summaries

Estimation of the refrigerated shelf life of pasteurized canned cured ham using an incubation procedure

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Cans containing minced ham trimmings and canned cured ham have been incubated at several temperatures after heat treatments of different intensity. Since enterococci, aerobic and anaerobic sporeforming bacteria and other bacteria responded differently on the incubation temperatures, a short incubation test with which the refrigerated shelf life may be predicted appears improbable.

Die Bestimmung der Haltbarkeit von pasteurisierten Dosenschinken bei gekühlter Aufbewahrung mit einer Laboruntersuchung

H. Labots

Dosen mit zerkleinerten Schinkenabschnitzeln, bis verschiedene Temperature pasteurisiert, sind bebrütet worden bei einigen Temperaturen. Weil die Entwicklung von Enterokokken, Sporenbildern und andere Bakterien nicht in gleicher Weise beeinflusst werd durch eine Aenderung der Inkubationstemperatur, ist eine Voraussage der gekühlten Haltbarkeit durch eine Laboruntersuchung nicht wahrscheinlich.

Détermination de la aptitude de la conservation de jambon pasteurisé en boite à l'aide d'une étuvage

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Des boites contenants de la retaille de jambon ou du jambon entier ont été pasteurisées à temperatures differentes et après cela étuvées à quelques temperatures.
Les groupes bacteriennes agissaient differemment selon les étuvages divers et à propos de ce phénomène une étuvage qui peut prédire la aptitude de la conservation n'est pas probable.

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Introduction

Pasteurized canned cured hams should have a shelf life of 3 to 6 months when stored under refrigeration. In this paper shelf life may be defined as the storage time at which the product is deteriorated organoleptically or the number of bacteria has increased to an undesirable level. Meat packers and others are interested in a short laboratory incubation test that could predict the shelf life of their products under refrigeration. In 1954 an incubation temperature of 37°C was preferred (1), as some authors do in 1974 (9). Beganović and Matić (2) draw the attention to the effects of different temperatures on the development of several bacterial groups in pasteurized canned ham, viz. enterococci at low temperatures, enterococci and aerobic sporeforming bacteria at ambient temperatures, completed with anaerobic sporeformers at 37°C, while anaerobic sporeformers were the dominant group at even higher temperatures. Since, however, no specific information was available on the effect of different heat treatments, brine contents and residual nitrite content on the development of several bacterial groups in canned ham, an attempt to set up an incubation test to predict the shelf life under refrigerated conditions seemed worthwile.

Experimental

In the experiments I and II minced ham trimmings were used, in expt. IV a minced whole ham. Expt. III was carried out using canned hams. Hams and trimmings were supplied by at least 5 meat packing plants. Ham trimmings of different origin were canned separately. The heat treatments were carried out in 12 oz rectangular cans (Expt. I), or in 100 g cans (Expt. II and IV) (76 x 35 mm). At the desired times the cans were opened aseptically, samples were taken and plated out after homogenizing and dilution. The samples of the small cans were segments of at least 10 g, from the hams samples were taken of the heart and the jelly. The samples were examined for aerobic count (Plate Count Agar at 30°C) and sulphite reducing anaerobic bacteria (6). Colonies from PCA were picked and confirmed. Further details of the separate experiments have been mentioned below.

Experiment I

25 cans have been heated for 75 min. in a waterbath of 67°C, the same number also for 6 hours. The first heat treatment can be compared with the heat treatment of the centre of a ham, the second with the heat treatment of the outside of the ham. Both treatments showed a negative coagulation test. After cooling the cans have been incubated at 37°C (5 days), 30°C (14 days), 25°C (14 days), 15°C (6 weeks) and at 5°C (6 months). The ham trimmings had been supplied by 5 meat packers and were distributed evenly in all groups. Chemical analysis (moisture, fat, sodium chloride, nitrite, polyphosphate) was carried out after the heat treatments but before the incubation.

Experiment II

In the expts. II and IV the heat treatments of 65.5°C and 69°C were carried out in such a way that the time+temperature diagram of heating

and cooling was comparable with that of the centre of a ham pasteurized to these temperatures. During the heat treatment of 72°C, this temperature was maintained during one hour. After cooling the cans (30 for each treatment) have been incubated at 37°C (5 days), 30°C (14 days and 4 weeks), 15°C (3 and 6 months), 8°C and 5°C (both 6 months).
The ham trimmings had been supplied by 5 meat packers and were distributed evenly in all groups. Chemical analysis was carried out as in expt. I.

