomandata data di scadenza per la carne tacchina trattata con la miscella di aditivi a base di acetati, citrati e antiossidanti è fino a 12 giorni.

***Parole chiave:**carne tacchina fresca, confezione, atmosfera modificata*

with the regulations. Shelf life for turkey meat treated with mixture of additives based on acetate, citrate and antioxidant in our research was 12 days. Through that time meat samples were sensorially unchanged and safe according to current regulations. New methods of packing in controlled atmosphere can be a guarantee of safety for nutrition in recommended shelf life.

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