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Evaluation of shelf life of cured, cooked, sliced turkey fillets and cooked pork sausages—'piroski'—stored under vacuum and modified atmospheres at +4 and +10 °C

Efthimia S. Pexara, John Metaxopoulos, Eleftherios H. Drosinos*

Agricultural University of Athens, Department of Food Science and Technology, Laboratory of Food Quality Control and Hygiene, Iera Odos 75, Votanikos, Athens, GR-118 55, Greece

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Abstract

Evaluation of shelf life was made of cured, cooked, sliced turkey breast fillets and a type of cooked pork sausage called 'piroski', stored in vacuum and in six different modified atmospheres (MA) at +4 and +10 °C. Total viable count, lactic acid bacteria, pH changes, colour attributes and the presence of pathogenic bacteria (listeriae, staphylococci) were monitored during the storage. The results of the study showed that the average shelf life for both products was 2 and 1 week at 4 and 10 °C, respectively. By the end of these periods, the bacterial population consisting of only lactic acid bacteria reached 10^8 cfu g^{-1}. Macroscopical (colour, drip loss and slime) and organoleptical changes (sour odours) were not related to pH and observed already at pH values >5.5. It is concluded that the use of MA packaging in these tests did not extend and not reduce the product shelf life in comparison to vacuum packaging.

Keywords: Shelf life; Smoked turkey breast fillet; Pork sausages; Cured meat products; Food safety; Vacuum; Modified atmosphere packaging

1. Introduction

The improvement of the microbial quality of products of animal origin by amendment of the extrinsic parameters of the food ecosystem, is familiar practice in the meat industry. Temperature and gaseous atmosphere prevailing during transportation, storage and retailing are among the parameters that most of the industries intervene to succeed better keeping quality and thereby extension of the shelf life.

The visual appearance of fresh meat and meat products is of major importance when consumers assess product quality. Thermal processed cured meat products are discoloured faster during illuminated retail display than in darkness. The combination of light and residual oxygen, that presents in both vacuum and modified atmosphere (MA) packages, causes discolouration. The pigment responsible for the characteristic pink colour of cured cooked meat products is the nitrosomyochrome. Exposure of nitrosomyochrome to oxygen, even at low oxygen levels, promotes its oxidation imposing a dull greyness on the meat surface. In the MA packaging of fresh retail meat the stabilization of the red colour of the product is a challenge. During the past 15 years, a part of the Norwegian meat industry has been using a gas mixture of 60–70% CO_2, 30–40% N_2, and 0.3–0.4% CO for the packaging of fresh retail meat namely beef, pork and lamb. This gas mixture with carbon monoxide maintains a stable, cherry red colour during shelf life of the meat. MA containing CO can also be beneficial for cooked, cured meat products (Aasgaard, 1993; Sørheim, Aune, & Nesbakken, 1997).

The great vulnerability of MA-packed foods is that with MA containing moderate to high levels of carbon dioxide, although the aerobic colour spoilage organisms, which usually warn consumers of spoilage, are inhibited, the growth of pathogens may be allowed or even stimulated. In addition, the extended shelf life of products packed in MA, may allow pathogens to reach dangerously high levels in a food (Farber, 1991; García de Fernanto, Nychas, Peck, & Ordóñez, 1995; Genigeorgis, 1985).

* Corresponding author. Tel.: +30-1-529-4684; fax: +30-1-529-4683.

E-mail address: ehd@aua.gr (E.H. Drosinos).

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In the present study, the shelf life of cooked, cured turkey breast fillets and a type of pork sausage (piroski), was evaluated under two different kinds of packaging conditions: vacuum and a modified atmosphere (80% CO_2/ 20% N_2) currently used by the meat industry in Greece. These two packaging conditions were compared with five other mixtures of modified atmospheres used to extend shelf life of the products. The assessment of the shelf life was based on the microbiological counts of the total microbial population and lactic acid bacteria, pH and colour measurements as well as on the presence of pathogenic bacteria, namely *Staphylococcus aureus* and *Listeria monocytogenes*.

2. Materials and methods

2.1. Meat products

2.1.1. Processing of smoked turkey breast fillets

The meat raw material was frozen skinless turkey breasts purchased as 'ready-to-process' from suppliers abroad. The frozen turkey breast was allowed to thaw at 20 °C for 18 h. The temperature after thawing was kept at 0–2 °C. The thawed breasts were mechanically stitched with brine containing NaCl (10%), nitrate (0.075%), nitrite (0.075%), sodium ascorbate (0.5%), sodium polyphosphate (2%), flavourings (2.5%), monosodium glutamate (1%) and sucrose (1%). There was a 25% weight increase of the meat raw material due to the injected brine. The temperature of the brine was 1–4 °C. The cured fillets were transferred to a tumbling machine and 'massaged' 30 min twice in succession, with a time interval of 8 h, at 6–7 °C under vacuum (0.8 bar). After resting for 12 h, 3 kg tumbled breast was pressed into cylindrical nets, placed in cloth packs and cooked to a core temperature of 72–73 °C. At the beginning, smoke was applied at 45–50 °C to enhance the desired aroma and surface colour formation. Then heating was continued until the final core temperature was reached. After the heat treatment, the turkey fillets were chilled to 10 °C by water shower and air in a chiller for 8–10 h. The final product was stored at 2 °C for 24 h, sliced and packed. The weight of each fillet pack (five slices) was approximately 100 g.

2.1.2. Processing of the pork sausages

The meat raw material was frozen pork trimmings purchased as 'ready-to-process' from suppliers abroad. The frozen pork trimmings was thawed in water bath and tempered to a core temperature of –4 °C. After grinding, the meat raw material was mixed with salt (NaCl, 2%), starch (3%), skimmed-milk powder (2%), pork fat, spices (0.5%), sodium ascorbate (0.1%), polyphosphates (0.4%), potassium nitrate (0.015%), sodium nitrite (0.015%) and the mixture was filled into inedible casings. After stuffing, sausages were cooked to a core temperature of 74 °C. After cooking, the sausages were showered with cold water (10 °C) for 10 min to a core temperature 30–35 °C, drained and transferred to an air blast cooling room (−5 °C) to reduce their temperature to 2 °C. Then, the sausages were peeled and, after storage at 2 °C for 18 h, packed. The total weight of each package (five 'piroski' sausages) was 150 g.

