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Staphylococcus aureus in vacuum packed bacon

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Introduction

Vacuum packaging a food influences the growth of contaminating micro-organisms, inhibiting the growth of some and possibly stimulating the growth of others. The overall result is usually to extend the shelf life of the food. Because of this influence in contaminating micro-organisms, however, concern has been expressed as to whether vacuum packaged perishable non-sterile foods in general present a particular health hazard and whether vacuum packed bacon, in particular, presents an increased risk of food poisoning from Staphylococcus aureus.

Ingram (1960) and Bardsley and Taylor (1960) first drew attention to the possibility of Staphylococcus aureus multiplying in vacuum packed bacon stored under warm conditions and Thatcher, Robinson and Erdman (1962) claimed to have demonstrated the ability of enterotoxigenic strains of Staph. aureus to grow and produce enterotoxin in vacuum packed bacon stored at 37°C. Eddy and Ingram (1962) and Cavett (1962) showed the temperature dependence of the ability of staphylococci to multiply on vacuum packed bacon. At temperatures below 25°C these organisms appear to have difficulty in competing with other micro-organisms present, such as lactobacilli, but at temperatures above 25°C staphylococci appear to be at an advantage and extensive multiplication can take place. It has consequently been recommended that vacuum packed bacon, particularly when the curing process results in low numbers of bacteria being present, should be

stored under cool conditions.

Despite the concern expressed on the possibility of vacuum packaging bacon increasing the risk of Staph. aureus food poisoning, little information has appeared on the incidence of this organism in commercial vacuum packed bacon on sale to the public and on its ability to multiply in vacuum packed bacon-particularly non-Wiltshire cured bacon- under commercial conditions of distribution, storage and sale. A survey of vacuum packed bacon on sale in part of England afforded the opportunity of obtaining such information.

No explanation, other than that of "competition", has been advanced for the inability of Staph. aureus to multiply in vacuum packed bacon at temperatures considerably below this organism's optimum. The observations that much of the preservative effect on bacon of vacuum packaging is due to the inhibitory effect on micrococci and staphylococci of the high carbon dioxide tension which develops (Spencer and Taylor, 1966), and that the antimicrobial effect of carbon dioxide is magnified at low temperatures, i.e. temperatures well below the optimum for the organism in question (Tomkins, 1932, Coyne, 1933), provide a more detailed explanation which, if correct, would indicate that carbon dioxide packing of bacon, particularly bacon which for some reason does not produce carbon dioxide on storage in vacuum packs, would diminish the risks of Staph. aureus food poisoning.

Incidence of Staphylococcus aureus in commercial vacuum packed bacon

Experimental

Samples of vacuum packed bacon were obtained from shops within a 20 mile radius of Leatherhead, England, within a sampling scheme which took account of brand of bacon (four brands, see Spencer and

Taylor, 1966) age of pack (classified as "old", i.e. less than seven days from expiry date, and "fresh" more than seven days from expiry date), condition of sale (from refrigerated display cabinets and from non-refrigerated displays), and season of the year (winter and summer).

The bacon packs were opened aseptically and 10g of lean meat were cut out and macerated in 100 ml Ringer - peptone water diluent. One ml of the macerate (i.e. approximately 0.1g of bacon) was enriched in salt meat broth (Oxoid Ltd.) for 24 hours at 37°C which was then plated out on Baired - Parker's (1962) egg-yolk tellurite glyeine pyruvate (ETGPA) agar with incubation at 37°C for 24 hr. Also, drop counts were put up from the macerate on ETGPA. Colonies suspected on ETGPA of being Staph. aureus were plated out on blood agar and subsequently examined for the presence of coagulase by slide test.

Results

Staph. aureus was detected in 0.1g but not in 0.01g of bacon, i.e., at a level of 10-100 organisms per g., in 20 samples of bacon out of 231 examined, approximately 9%. It is statistically significant ($P < 0.01$) that 13 out of 81 of the isolations occurred in the summer season and only 7 out of 150 in the winter. These results are given in Table 1. It should not be deduced from this, however, that in summer multiplication in the bacon was occurring or was more extensive than in winter, for the positive isolations occurred somewhat more frequently in "fresh" than in "old" samples, and in "refrigerated" than in "non-refrigerated" samples. They were also dispersed more or less uniformly among the four brands examined.

