EFFECTS OF A HIGH CO_2/LOW CO ATMOSPHERE ON COLOUR AND YIELD OF COOKED GROUND BEEF PATTIES

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Background

The internal colour of cooked beef patties is by many consumers considered as an indicator of doneness. Consumption of undercooked patties below 71 °C implies a risk of survival of *Escherichia coli* O157:H7 and other verotoxin producing *E. coli* (VTEC). The temperature for denaturation of myoglobin and the development of a brown or grey core colour vary according to different forms of myoglobin, pH and pre-handling of the meat (Hunt et al. 1999). Deoxymyoglobin (DMB) has a high denaturation temperature of 70 - 75 °C. Carbon monoxide (CO) binds strongly to myoglobin and forms the stable, bright red carboxymyoglobin (COMB) (El-Badawi et al. 1964). CO is currently used in concentrations of 0.3 – 0.5 % in modified atmosphere packaging of meat in Norway (Sørheim et al. 1997).

Objective

To study the internal colour and yield of ground beef patties made of meat packaged in a high CO_2/ low CO atmosphere and cooked to different temperatures.

Materials & methods

Ground beef patties were prepared and cooked according to Hunt et al. (1999). Six batches of beef trimmings with 14 % fat were ground twice through a 4 mm plate. The meat was put in polyamide bags, compressed to less than 5 mm thickness, and packaged either in 0.4 % CO/ 60 % CO_2/ 40 % N_2 for production of COMB meat or in vacuum for DMB meat (control). The bags were stored for 4 days at 3 °C. Bags with COMB meat were turned around after 2 days for gas exposure of the under side. After opening of the bags, 100 g of ground beef were formed into beef patties in a circular mould 102 mm wide and 12 mm high. Patties temperated to 20 °C were cooked on a 23 x 23 cm flat-surface grill (Swedish Food Research Institute, Gothenburg, Sweden) at 165 °C for 4, 5 and 6 minutes corresponding to mean end point core temperatures of 72, 77 and 83 °C, respectively. During cooking, the patties were turned every minute. Core temperatures were measured with a 1 mm needle thermistor (Teck Instrument, Tranby, Norway). The patties were cooled at 20 °C for 3 minutes, and then sliced horizontally. Four patties were cooked for each batch, myoglobin type and cooking time.

The following analyses were performed: pH of the ground beef after storage, visual colour evaluation (three trained panellists, scale 1 = red uncooked to 5 = tan or brown (AMSA, 1991)) immediately after slicing, CIE L*a*b* (lightness, redness and yellowness) values with a Minolta Chroma Meter CR-300 (Minolta Camera Co., Osaka, Japan) with 8 mm viewing port and illuminant D_{65} 3 minutes after slicing, and cooking loss. Analysis of variance with Tukey's multiple comparisons test was performed with SAS for Windows, Release 6.12 (SAS Institute Inc., Cary, NC, USA).

Results and discussion

The mean pH of the ground beef after storage was 5.47 (5.21 – 5.84) for COMB meat and 5.49 (5.25 – 5.86) for DMB meat and did not differ ($p>0.05$). The visual colour evaluation immediately after slicing, as shown in Fig. 1, demonstrated that the COMB patties were more pink than the DMB patties at 72, 77 and 83 °C internal temperature ($p<0.05$). At 83 °C, the DMB patties were completely tan/brown, while the COMB patties still had traces of pink core colour. Exposure to CO is one of the causes for pink discoloration in cooked uncured meat (Cornforth 1994, Sørheim et al. 1997). Table 1 for the instrumental colour measurements, shows that the COMB patties were lighter at 72 and 77 °C ($p<0.05$) and less yellow at 77 and 83 °C ($p<0.05$) than the DMB patties. However, redness values did not differ at any temperature ($p>0.05$). The fading or loss of redness during the time from slicing to instrumental colour analysis was only at the surface of the sliced COMB patties, because the patties were still pink 1 – 2 mm below the surface. The cause of the instability of the surface colour is not known, but the myoglobin is likely to be affected by the exposure to oxygen from the air. Further studies are needed to clarify this issue.