2.2. Packaging of products

The cured, cooked, smoked and sliced turkey breast fillets as well as the pork "piroski" sausages were packed in vacuum and modified atmosphere containing 80% CO_2/20% N_2. Fillets and sausages were under refrigeration transported to a laboratory and handled immediately. Half of the vacuum packed samples were opened aseptically and repacked in the five gas mixtures to be tested using a Henco Vac 1900 packaging machine and a water vapour-impermeable film (type V 40-2, 40 μm thick). The oxygen transmission rate of the film was <35 $cm^3/m^2/24$ h/atm at 20 °C and 65% RH. The ratio among gas volume and product was 1:2. The other five gas mixtures to be compared with vacuum and 80% CO_2/ 20% N_2 were: (1) 60% CO_2 /20% O_2/20% N_2; (2) 0.4% CO/80% CO_2/rest N_2; (3) 1% CO/80% CO_2/rest N_2; (4) 0.5% CO/ 24% O_2/ 50% CO_2/ rest N_2; and (5) 100% N_2. Packed samples were stored at 4 and 10 °C.

2.3. Sampling procedure

One sample of 'piroski' sausage and one of turkey breast fillet from each storage trial and each kind of the five modified atmospheres and vacuum was taken at: 0, 3, 7, 14, 21 and 28 days for microbiological analysis, pH and colour determination.

2.4. Microbiological analyses

A sample (25 g) was transferred to a stomacher bag and 225 ml of sterile 0.1% (w/v) bacteriological peptone were added (Oxoid, Unipath, Basingstone, UK). The sample was homogenized with a stomacher (Stomacher 400, Seward) for 1 min at low speed, and for 30 sec at high speed, at room temperature. Serial decimal dilutions were prepared in Ringer's solution (Oxoid) and duplicate 1 or 0.1 ml samples of appropriate dilutions were poured or spread on total count and selective agar plates.

Aerobic mesophilic bacteria were determined on Plate Count Agar (Merck, Darmstadt, Germany), incubated at 30 °C for 72 h; lactic acid bacteria (LAB) on de Man, Rogosa, Sharpe (MRS) Agar (Merck), incubated anaerobically at 30 °C for 72 h (Gas-Pack System, BBL, Becton Dickinson, Cockeysville, MD, USA); enterobacteria on Violet Red Bile Dextrose (VRBD) Agar (Merck) incubated anaerobically at 37 °C for 24 h

(Gas-Pack System); staphylococci on Baird-Parker Agar (Merck) incubated at 37 °C for 48 h. Black colonies showing lecithinase activity on Baird-Parker's medium were tested for positive coagulase reaction (Bactident Coagulase, Merck).

Presence of *Listeria monocytogenes* was determined by suspending 25 g of sausage or fillet into 225 ml *Listeria* Enrichment Broth (Merck) followed by incubation at 30 °C for 48 h. Then the culture was streaked on PALCAM agar (Merck) and incubated at 30 °C for 48 h. The lowest detection limit for all microbiological analysis was 10^2 cfu g^{-1}, except for enterobacteria and *Listeria*; the detection limit of which were 10 cfu g^{-1} and absence in 25 g, respectively.

2.5. pH values

pH was measured by blending 10 g of sample with 90 ml of distilled water. A Multical 526 pH meter was used.

2.6. Colour measurements of pork sausages

The surface colour of pork sausages was measured using a colorimeter (Minolta Chroma Meter CR-200, Minolta, Osaka, Japan). Before each measurement, the apparatus was standardised against a white tile ($L=90.7$, $a=-0.9$ and $b=-0.1$). The colour was measured after opening the packs directly on three selected locations of the sausage surfaces. The red colour was expressed as the *a*-value, the higher the *a*-value the more red the sample. Colour of sliced turkey fillets was not measured as discolouration of this product is of minor importance.

3. Results

3.1. Fillets

The growth of the microbial population of fillets in vacuum and MA (80% CO_2/20% N_2) is shown in Fig. 1. It is evident that both total population and lactic acid bacteria grew at a similar rate. Essentially, the microbial population is nearly only lactic acid bacteria. The importance of storage temperature on the growth of bacteria is demonstrated by a higher growth at 10 °C than at 4 °C. No differences between vacuum and 80% CO_2/20% N_2 were noted after 25 days at 4 °C.

In the other five tested MA stored samples, insignificant differences in growth of lactic acid bacteria were evident except for the mixture (60% O_2/20% CO_2/20%

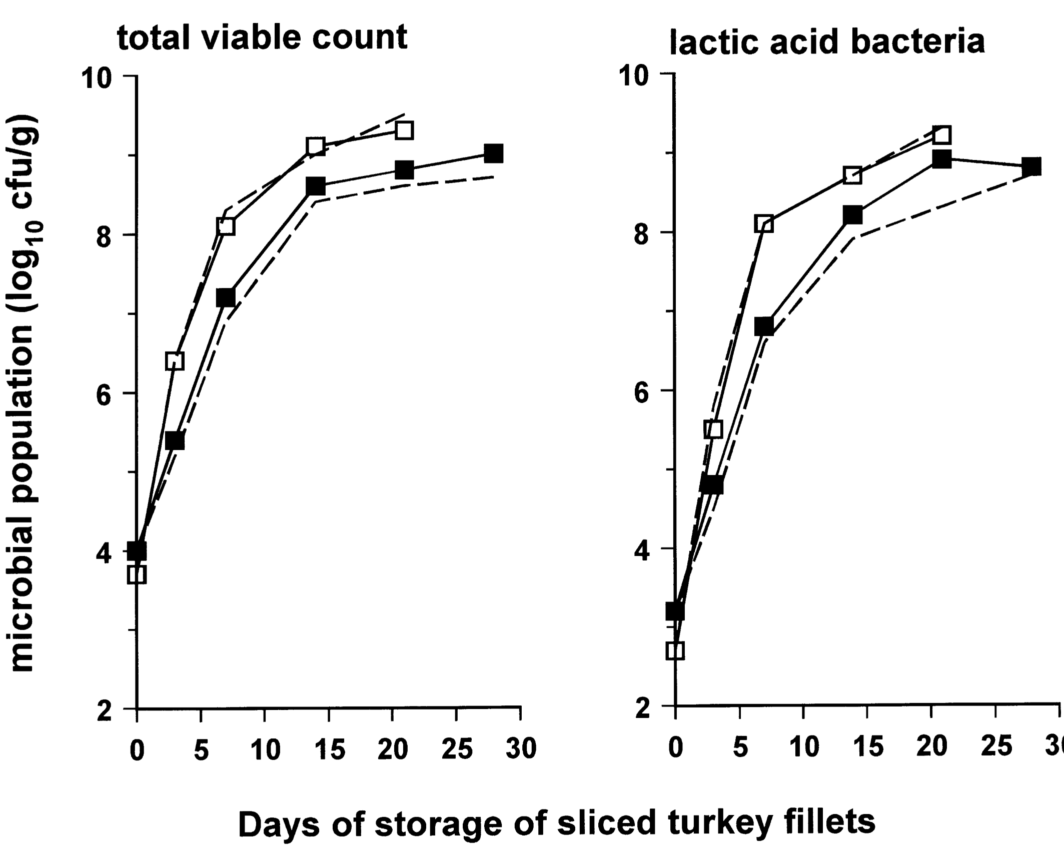

Fig. 1. Mean values ($n=5$) for total viable counts and lactic acid bacteria for cooked, sliced turkey breast fillets stored under vacuum (dashed lines) and in modified atmosphere (80% CO_2/20% N_2) at 4 °C (■) and 10 °C (□).

