SHELF LIFE OF CHICKEN FILLETS WITH CHEESE SAUCE STORED IN A LOW CO/HIGH CO_2 ATMOSPHERE

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Background

As a component of modified atmospheres, carbon monoxide (CO) produces a stable, bright red colour of meat due to the formation of carboxymyoglobin. Modified atmospheres with high levels of carbon dioxide (CO_2) and absence of oxygen (O_2) extend the microbiological shelf life. Research on low CO/high CO_2 packaging has primarily been conducted on red meats, in particular beef (Sørheim et al., 2001a). Little information is available on the use of CO in packaging of poultry. Fraqueza et al. (2000) found increased redness and reduced growth of spoilage bacteria in sliced raw turkey breast fillets by storage in 0.5 % CO/ 50 % CO_2/ 49.5 % nitrogen (N_2). Sante et al. (1994) recommended 100 % CO_2 with O_2-absorbers for maximising shelf life and colour stability of turkey breast fillets. Chicken differs from red meats by having a lower content of myoglobin and a distinct microflora. Meat of chicken is lean with a high nutritional value. Due to the low fat content, this meat can be enhanced with cheese sauces to make a more juicy and tasty product.

Objective

To study the effects of different modified atmospheres and storage temperatures on the colour and microbiological shelf life of chicken breast fillets filled with cheese sauce.

Methods

The day after slaughter, chicken breast fillets of approx. 125 g were filled with high-pasteurised, heat stable cheese sauce (Bakefast - TINE, Oslo, Norway) in a "pocket" of the meat piece. The filled fillets were packaged on a Tiromat PowerPak thermoforming machine (Convenience Food Systems (CFS), Bakel, The Netherlands) in packages of 155 x 130 x 45 mm. Packages with high O_2 were filled with gas in a subsequent manual flushing operation. The lower film was an expanded polypropylene film with a high barrier ethylene vinyl alcohol layer (CFS). The upper film was a polyamide laminate with O_2 transmission rate of approx. 30 $cm^3/m^2/24h$ at 23 °C and 0 % RH (Amcor/Danisco, Horsens, Denmark). Three gas mixtures and two storage temperatures were used (symbols are valid for Figs. 1 and 2):

- □ 0.4 % CO/ 60 % CO_2/ 40 % N_2 at 4°C
- ■ 0.4 % CO/ 60 % CO_2/ 40 % N_2 at 8°C
- ○ 60 % CO_2/ 40 % N_2 at 4°C
- ● 60 % CO_2/ 40 % N_2 at 8°C
- △ 70 % O_2/ 30 % CO_2 at 4°C
- ▲ 70 % O_2/ 30 % CO_2 at 8°C

The packages were stored in darkness. Sampling was performed in triplicate at 4, 7, 11, 14 and 18 days storage until termination of shelf life. All packages were measured for O_2 and CO_2. The fillets were analysed for pH, off-odour and visual colour (3 trained assessors), total counts of bacteria (Plate Count Agar at 30 °C at 0, 7 and 14 days only) and L*a*b* lightness, redness and yellowness values (Minolta CR-300, D_{65}, 8 mm viewing port).

Results and discussion

Residual O_2 were 0-0.1 % in the high CO_2 packages. In these packages, CO_2 was reduced from initially 60 % to approx. 55 % after storage. pH of the meat was reduced from initially 6.05 to approx. 5.90 after storage in all gas mixtures due to absorption of CO_2.

Table 1 describes the shelf life of the fillets as limited by off-odour and discoloration. Fillets in CO_2/N_2 with CO had the longest shelf life, up to 18 days at 4 °C. It is noticeable that slight discoloration occured in meat in low CO/high CO_2 at 8°C after 14 days storage. By excluding CO from the CO_2 /N_2 mixture, the shelf lives were reduced to 7 and 11 days at 8 and 4 °C, respectively, because of myoglobin oxidation and discoloration. The shortest shelf life was obtained with high O_2. Off-odour limited the shelf lives in high-O_2 to < 7 and <11 days at 8 and 4 °C. Initial total bacterial counts of the meat were approx. 10^3 CFU/g, as shown in Fig. 1. During storage, the increase in counts were more affected by temperature than type of atmosphere.

