EVALUATION OF OXYGEN CONTENT IN COMMERCIAL MODIFIED ATMOSPHERE PACKS (MAP) OF PROCESSED COOKED MEATS, TAKEN AT THE POINT OF MANUFACTURE

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Background

Modern trends towards convenience foods have led to an increase in the production of precooked and restructured meat products. Modified atmosphere packaging (MAP) is widely used for these foods and residual oxygen may be an important determinant of muscle food quality and shelf-life (Tewary *et al.*, 1999). Although oxygen-sensitive foods can be packaged under modified atmosphere conditions, oxygen is not always completely removed, and often may permeate through the packaging material (Vermieren *et al.*, 1999). Knowledge of the actual levels of oxygen in each pack provides useful information about the integrity of packages, the efficiency of the packaging machine as well as an indication of quality changes in the product (Fitzgerald *et al.*, 1999). MAP involves holding perishable foods in an environment designed to inhibit spoilage of the food, thereby maintaining food quality during the product's natural life and/or extending its shelf life (Church and Parsons, 1995). Removal of oxygen is particularly important for cooked muscle foods held in MAP systems. In many cases, deterioration of meats is caused by oxidation of meat components or spoilage by aerobic microorganisms, both of which are accelerated in the presence of oxygen.

Objective

The objective of this study was to assess the levels of oxygen in a variety of commercial modifed atmosphere packs (MAP) of processed and cooked meat products, produced by three manufactureres and sampled at the point of packing.

Methods

A total of 13 processed and cooked turkey, pork, beef or ham products were collected from three separate manufacturers 24 h post-packaging. The products were packaged under modified atmosphere (MAP) conditions of 70 % N_2 and 30 % CO_2 between two layers of thermoformed plastics (polyamide/polyethylene-based laminates), which were heat-sealed together. The lower layer was evacuated which created a cavity within which the meat product was housed. A total of 25 packs of each product were refrigerated and stored under simulated retail conditions (4 °C under 616 lux fluorescent lighting) for 21 days. Headspace composition was analysed on days 1, 7, 14 and 21, using a O_2/CO_2 gas analyser (PBI Dansensor Rennedevej 18, DK-4100, Ringstead, Denmark), where the needle was inserted through a neoprene rubber pad fitted to the packs. Percentage oxygen levels for each of the 13 products were recorded at each time interval, and were categorised as ideal, desirable, unacceptable or reject (0.0, 0.01-0.5, 0.51-1.2, or >1.2 % O_2, respectively) based on manufacturing standards.

Results and discussion

The level of residual oxygen in MAP packs may be attributed to a number of factors such as the oxygen permeability of the packaging material, the ability of the food to trap air, poor sealing of the pack which may cause air to leak in, or inappropriate evacuation and/or gas flushing procedures (Smith *et al.*, 1986). No package leaks were observed for any of the products during the study, suggesting that this factor did not affect the residual oxygen results. Overall, the packs of turkey (products 1 and 2) were shown to have the lowest levels of residual oxygen, and remained within the ideal or desirable categories (0.0% or 0.01-0.5% 0_2, respectively) throughout the 21 day storage period. With the exception of these turkey products, the oxygen levels in all other packs increased from day 1 to 7 (Tables 1 and 2), changing from ideal/desirable to unacceptable/reject categories. A ham-based product (product 6) was shown to perform the worst of all of the 13 products sampled, with over 60 % of the packs on day 1 (Table 1) considered worthy of rejection (>1.2% 0_2) to 100 % of packs on days 7, 14 and 21 (Tables 2, 3 and 4). At day 21, at least 78 % of the packs tested in 10 of the products had reject levels of residual oxygen (>1.2% 0_2), suggesting that these packs may not be suitable for storage of products for periods of more than 7 days. The increases in residual oxygen in packs during storage may be attributed to permeation of oxygen through the thermoformed plastic packs. The high proportion of packages containing high levels of oxygen (>1.2 %) may pose a risk in terms of quality deterioration and reduced shelf-life of muscle-based foods. Measurement of residual oxygen in product packs in conjunction with oxygen permeability of the packaging materials may provide a better insight into the applicability of these materials as suitable protectors of food during storage.

References

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Table 1. Percentage of total number of packs containing oxygen in processed, cooked and MAP meat products 1 day after packaging. Categories: 0.0%, 0.01-0.5%, 0.51-1.2% and >1.2% 0_2.

	% Product Packs			
Product No	0.0% 0_2	0.01-0.5%0_2	0.51-1.2%0_2	>1.2% 0_2
1[a]	88	12	0	0
2[a]	44	48	4	4
3[b]	16	48	4	32
4[b]	4	31	52	13
5[c]	0	39	31	30
6[d]	0	8	32	60
7[d]	0	64	4	32
8[d]	0	26	64	10
9[d]	0	46	27	27
10[d]	0	63	37	0
11[d]	0	46	33	21
12[d]	0	69	4	27
13[d]	0	4	84	12

[a].. turkey based products
[b].. pork based products
[c].. beef based product
[d].. ham based products

Table 2. Percentage of total number of packs containing oxygen in processed, cooked and MAP meat products 7 days after packaging. Categories: 0.0%, 0.01-0.5%, 0.51-1.2% and >1.2% 0_2.

	% Product Packs			
Product No	0.0% 0_2	0.01-0.5%0_2	0.51-1.2%0_2	>1.2% 0_2
1[a]	0	80	16	4
2[a]	0	76	4	20
3[b]	4	24	12	60
4[b]	0	4	0	96
5[c]	4	9	22	65
6[d]	0	0	0	100
7[d]	0	4	0	96
8[d]	0	3	7	90
9[d]	0	4	23	73
10[d]	0	4	8	88
11[d]	0	42	4	54
12[d]	0	0	4	96
13[d]	0	12	12	76

[a].. turkey based products
[b].. pork based products
[c].. beef based product
[d].. ham based products

Table 3. Percentage of total number of packs containing oxygen in processed, cooked and MAP meat products 14 days after packaging. Categories: 0.0%, 0.01-0.5%, 0.51-1.2% and >1.2% 0_2.

	% Product Packs			
Product No	0.0% 0_2	0.01-0.5%0_2	0.51-1.2%0_2	>1.2% 0_2
1[a]	0	80	12	8
2[a]	0	76	8	16
3[b]	0	8	16	76
4[b]	0	0	0	100
5[c]	9	4	4	83
6[d]	0	0	0	100
7[d]	0	4	0	96
8[d]	0	10	3	87
9[d]	0	9	14	77
10[d]	0	0	0	100
11[d]	0	16	8	76
12[d]	0	0	0	100
13[d]	0	8	8	84

[a].. turkey based products
[b].. pork based products
[c].. beef based product
[d].. ham based products

Table 4. Percentage of total number of packs containing oxygen in processed, cooked and MAP meat products 21 days after packaging. Categories: 0.0%, 0.01-0.5%, 0.51-1.2% and >1.2% 0_2.

	% Product Packs			
Product No	0.0% 0_2	0.01-0.5%0_2	0.51-1.2%0_2	>1.2% 0_2
1[a]	0	80	16	4
2[a]	0	76	8	16
3[b]	0	8	4	88
4[b]	0	0	0	100
5[c]	0	9	13	78
6[d]	0	0	0	100
7[d]	0	4	0	96
8[d]	0	10	3	87
9[d]	0	9	9	82
10[d]	0	0	0	100
11[d]	0	4	8	88
12[d]	0	0	0	100
13[d]	0	0	8	92

[a].. turkey based products
[b].. pork based products
[c].. beef based product
[d].. ham based products