N_2) which gave the fastest growth. The other used mixtures had all the same influence as vacuum on the growth of the spoilage flora at 4 °C (Fig. 2). An inhibitory effect of the modified atmosphere was found for 0.5% CO/50% CO_2/24% O_2/N_2 due to the presence of carbon dioxide and the low initial microbial flora. As shown in Fig. 3, gaseous mixtures did not affect the growth at 10 °C in comparison with the growth at 4 °C. However, the lowest total count and lactic acid bacteria count at 10 °C were observed in 100% N_2 (Fig. 3).

Fig. 4 shows changes in pH of fillets stored under vacuum, in 80% CO_2/20% N_2 and in the five other tested MA at both storage temperatures. A drop was noted during storage from the initial 6.2 to 5.5 and to 5.0 at 4 and 10 °C, respectively. This decrease in pH was linear during the first 15 days of storage and occurred more rapidly for samples stored at 10 °C. For fillets stored in 100% N_2 at 10 °C, a delayed decrease of pH value was noted during the first 2 weeks of storage.

3.2. Pork sausages

Fig. 5 shows the growth of total microbial population and lactic acid bacteria for pork sausages stored in vacuum and in 80% CO_2/ 20% N_2 at 4 and 10 °C. The initial bacterial counts for samples stored under vacuum were ca. 4 $\log_{10}$ cfu g^{-1} and increased up to 8 $\log_{10}$ cfu g^{-1} during the first 2 weeks of storage. The product appeared macroscopically unacceptable (drip loss, slime) when the lactic acid bacteria reached counts of 10^7 cfu g^{-1}. Development of sour odours occurred when the lactic acid bacteria reached counts of 10^8 cfu g^{-1}. As indicated also in Fig. 5, the spoilage population is constituted only of lactic acid bacteria. For sausages stored in 80% CO_2/20% N_2, the microbial growth pattern was similar to the one stored in vacuum.

Pork sausages stored under each of the five tested MA, showed a trend in microbial growth resembling the one that was obtained at MA storage conditions currently used by the Greek meat industry. A bacteriostatic effect was noted (Fig. 6) for the modified atmosphere containing 0.5% CO and 50% carbon dioxide at 4 °C. Although storage of sausage samples at 10 °C (Fig. 7) accelerated the growth of the lactic acid bacteria spoilage population, a lower rate was noted for the samples stored in 0.4% CO/80% CO_2/20% N_2.

In Fig. 8 changes in pH value of sausages are shown. pH decreased slower in sausages than in fillets and less in vacuum than MA at 4 °C. The retarding influence of a low storage temperature 4 °C, on the rate of pH decline was more pronounced in samples stored under vacuum.

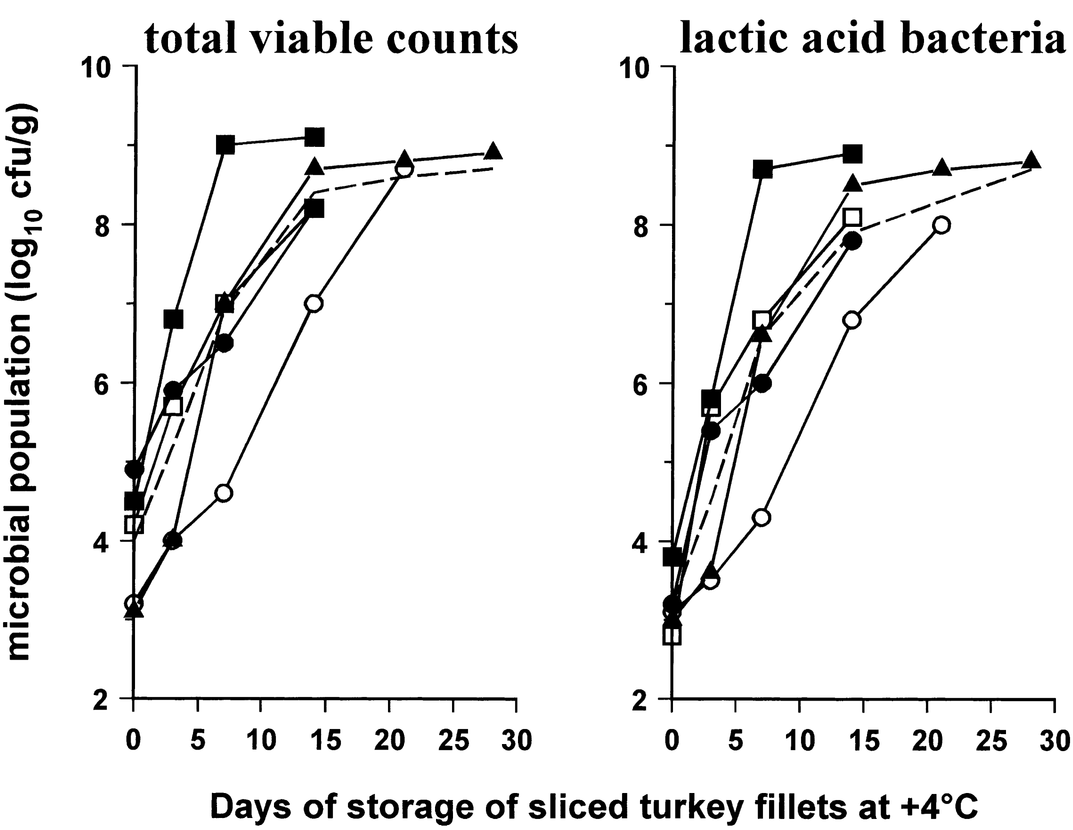

Fig. 2. Mean values (n=5) for total viable counts and lactic acid bacteria for cooked, sliced turkey breast fillets stored under different modified atmospheres: 60% O_2/20% CO_2/20% N_2 (■), 0.4% CO/80% CO_2/20% N_2 (□), 1.0% CO/80% CO_2/20% N_2 (●), 0.5% CO/50% CO_2/24% O_2/N_2 (○) and 100% N_2 (▲) at 4 °C. Dashed lines: vacuum.