The highest a* values were measured on fillets in the atmosphere with low CO; see Fig. 2. b* values decreased during storage for all treatments, but L* values did not change or differ between treatments; results not shown. In addition to the increased colour stability of raw meat, the inclusion of CO in a packaging gas mixture may increase the likelihood of persistent redness in cooked meat of beef and other meats (Sørheim et al., 2001b). Further studies are needed to clarify this issue in chicken meat.

In conclusion, storing chicken breast fillets with cheese sauce in 0.4 % CO/ 60 % CO_2/ 40 % N_2 resulted in a combination of a long microbiological shelf life with a stable, light bright red colour. Depending on type of atmosphere, a storage temperature of 4 °C increased the shelf life with 4-7 days compared to 8 °C.

Literature

Fraqueza, M.J.; Ferreira, M.F.; Ouakinin, J.S. & Barreto, A.S. 2000. *Proc. 46th ICOMST*, Buenos Aires, Argentina, 760-761.
Sante, V.; Renerre, M.; Lacourt, A. 1994. *J. Food Qual.* 17, 177-195.
Sørheim, O.; Nissen, H.; Aune, T. & Nesbakken, T. 2001a. *Proc. 54th Reciprocal Meat Conference*, Indianapolis, IN, USA, 47-51.
Sørheim, O.; Lea, P.; Nissen, H. & Nesbakken, T. 2001b. *Proc. 47th ICOMST*, Krakow, Poland, 74-75.

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Table 1
Shelf life (days) of chicken breast fillets filled with cheese sauce as affected by different modified atmospheres and storage temperatures in terms of development of slight off-odour and slight gray/brown colour.

Gas mixture	Storage temperature °C	Off-odour days	Discoloration days	Limited by*
0.4 % CO/ 60 % CO_2/ 40 % N_2	4	18	>18	M
	8	11	14	M
60 % CO_2/ 40 % N_2	4	< 18	11	C
	8	11	7	C
70 % O_2/ 30 % CO_2	4	< 11	<14	M
	8	< 7	< 7	M/C

* M=off-odour or C=discoloration.

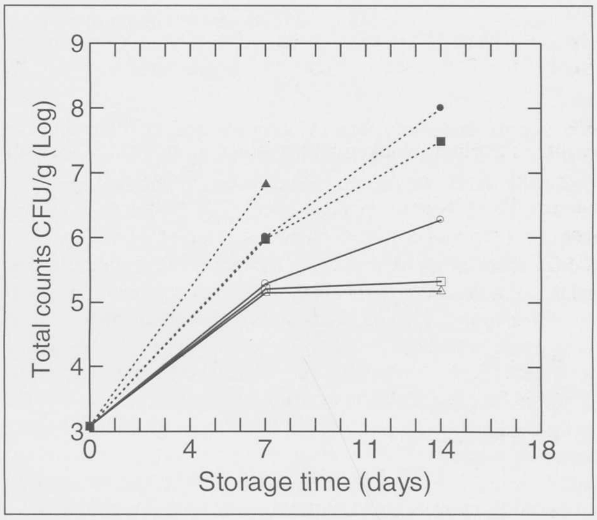

Figure 1
Total bacterial counts of chicken fillets filled with cheese sauce stored in different atmospheres and temperatures. For symbols; see the methods chapter.

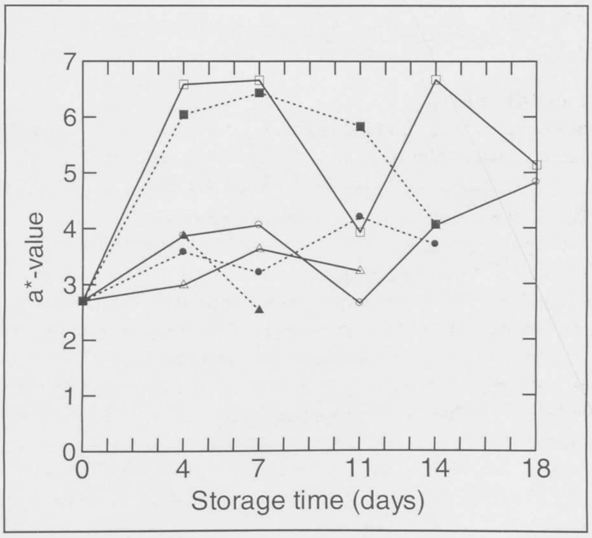

Figure 2
a* redness values of chicken fillets filled with cheese sauce stored in different atmospheres and temperatures. For symbols; see the methods chapter.