ELSEVIER

International Biodeterioration & Biodegradation (1995) 407–410

0964-8305/95 $9.50 + 0.00
0964-8305(95)00099-2

Fate of Food-borne Pathogens on Modified-atmosphere Packaged Meat and Fish

A. R. Davies

Department of Food Microbiology, Leatherhead Food Research Association, Leatherhead, Surrey, UK

ABSTRACT

The fate of several food-borne pathogens on modified-atmosphere-packaged (MAP) meat and fish has been examined. In no instance was growth of the pathogen in MAP greater than that in the appropriate control. Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

The ability of modified atmospheres to extend the shelf-life of meat and fish has been recognized for many years. However, concern has been expressed by regulatory authorities, food industry groups and others that MAP may represent an undue safety hazard. Historically, the psychrotrophic strains of *Clostridium botulinum* have been the major safety concern. More recently, concerns have been expressed about the ability of the other psychrotrophic pathogens, e.g. *Aeromonas*, *Listeria*, *Yersinia*, to grow in MAP products.

As part of two recently completed European Community programmes we have examined the growth/survival of these psychrotrophic pathogens as well as some of the established mesophilic pathogens on MAP meat and fish and their products.

MATERIALS AND METHODS

Studies with meat have concentrated on beef steaks, whilst those on fish have concentrated on cod (*Gadhus morhua*) and rainbow trout (*Oncor-*

TABLE 1
Parameters Examined

Products	*Temperatures*	*Organisms*	*Atmospheres*
Fish			
Rainbow trout	0°C	*Aeromonas* spp.	Aerobic
Cod	5°C	*Listeria monocytogenes*	60% CO_2/40% N_2
Breaded cod	12°C[a]	*Salmonella typhimurium*	80% CO_2/20% N_2[b]
		Yersinia enterocolitica	40% CO_2/30% N_2/30% O_2[c]
			60% CO_2/30% N_2/10% O_2[d]
Meat			
Beef	0°C	*Aeromonas* spp.	Vacuum pack[f]
Cooked ham	5°C	*Listeria monocytogenes*	20% CO_2/80% O_2[f]
Dry cured ham	12°C	*Salmonella typhimurium*	50% CO_2/50% N_2[f]
	25°C[e]	Verotoxigenic *E. coli*	100% CO_2[f]
		Yersinia enterocolitica	

[a] *Aeromonas* and *Yersinia* only; [b] trout only; [c] cod only; [d] breaded cod only; [e] cooked and dry cured hams only; [f] beef only.

hyncus mykiss). Details of all the substrates, organisms, modified atmospheres and temperatures examined are presented in Table 1. To facilitate enumeration of the pathogens from the natural flora, antibiotic-resistant strains of all the pathogens except *Listeria monocytogenes*, for which the selective medium was found to be satisfactory, were used. These antibiotic-resistant strains were produced and evaluated, and appropriate selective/differential media identified using the methods of Blackburn and Davies (1994).

RESULTS AND DISCUSSION

With all the fish examined, in no instance was the growth/survival of any of the pathogens examined greater than that in the aerobically stored control and frequently growth was reduced in MAP. An example of the results obtained with *Aeromonas* and *Yersinia* on cod is presented in Fig. 1. As reported by others the inhibition of growth by the modified atmospheres decreased markedly with increasing temperature. For both cod and trout, the higher carbon dioxide containing atmosphere (80% CO_2 for trout and 60% CO_2 for cod) was generally more inhibitory than the lower CO_2 containing atmosphere.

Studies on meat concentrated on raw beef but also included cooked and dry-cured hams. The control atmosphere used throughout for meats was vacuum pack. As for fish, but with one exception, the growth/survival in