Table 1
Incidence of staphylococci

Atmosphere[a]	Days of storage											
	Sliced turkey fillets						Sausages					
	0	3	7	14	21	28	0	3	7	14	21	28
4 °C												
Vacuum			2[b]	1				2				
80 CO_2/20 N_2	2	5	3	4	1				1			
60 O_2/20 CO_2/20 N_2			1	4	2			1				
0.4 CO/80 CO_2/ N_2		1		1								
1.0 CO/80 CO_2/ N_2		1	1									
0.5 CO/24 O_2/50 CO_2/N_2			1	1	20			2		1	1	
100 N_2		1+	2		2							
10 °C												
Vacuum		2	5	2				4	1			
80 CO_2/20 N_2			1					1	3			
60 O_2/20 CO_2/20 N_2				1								
0.4 CO/80 CO_2/N_2									1+	1		
1.0 CO/80 CO_2/N_2			1							4		
0.5 CO/24 O_2/50 CO_2/N_2			1							2		
100 N_2					20					1+	16	

[a] Percentages in volumes of gases of the used mixtures for modified atmosphere packaging.
[b] Numbers of colonies grown on Petri dishes in the 10^{-1} dilution, + positive coagulase test.

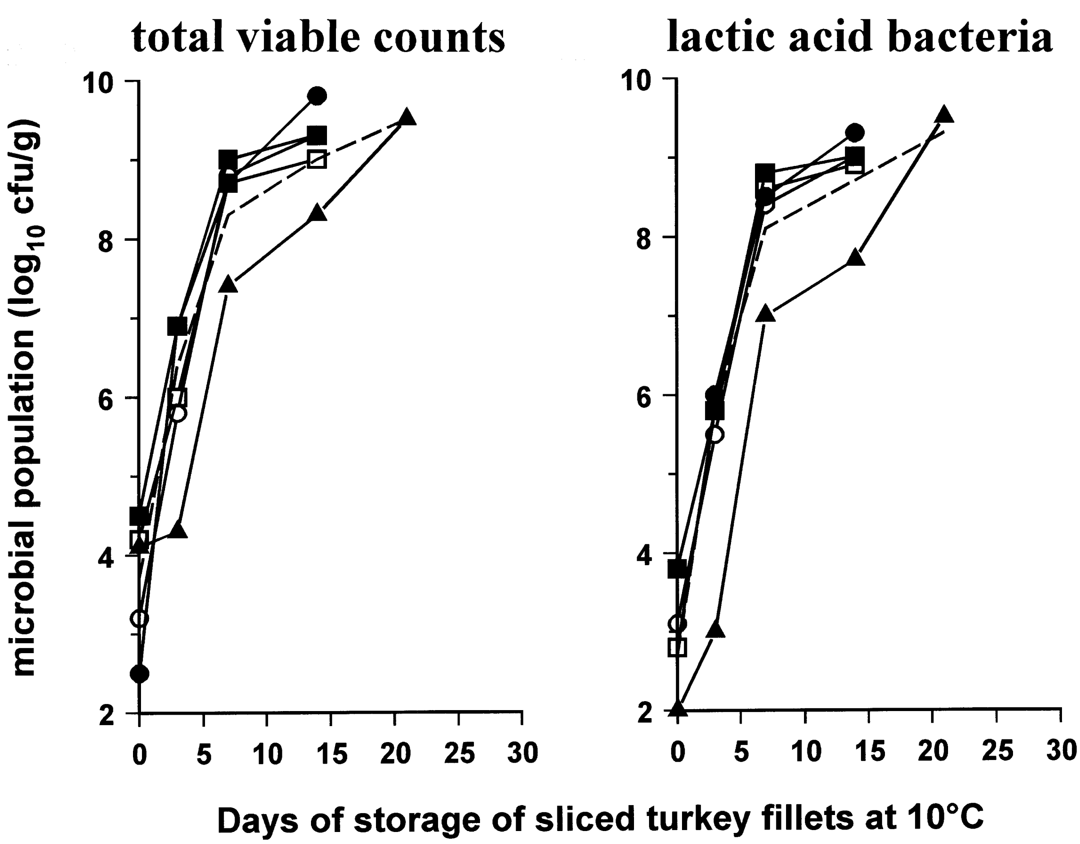

Fig. 3. Mean values ($n=5$) for total viable counts and lactic acid bacteria for cooked, sliced turkey breast fillets stored under different modified atmospheres: 60% O_2/20% CO_2/20% N_2 (■), 0.4% CO/80% CO_2/20% N_2 (□), 1.0% CO/80% CO_2/20% N_2 (●), 0.5% CO/50% CO_2/24% O_2/N_2 (○) and 100% N_2 (▲) at 10 °C. Dashed lines: vacuum.