Experiment III

The raw cured canned hams (Flat, 11-12 lbs), from 6 different plants, have been heated till a heart temperature of 65,5°C (18 cans) or 69,5°C (18 hams). After cooling the hams were stored at 5°C and 10°C (both 4 and 8 months) when they had been heated till 65,5°C and at 10°C and 15°C (both 4 and 8 months) when they had been tested till 69,5°C. All hams showed a negative coagulation test. Chemical analysis was carried out as in expt. I.

Experiment IV

A minced cooked ham provided with 5 o ppm nitrite and inoculated with enterococci from a commercial "rookworst" was heated in 100 g cans as described in expt. II (each treatment 30 cans). After cooling the cans were incubated at 37°C (5 days), 41°C (5 days), 45°C (5 days) and 15°C (14 days).

Results

The results of the 4 experiments have been summarized in the Tables 1-4 and in Fig. 1 respectively. In the tables development means at least a 10-fold increase of the number of bacteria. In general, bacterial numbers after incubation varied for enterococci from 10^6 to 10^9, for Clostridium from 10^4 to 10^7, for Bacillus from 10^3 to 10^6 and for other bacteria from 10^3 to 10^6 per gram.
In the first experiment (Table 1) enterococci developed better, especially at the higher incubation temperatures, after the short heat treatment, than after the long heat treatment (centre vs. outside of a canned ham). However, as a result of the heating damage, the development was slower at low than at high incubation temperatures. The high brine content should be the main reason for the absence of clostridial development. Aerobic sporeformers did develop, but not below 15°C, Bacillus being the dominant flora after the 6 hours treatment. Other bacterial groups developed only from 37°C to 25°C but not at lower temperatures, and could not be found after the "outside" treatment. Possibly due to high initial numbers, lower brine percentages and less polyphosphate (4) enterococcal development in the second experiment was better than in the first one. Especially the 69°C heating caused a decrease of the number of positive cans at decreasing incubation temperatures. No enterococci could be detected after the 72°C heat treatment. Clostridial growth, somewhat decreasing at the higher heat treatments, was better at low than at high incubation temperatures. At high brine contents clostridial development was smallest. Aerobic sporeforming bacteria failed to develop at temperatures below 15°C. Other bacteria did grow, but not below 15°C.
Generally the hams in expt. III showed less bacterial development than the trimmings in the first two expts., as could be expected. Only two groups of bacteria could be detected, viz. enterococci and anaerobic sporeforming bacteria, the latter occurring in the hams of one plant, having a brine percentage of 3.6, but an unusual low nitrite content after pasteurization: 20 ppm.
Since in the expts. I and II incubation at 37°C or 30°C always yielded more positive cans with enterococci than storage at low temperatures, the experiment of Beuchat and Lechowich (3) was repeated using a resistant enterococcus strain, and minced ham as the heating and recovery medium.

Fig. 1(Expt. IV) shows the effect of different incubation temperatures on the growth of the enterococcus after a mild and a more severe heating. The results of the above mentioned authors were confirmed in the ham medium, so it can be expected that an incubation of hams at temperatures higher than 37°C will give results that agree more with results at refrigeration temperatures than the results at 37°C or 30°C.

Discussion and conclusions

The results obtained supplied some information regarding earlier observations (5), viz. the occurrence of enterococci only in the centre of a ham and aerobic sporeformers only in the jelly after a short incubation at 25°C. The damage of the enterococci at the outside of the ham being more severe than in the centre, growth in the heart should be better than in the jelly (expt. I). The heat activation of aerobic bacterial spores at the outside, more than in the centre, a probably higher redoxpetential and the possibility of spreading through the fluid jelly, may be responsable for the occurrence of aerobic sporeformers especially in the jelly. In those earlier observations (5) a striking correlation was found between brine content and clostridial development after incubation at 25°C. This effect, a combined effect of sodium chloride, nitrite and pH, particularly appearing after a heat treatment (7), appears to be present without a heat treatment also (8).

In expt. I, the lowest brine content being 3.8%, no clostridial growth was observed. In expt. II clostridial growth was observed especially in cans having a brine content of less than 3.5%, nitrite and polyphosphate probably being important too. In expt. III the four hams showing clostridial growth, had a brine content just over 3.5%, but a very unusual low nitrite content.

The importance of sodium chloride and residual nitrite for the prevention of clostridial growth appears to be ocnfirmed in the reported experiments. However, since heat damaged enterococci appeared to develop better in ham or ham trimmings at elevated temperatures than at refrigerated temperatures, and aerobic sporeformers together with micrococci and coryneformbacteria, developed from 37°C till 15°C, but not under refrigeration, it seems to be impossible to eleborate a short laboratory incubation at elevated temperatures that give a reliable prediction of the shelf life of a refrigerated ham.