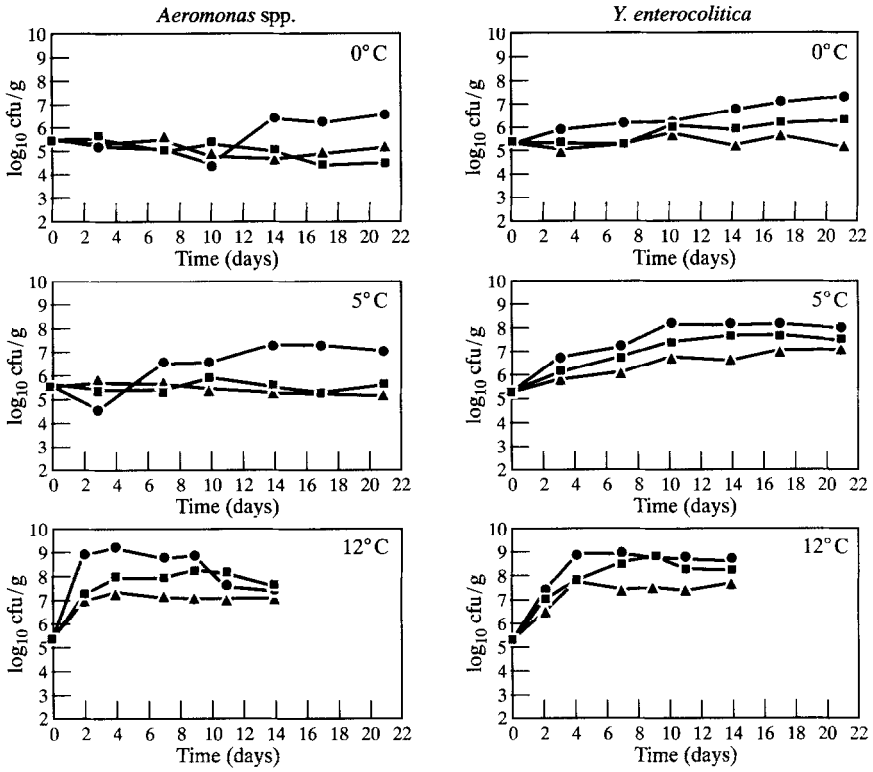

Fig. 1. Growth/survival of *Aeromonas* spp. and *Y. enterocolitica* at 0, 5 and 12°C on cod (*Gadus morhua*) stored aerobically (—●—), in 60% CO_2/40% N_2 (—▲—) and in 40% CO_2/30% N_2/30% O_2 (—■—).

MAP was never greater than that in the control and occasionally growth was reduced in MAP. The one exception was with verotoxigenic *E. coli* (VTEC) on beef stored at 12°C, in which growth in one of the modified atmospheres (80% O_2/20% CO_2) examined was greater than that in the vacuum-pack control. However, this atmosphere was included as an atmosphere recommended for the retail packaging of beef, and hence a more appropriate control for this atmosphere may be aerobic storage. A comparison of VTEC growth on aerobically stored and 80% O_2/20% CO_2 stored beef showed that growth in the MAP was reduced in comparison with that in aerobically stored product.

As found by others we observed a CO_2-dependent bacteriostasis of *Salmonella* at chill temperatures. We did not, however, see the marked differences reported (Wimpfheimer *et al.*, 1990) between aerobic and anaerobic modified atmospheres on the growth of *Listeria monocytogenes*. Our results with *Aeromonas* and *Yersinia* on beef differ from those

reported for high-pH beef (Gill & Reichel, 1989) and highlight the importance of assessing the safety of individual foods to be packaged in MAP.

Overall, our results indicate that for beef and fish the risks from the food-borne pathogens examined in MAP are no greater and frequently less than from the control (aerobic/vacuum pack) stored foods.

ACKNOWLEDGEMENTS

The financial support of the European Community, MAFF, MLC and individual members of the Leatherhead Food Research Association is gratefully acknowledged.

REFERENCES

Blackburn, C. de W & Davies, A. R. (1994). Development of antibiotic-resistant strains for the enumeration of foodborne pathogenic bacteria in stored foods. *Int. J. Food Microbiol.*, **24,** 125–136.

Gill, C. O & Reichel, M. P. (1989). Growth of the cold-tolerant pathogens *Yersinia enterocolitica, Aeromonas hydrophila* and *Listeria monocytogenes* on high-pH beef packaged under vacuum or carbon dioxide. *Fd Microbiol,* **6,** 223–230.

Wimpfheimer, L., Altman, N. S. & Hotchkiss, J. H. (1990). Growth of *Listeria monocytogenes* Scott A, serotype 4 and competitive spoilage organisms in raw chicken packaged under modified atmospheres and in air. *Int. J. Food Microbiol.*, **11,** 202–214.