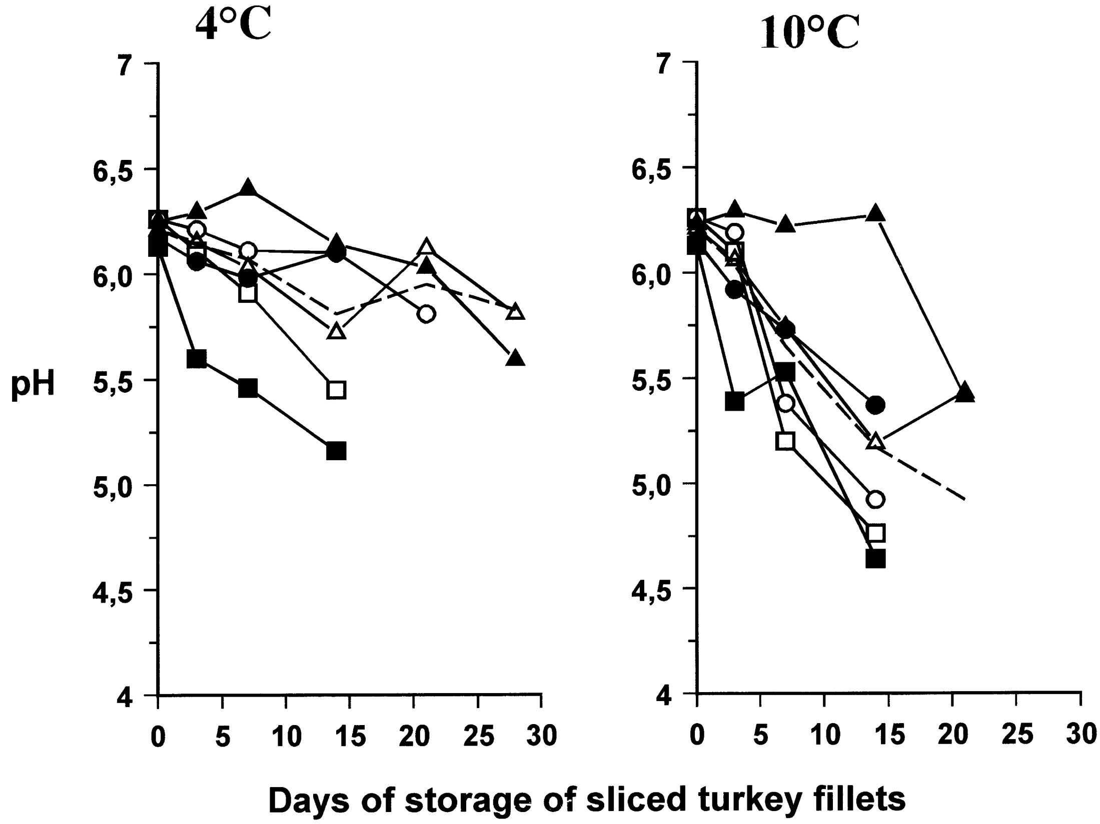

Fig. 4. Mean values ($n=5$) for pH values for cooked, sliced turkey breast fillets stored under vacuum (dashed lines) and in different modified atmospheres: 80% CO_2/20% N_2 (Δ), 60% O_2/20% CO_2/20% N_2 (■), 0.4% CO/80% CO_2/20% N_2 (□), 1.0% CO/80% CO_2/20% N_2 (●), 0.5% CO/50% CO_2/24% O_2/N_2 (○) and 100% N_2 (▲) at 4 and 10 °C.

Counts of enterobacteria and staphylococci were lower than 10 cfu g^{-1}, whereas *Listeria* was absent in 25 g. During storage pathogenic bacteria (staphylococci and listeriae) remained at low or zero initial levels in all samples. From totally 131 colonies of staphylococci (10^{-1} dilution), only three were positive to coagulase test (Table 1).

In Fig. 9 changes in sausage colour are shown. Sausages stored under vacuum and in 80% CO_2/20% N_2 had a stable red colour, as seen by the high a* values. The a* values of vacuum packed sausages and sausages packed under modified atmosphere of 80% CO_2/20% N_2 were insignificantly affected by the storage temperature. Sausages packed in high O_2 concentration were less red than sausages packed in other gas mixtures and discolouration was significantly greater at 10 °C than at 4 °C. The bright red colour of the sausages was more stable in 100% N_2 until 21 days of storage without noticeable signs of oxidation at both temperatures 4 and 10 °C (data not shown).

4. Discussion

Lactic acid bacteria is the major bacterial group associated with spoilage of refrigerated vacuum or MA-packed cooked meat products (Holley, 1997; Labadie, 1999; Samelis, & Georgiadou, 2000; von Holy, Cloete, & Holzapfel, 1991; Samelis, Kakouri, & Rementzis, 2000). At the time of spoilage, some products contain a 'pure' culture of only two species, while in others a mixture of *Lactobacillus* spp. and *Leuconostoc* spp. was found. The genus/species of lactic acid bacteria being responsible for spoilage, depend on the product composition (product-related flora) as well as on the house-related flora (Korkeala & Mäkelä, 1989). Lactic acid bacteria spoil refrigerated meat products by causing off-flavours, discolouration, gas formation, slime production and low pH (Borch, Kant-Muermans, & Blixt, 1996). *Lactobacillus sake* has been reported as one of the most important spoilage organisms of cooked meats (Borch et al., 1996; Borch & Molin, 1988; Dykes, Britz, & von Holy, 1994; Mäkelä, Schillinger, Korkeala, & Holzapfel, 1992). The high spoilage potential of *L. sake* is primarily due to its ability to form ropy slime (Korkeala, Suortti, & Mäkelä, 1988; Mäkelä et al., 1992; von Holly et al., 1991) or hydrogen sulphide (Egan, 1983).

The results of the present work indicated that the hygienic quality of the here tested industrially manufactured smoked turkey fillets and 'piroski' pork sausage was good. Only the high levels of lactic acid bacteria were of concern for the product shelf life. To