The contradictory results of clostridial development at different temperatures obtained in the expts. II and III, moreover not quite in agreement with the results of Beganović and Matić (2) do not increase the chance of a suitable incubation test. Even when an incubation above 37°C should give a good prospect concerning enterococcal development under refrigeration, a dissimilar behaviour of other bacteria probably will highly reduce the value of the test.

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Table 1 - Experiment I. Development of different bacterial groups in heated minced ham trimmings[1]

Heat treatment at 67°C	number of cans incubated	bacterial group	number of cans wherein bacteria had developed after: 5 days at 37°C	14 days at 30°C	14 days at 25°C	6 weeks at 15°C	6 months at 5°C
75 min	20	enterococci	12	16	12	11	5
		Clostridium[2]	0	0	0	0	0
		Bacillus	3	3	4	2	0
		other[3]	4	5	3	0	0
6 hrs	20	enterococci	4	0	0	0	0
		Clostridium	0	0	0	0	0
		Bacillus	3	4	6	0	0
		other	2	0	0	0	0

1) Chemical analysis: see Table 4
2) only sulphite-reducing clostridium species have been enumerated
3) micrococci, coryneform bacteria and Gram-negative rods

Table 2 - Experiment II. Development of different bacterial groups in heated ham trimmings[1]

Temperature maximum °C	number of cans incubated	bacterial groups	number of cans wherein bacteria had developed after: 5 days 37°C	14 days 30°C	4 weeks 30°C	3 months 15°C	6 months 15°C	6 months 8°C	6 months 5°C
65.5	30	enterococci	30	30	30	30	30	30	20
		Clostridium[2]	2	1	0	22	12	20	17
		Bacillus	3	3	2	0	2	0	0
		other[3]	7	4	7	0	3	0	0
69	30 (24)	enterococci	30	30	30	20	19	7	2
		Clostridium	0	7	7	14	18	19	16
		Bacillus	6	2	4	1	7	1	0
		other	0	0	0	0	0	0	0
72	30	enterococci	0	0	0	0	0	0	0
		Clostridium	0	3	1	7	9	15	12
		Bacillus	7	5	5	5	12	0	0
		other	0	0	0	0	0	0	0

1) chemical analyses: see Table 4
2) + 3) see Table 1

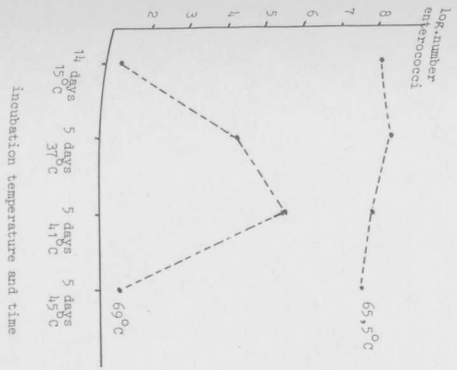

Fig. 1 Expt. IV Development of enterococci at different temperatures in minced hams, heated till 65,5°C and 69°C

Table 3 - Experiment III. Development of different bacterial groups in hams heated till 65.5°C and 69.5°C [1]

Maximum temperature °C	number of cans incubated	bacterial groups	number of cans wherein bacteria had developed after					
			5 months 15°C	8 months 15°C	4 months 10°C	8 months 10°C	4 months 5°C	8 months 5°C
65.5	18	enterococci	- [4]	-	11	13	3	7
		Clostridia [2]	-	-	0	1	0	0
		Bacilli	-	-	0	0	0	0
		others [3]	-	-	0	0	0	0
69.5	18	enterococci	3	2	1	3	-	-
		Clostridia	0	3	0	0	-	-
		Bacilli	0	0	0	0	-	-
		others	0	0	0	0	-	-

1) chemical analysis: see Table 4

2) + 3) see Table 1

4) incubation not carried out

Table 4 - Chemical analysis of the products in the expts I, II and III

analysis	average values and ranges, immediately after heat treatment		
	Expt. I (Table 1)	Expt. II (Table 2)	Expt. III (Table 3)
pH	6.48 (6.3-6.7)	6.50 (6.4-6.7)	6.25 (6.0-6.5)
moisture %	65.0 (56.8-69.8)	69.1 (60.6-77.0)	74.5 (70.8-76.7)
fat %	17.8 (12.0-19.5)	12.5 (3.4-24.5)	-
sodium chloride %	3.02 (2.67-3.62)	2.46 (1.84-3.44)	-
brine %	4.45 (3.77-4.96)	3.50 (2.48-5.06)	4.00 (3.0-5.6)
sodium nitrite ppm(75 min: 101 (28-169) (6 hrs : 89 (22-149)	(65.5°C: 112 (73-140) (69 °C : 117 (75-178) (72 °C : 95 (66-142)	(65.5°C: 62 (22-78) (69.5°C: 72 (18-98)	