The cooking loss was higher for COMB than DMB patties at all internal temperatures ($p<0.01$), as shown in Fig. 2. The mean cooking loss for all COMB patties was 27.8 % and all DMB patties 24.2 % ($p<0.01$). The difference in cooking loss between patties of meat that has been packaged in modified atmospheres and vacuum, is not well described in the literature. However, the absorption of CO_2 in meat in volumes up to 1 : 1 can negatively affect the binding properties of meat.

Conclusions

Patties made of ground beef packaged in a high CO_2/low CO atmosphere were cooked to a core temperature of more than 80 °C while still having traces of pink colour and an uncooked appearance. Based on the internal cooked colour development, ground beef containing COMB reduces the risk of consuming undercooked patties contaminated with *E. coli* O157:H7 or other VTEC. However, the cooking loss of COMB patties was higher than DMB patties.

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Table 1

CIE L* (lightness), a* (redness) and b* (yellowness) values of COMB and DMB ground beef patties cooked to 72, 77 and 83 °C internal temperature. COMB meat was packaged in 0.4 % CO/ 60 % CO_2/ 40 % N_2, and DMB meat was packaged in vacuum. Colour was measured 3 minutes after slicing of the cooked patties.

Internal	L*		a*		b*	
temperature °C	COMB	DMB	COMB	DMB	COMB	DMB
72	57.1	55.3^{y}	11.5	11.2	11.3	11.8
77	57.3	56.1^{x}	8.4	8.6	10.8	11.7^{x}
83	57.5	56.0	7.4	7.4	10.8	11.3^{x}

Significance levels: ^{x} $p<0.05$, ^{y} $p<0.01$.

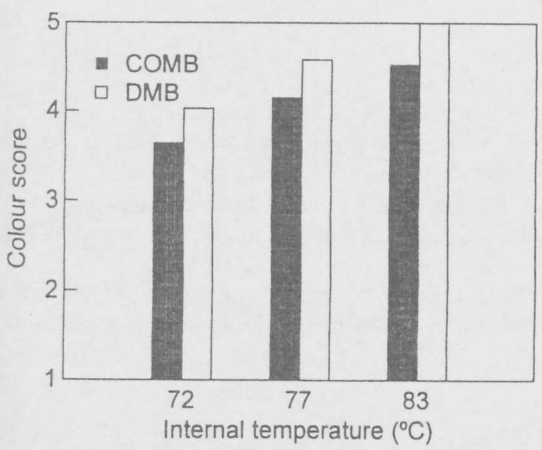

Fig. 1

Visual colour evaluation of COMB and DMB ground beef patties cooked to 72, 77 and 83 °C internal temperature. COMB = 0.4 % CO/ 60 % CO_2/ 40 % N_2 and DMB = vacuum. Colour scale: 1 = dark red, uncooked, 2 = bright red, 3 = very pink, 4 = slightly pink, 5 = tan/brown.

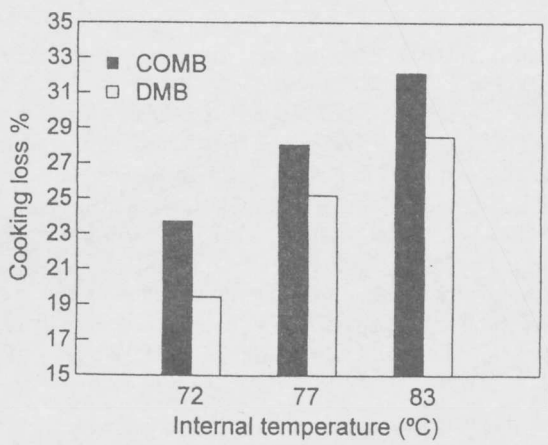

Fig. 2

Percentage cooking loss of COMB and DMB ground beef patties cooked to 72, 77 and 83 °C internal temperature. COMB = 0.4 % CO/ 60 % CO_2/ 40 % N_2 and DMB = vacuum.