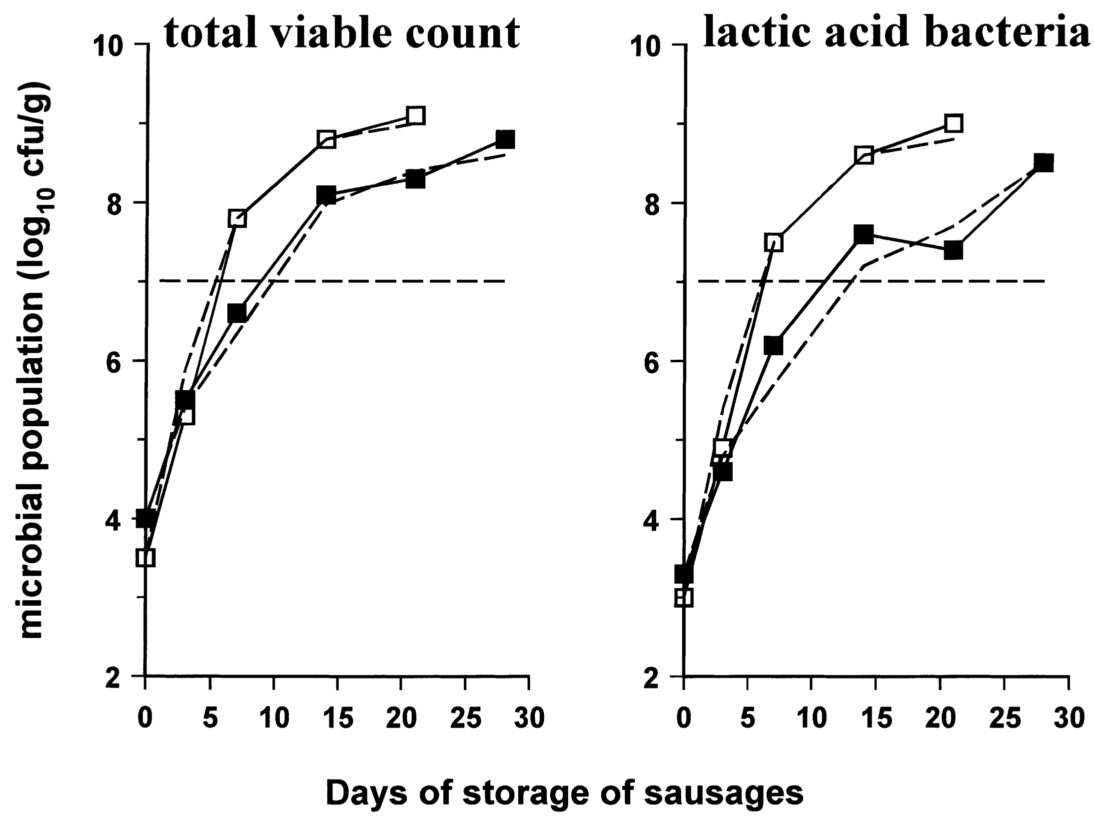

Fig. 5. Mean values ($n=5$) for total viable counts and lactic acid bacteria for piroski sausages stored under vacuum (dashed lines) and in modified atmosphere (80% CO_2/20% N_2) at 4 °C (■) and 10°C (□). Horizontal dashed line: spoilage limit.

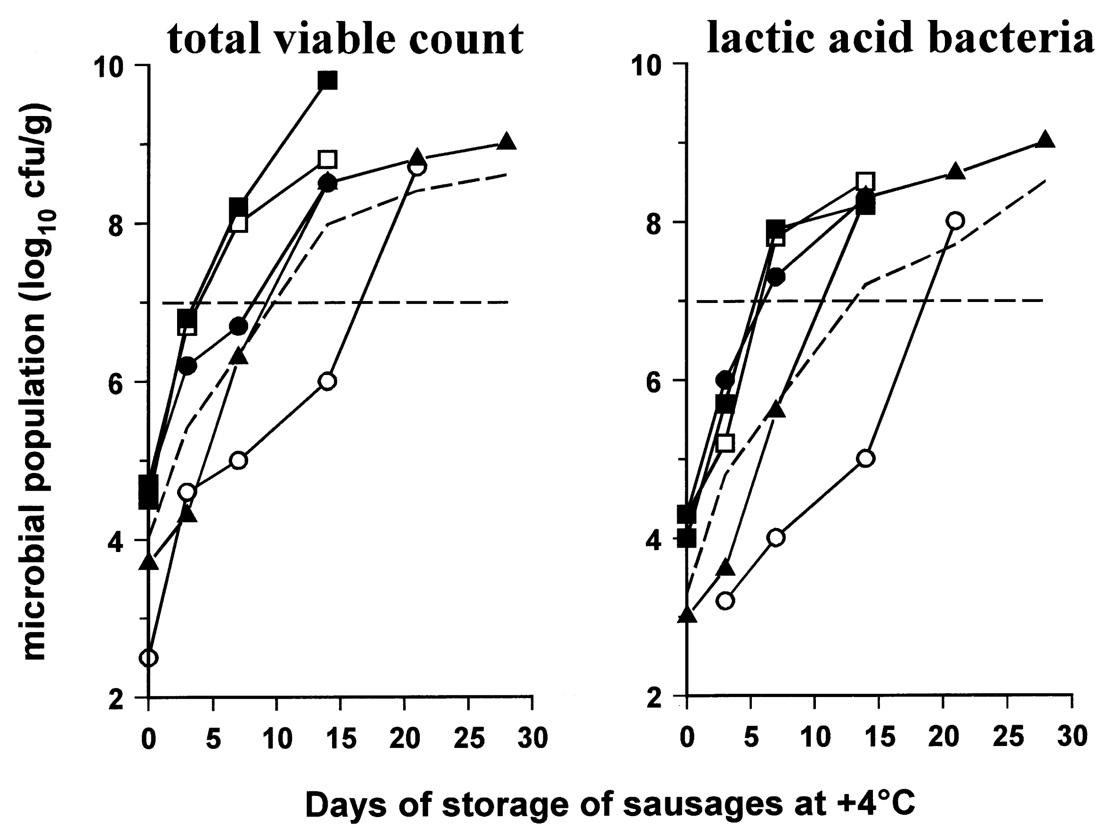

Fig. 6. Mean values ($n=5$) for total viable counts and lactic acid bacteria for piroski sausage stored at 4 °C under vacuum (dashed lines) and in different modified atmospheres: 60% O_2/20% CO_2/20% N_2 (■), 0.4% CO/80% CO_2/20% N_2 (□), 1.0% CO/80% CO_2/20% N_2 (●), 0.5% CO/50% CO_2/24% O_2/N_2 (○) and 100% N_2 (▲). Horizontal dashed line: spoilage limit.