The influence of carbon dioxyde concentration on the growth of Staphylococcus aureus in vacuum packed bacon.

Experimental

A series of eye muscles of fresh bacon, Wiltshire cured,

was inoculated with known numbers of organisms of a mixture of two cultures of Staph. aureus and incubated at 21°C in various gaseous environments in the apparatus described by Spencer and Taylor (1966). At intervals samples were examined for the numbers of various micro-organisms present.

A further series of eye muscles were sterilised by exposure to ethylene oxide vapour, inoculated with a mixture of the two strains of Staph.aureus at a mean level of 215 organisms per g bacon, and stored at 21°C in various gaseous environments. At intervals the numbers of Staph.aureus present were determined, again by drop counts on ETGPA.

Results

The counts of various microorganisms on the non-sterile bacon are shown in Tabel 2. It is clear that Staph.aureus showed no particular tendency to multiply in any of the gaseous environments. Indeed, it tended to die out.

The multiplication of Staph.aureus in the sterile bacon in various gaseous environments is shown in the Figure. It is clear that although an atmosphere containing 50% carbon dioxide had little if any inhibitory effect on this organism, 100% carbon dioxide had an inhibitory effect, doubling the period of time necessary for the inoculum to reach a level of 10^5-10^6 per g. bacon.

Discussion

Although commercial vacuum packed bacon not infrequently contains Staph.aureus, it appears that this organism is not likely to multiply to dangerous levels under normal conditions of distribution and sale. The reasons for this inability to multiply extensively do not seem to involve the high carbon dioxide tensions which develop inside packs of vacuum-packed bacon. However, carbon dioxide tensions of approaching 100% do retard the growth of Staph.aureus in bacon where

the influence of competing microorganisms has been eliminated and thus carbon dioxide packing of bacon would seem to provide an additional safequard against Staph. aureus food poisoning should the temperature of storage of the packed bacon be too high or the initial microflora be too low for competition to be effective.

Acknowledgements.

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S u m m a r y

Staphylococcus aureus was detected at a level of 10 - 100 organisms per g in 20 samples of retail vacuum packed bacon out of 231 examined.

When inoculated into non-sterile bacon which was stored at 21°C., this organism did not multiply in various gaseous atmospheres. When inoculated into sterile bacon, extensive multiplication occurred in atmospheres of 100% nitrogen and 50% nitrogen/50% carbon dioxyde. Growth was retarded in an atmosphere of 100% carbon dioxide.

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Table 1.

Occurrence of Staphylococcus aureus in vacuum packed bacon

Season	Number of sample of bacon		
	Examined	Positive	Negative
Summer	81	13	68
Winter	150	7	143
Total	231	20	211

$X^2 = 7.2$

$p < 0.01$

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Tabele 2. *Changes in the microflora of bacon, inoculated with Staph. aureus on storage at 21°C in various gaseous environments.*

Gaseous environment	days' storage	Log Number of microorganisms per g bacon			
		Lactobacilli	Micrococci	Yeasts	Staph. Aureus
Initial count					5.12
100% nitrogen	3	7.12	5.02	1.84	5.73
	10	7.83	5.82	1.60	4.50
	16	-	-	-	4.72
100% carbon dioxide	3	7.12	4.10	1.15	4.93
	10	8.10	4.75	1.35	4.40
	16	-	-	-	3.40
40% nitrogen, 60% carbon dioxide	3	7.12	5.41	1.0	4.96
	10	8.04	4.54	1.0	4.27
	16	-	-	-	1.15
70% nitrogen, 30% carbon dioxide	3	7.12	4.32	1.15	4.76
	10	6.94	4.80	1.30	4.22
	16	-	-	--	3.58

REFERENCES:

Baird-Parker, A.C. (1962). J. appl. Bact., 25, 441.

Bardsley, A.J. & Taylor, A. McM. (1960). Research Report No. 99, British Food Manufacturing Industries Research Association, Leatherhead.

Cavett, J.J. (1962). J. appl. Bact., 25, 282.

Coyne, F.P. (1933). J. Soc. Chem. Ind., 52, 19T.

Ingram, M. (1960). J. appl. Bact., 23, 206.

Ingram, M. (1962). J. appl. Bact., 25, 259.

Spencer, R. & Taylor, A.McM. (1966). 12th Meeting European Meat Workers, Oslo.