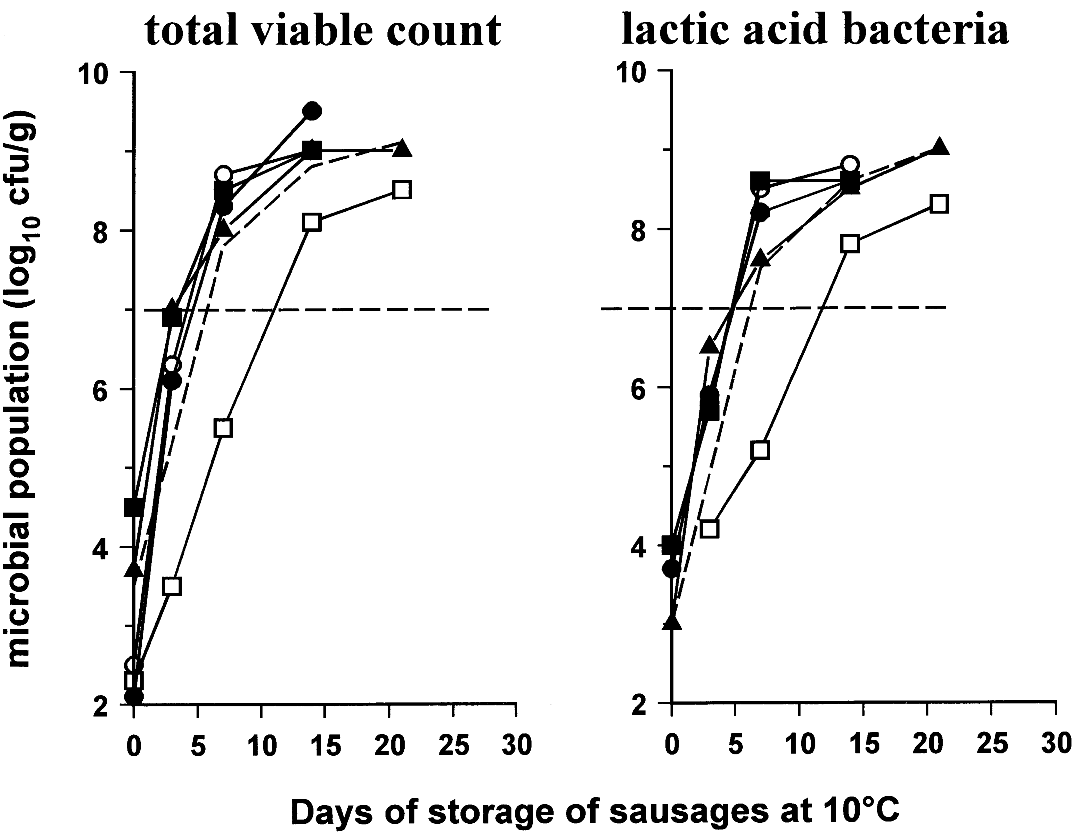

Fig. 7. Mean values ($n=5$) for total viable counts and lactic acid bacteria for piroski sausages stored under at 10 °C vacuum (dashed lines) and in different modified atmospheres: 60% O_2/20% CO_2/20% N_2 (■), 0.4% CO/80% CO_2/20% N_2 (□), 1.0% CO/80% CO_2/20% N_2 (●), 0.5% CO/50% CO_2/24% O_2/ N_2 (○) and 100% N_2 (▲). Horizontal dashed line: spoilage limit.

increase the shelf life of vacuum- or MA-packed cooked meats, the first measure is to reduce post-heating contamination, mainly with lactic acid bacteria. The quality of the hygiene in the slicing and packaging room is of vital importance since the higher the contamination at this stage is, the shorter the shelf life will be, regardless storage conditions (Samelis & Georgiadou, 2000).

In the present work modified atmosphere packaging did not indicate a pronounced retarding effect on the growth rate of lactic acid bacteria compared to vacuum packaging at both storage temperatures. The five gas mixtures of MA tested in the present study seemed to be ineffective of extending the product's shelf life in comparison with vacuum and 80% CO_2/20% N_2, used by the Greek meat industry. Korkeala, Rahkio, Ridell, and Mäkelä (1991) reported that cooked sausages inoculated with lactobacilli (10^4 cfu g^{-1}) stored in CO_2 and in vacuum had similar microbial counts and pH. CO_2 (100%) had no significant effect on extending the shelf life of Greek taverna sausages (Samelis & Georgiadou, 2000). Boerema, Penney, Cummings, and Bell (1993) concluded that the use of carbon dioxide could not be advocated to replace vacuum packaging for sliced, cooked, ham for extending product shelf life. Kant-Muermans, Stekelenburg, Zwietering, and Huis in't Veld (1997) observed no significant differences in growth behaviour of spoilage bacteria isolated from cooked meat products packed under vacuum and under MA.

In the present study, the inhibition of the tested modified atmospheres was higher when the gaseous mixture contains 50% CO_2, while higher concentrations of carbon dioxide had no retarding effect on microbial growth. It is well known that elevated levels of carbon dioxide inhibit microbial growth (Gill & Tan, 1979; Marchall, Wiese-Lehigh, Wells, & Farr, 1991; Wimpfheimer, Altman, & Hotchkiss, 1990). Gill and Tan (1979) have shown that little if any increase in effectiveness of modified atmosphere storage is obtained on meat or on complex media by increasing the CO_2 concentration well above 25%. For maximum antimicrobial effect, the storage temperature should be kept as low as possible, because the solubility of CO_2 decreases dramatically by increasing the temperature (Daniels, Krishnamurth, & Rizvi, 1985).

The present study confirmed that the shelf life of vacuum- or MA-packed cooked cured meats should preferably be defined by unacceptable appearance (slime, drip loss) rather than a certain maximum acceptable bacterial level. The dominating lactic acid bacteria, produce acids such as lactic acid, acetic acid and formic acid; the levels of which depending on genus, species and growth conditions which cause decrease in

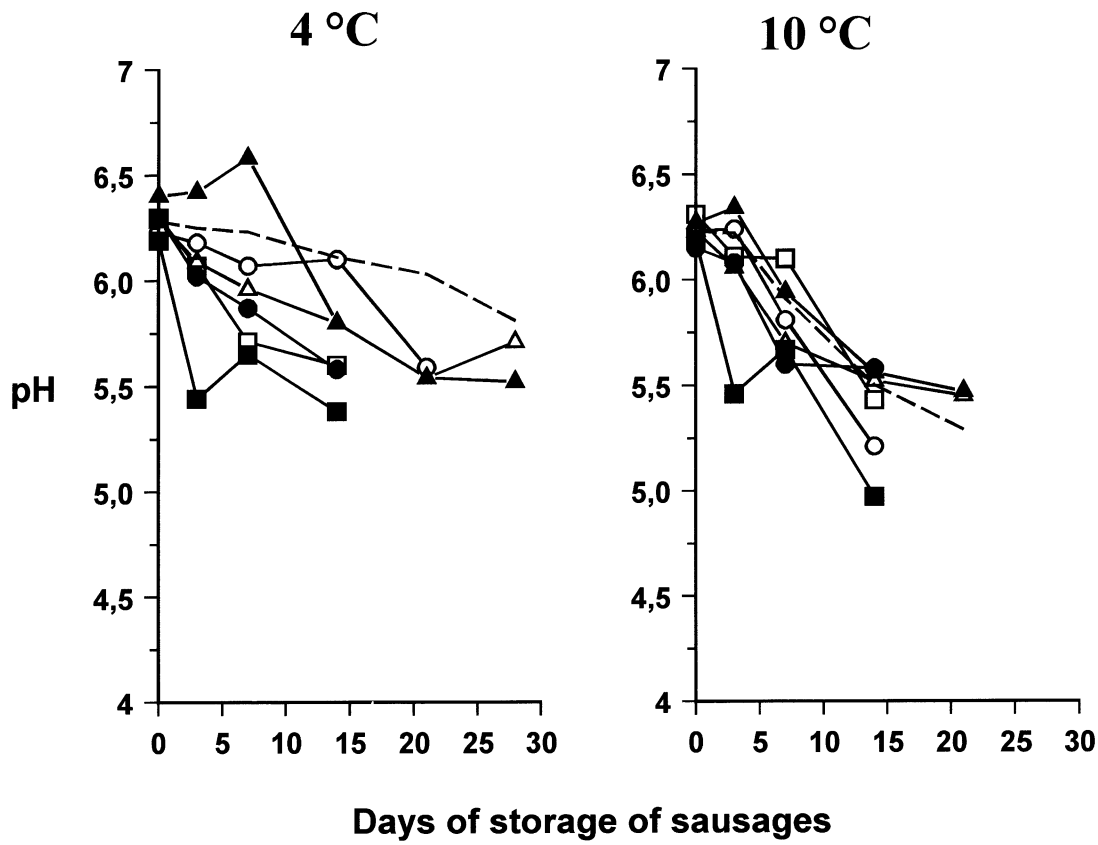

Fig. 8. Mean values ($n=5$) for pH values for piroski sausages stored at 4 and 10 °C under vacuum (dashed lines) and in different modified atmospheres: 80% CO_2/20% N_2 (△), 60% O_2/20% CO_2/20% N_2 (■), 0.4% CO/80% CO_2/20% N_2 (□), 1.0% CO/80% CO_2/20% N_2 (●), 0.5% CO/50% CO_2/24% O_2/N_2 (○) and 100% N_2 (▲).

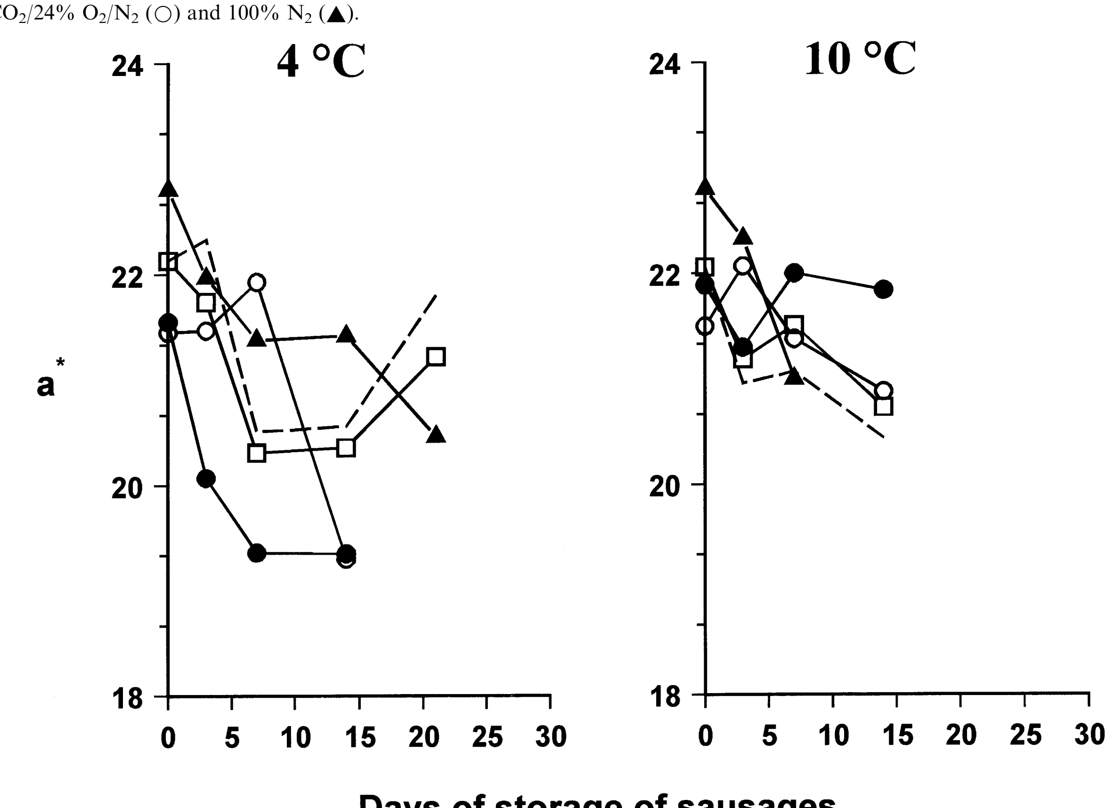

Fig. 9. Mean values ($n=5$) for a^* values for piroski sausages stored at 4 and 10 °C under vacuum (dashed lines) and in different modified atmospheres: 80% CO_2/20% N_2 (□), 0.4% CO/80% CO_2/20% N_2 (●), 1.0% CO/80% CO_2/20% N_2 (○), and 0.5% CO/50% CO_2/24% O_2/N_2 (▲).

pH (Borch, Berg, & Holst, 1991). The decrease in pH in meat products depends on the presence of fermentable carbohydrate. For example, a drop in pH from 6.3 to 5.6 was observed in Bologna-type sausages, while in liver sausages, the pH dropped to 5.0 (Borch et al., 1996). In the present work the pH decrease in sausages was less than in fillets. This is possible due to a lower carbohydrate concentration in sausages than in turkey fillets.

Carbon monoxide is a colourless, odourless and tasteless gas. The main function of low levels of CO in MA is to stabilize the cherry red fresh meat colour as a result of strong binding of CO to myoglobin and the formation of carboxymyoglobin. Carbon monoxide (0.1–1.0%), used in modified atmospheres, produces a stable, cherry red fresh meat colour (Brewer, Wu, Field, & Pay, 1994). Packing in 1% CO/99% N_2 stabilized the colour of sliced Bologna-type sausages, indicating binding between CO and denatured myoglobin (Aasgaard, 1993). Sørheim, Nissen, and Nesbakken (1999) reviewed the toxicological aspects of CO used in modified atmosphere packaging of fresh meat and concluded that a gas mixture with a low concentration of CO, up to 0.5%, do not present any toxic threat to consumers.

In the present study, use of modified atmosphere with CO had similar effects on the sausages redness compared to vacuum and modified atmosphere packaging of 80% CO_2/20% N_2. Discolouration was faster in samples, which were stored in atmosphere with high O_2 concentration (60%) at both 4 and 10 °C. High oxygen levels promoted the oxidation of denatured nitrosomyochrome imposed a dull greyness to piroski sausage surface. Discolouration was also noted to piroski sausages stored in 0.5% CO/50% CO_2/24% O_2/N_2 at 10 °C. The study of Møller, Jensen, Olsen, Skibsted, and Bertelsen (2000) provides evidence for the existence of a lower limit of initial oxygen content and below of this limit the discolouration of nitrosomyoglobin in meat product becomes insignificant. Those results show that for fading pink ham colour, the limit lies between 0.1 and 0.5% initial oxygen in headspace. In conclusion the results of the present study advocate the use of vacuum instead of modified atmospheres packaging for sliced breast turkey fillets and pork–piroski sausages.

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