Thatcher, F.S., Robinson J. & Erdman, I. (1962), J.appl. Bact., 25, 120.

Tomkons, R.G. (1932). Proc. Roy. Soc. Series B, 111, 210.

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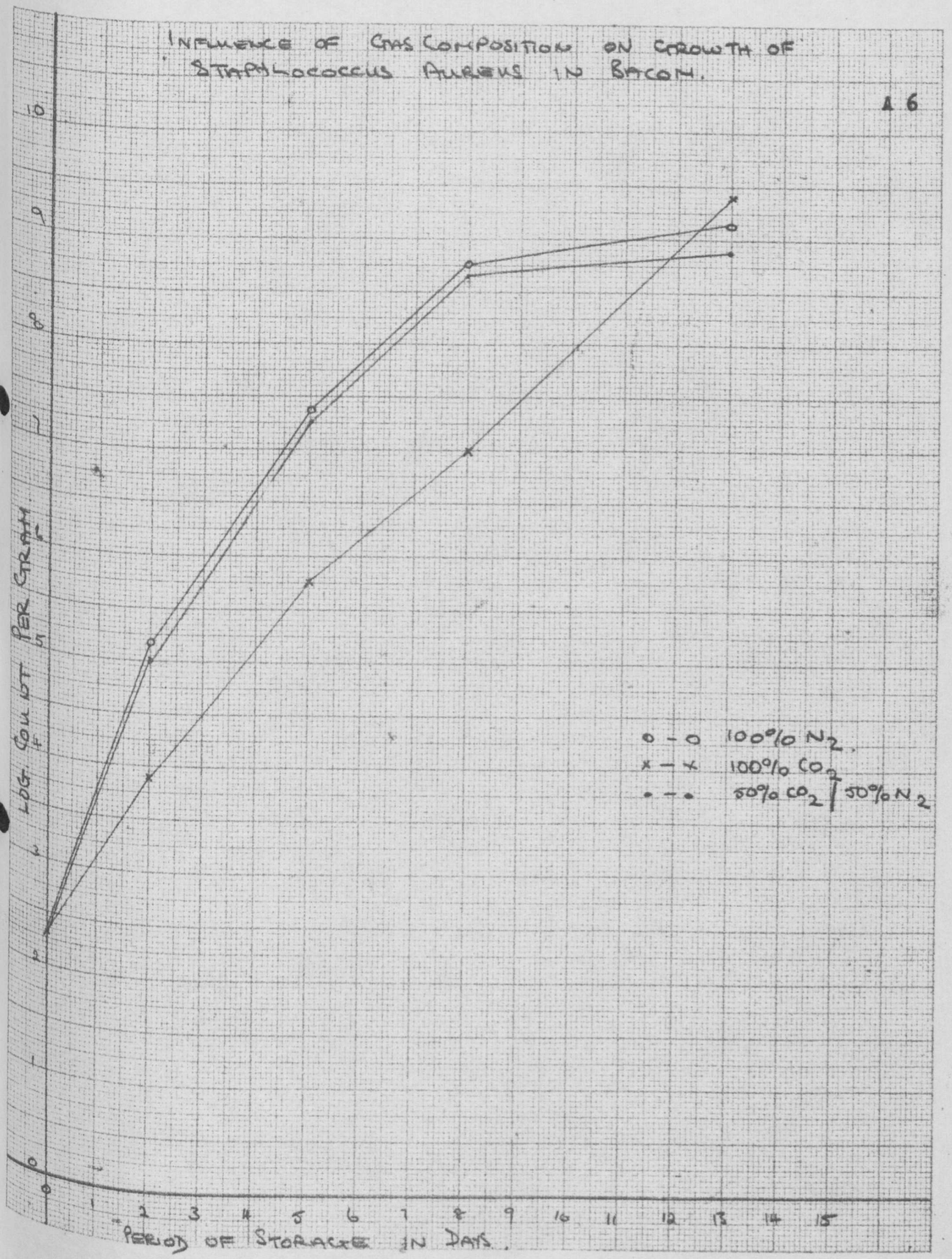
INFLUENCE OF GAS COMPOSITION ON GROWTH OF STAPHYLOCOCCUS AUREUS IN BACON.
A 6
LOG COUNT PER GRAM
PERIOD OF STORAGE IN DAYS.
o - o 100% N2.
x - x 100% CO2
• - • 50% CO2 / 50% N2