Effect of a Short Cold Storage on Frequency of Spoilage in Pasteurized (Perishable) Canned Meat Products Subjected to the Incubation Test

S. KAFEL* and E. JOZWIK

The Institute of Food and Nutrition, ul. Powsinska 61/63, 02-903 Warsaw, and Agro-Technical Academy, Faculty of Veterinary Medicine, 10-957 Olsztyn-Kortowo, Poland

(Received for publication February 11, 1986)

ABSTRACT

Investigations were carried out in 6 meat processing plants in Poland on the effect of a short storage period on the results of the incubation test of various canned pasteurized meat products. From the daily consignments, 1% of the cans was reserved within 1-3 d of production and incubated at 37°C for 3 d. The remaining cans of the consignments were stored at around 8°C. When spoilage resulted in one or more of the incubated cans from any consignment, about 2% of other cans from that consignment were taken, and the incubation test was repeated. These later incubation tests were initiated 7-10 d after the date of production. From among 4,322 cans subjected to first incubation test 980 (22.67%) produced swells but in the repeated incubation carried out on 8,290 cans only 347 (4.18%) became swollen. It is concluded that the bacteria responsible for spoilage of canned pasteurized meat products may disappear or lose their ability to spoil these products during the storage under refrigeration.

In some countries the keeping quality of canned pasteurized meat products has been for many years ascertained by the incubation test. The cans that are tested are kept, depending on the country, at elevated temperatures, mostly between 30 and 37°C for a few days. In Poland this test is carried out at 37°C for 3 d. It is considered by the controlling authorities that the consignment of the product is stable and may be stored under refrigeration for 6 months if its samples after incubation do not show swells or appreciable changes in odor, color, consistency, taste, and pH in comparison with the contents of unincubated cans. Authors of this publication are not convinced that only those consignments of pasteurized canned meat products kept under refrigeration are stable whose samples do not show swells after incubation. It is believed, however, that consignments with positive incubation tests are of worse microbiological and/or technological quality than those with the negative tests, and they may spoil easier when kept under unsuitable conditions.

We have noted that in the event of positive results of the incubation tests, the spoilage was usually manifested by gas production (bombage), which was sometimes accompanied by putrid odor. It was caused most frequently by clostridia, e.g. C. perfringens, C. sporogenes, C. bifermants, and C. oedematiens, or by both clostridia and bacilli. Some other authors also found that C. perfringens and putrefactive type C. sporogenes were the most common species isolated from canned meats (9,11,15).

Our earlier investigations carried out on pasteurized canned meat products revealed that some cans of certain consignments kept in the storage rooms of meat establishments became swollen shortly after their production, but in the course of time the number of cans showing swelling decreased in a logarithmic order. It was discovered that during storage of such products C. perfringens, C. sporogenes, C. oedematiens, B. cereus, and some other bacteria were gradually disappearing from the contaminated cans. It was also observed that if the incubation test was initiated soon after completing production of the products, the percentage of swells was clearly higher in comparison with the incubation carried out a few days later. On the basis of the above observation investigations were undertaken on the effect of a short cold storage on results of the incubation test of various cured canned pasteurized meat products.

MATERIALS AND METHODS

From the daily consignments in 6 meat processing plants 1% of the cans was reserved within 1-3 d (usually 1 d) of production and incubated at 37° for 3 d. The remaining cans of the consignments were stored at around 8°C. When spoilage resulted in one or more of the incubated cans from any consignment, about 2% of the other cans from that consignment were taken, and the incubation test was repeated. These later incubation tests were initiated 7-10 d after the date of production.
TABLE 1. Effect of a short cold storage on frequency of spoilage in pasteurized canned meat products subjected to the incubation test.

<table>
<thead>
<tr>
<th>Product</th>
<th>Cans sampled 1-3 d after production</th>
<th>Cans sampled 7-10 d after production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of cans subjected to incubation</td>
<td>Number and percent of swollen cans</td>
</tr>
<tr>
<td>Canned hams, 2-5 lb</td>
<td>2,620</td>
<td>389 (15%)</td>
</tr>
<tr>
<td>Canned ham, 7 lb</td>
<td>214</td>
<td>34 (16%)</td>
</tr>
<tr>
<td>Canned ham, 11 lb</td>
<td>338</td>
<td>175 (52%)</td>
</tr>
<tr>
<td>Chopped ham, 6, 11 lb</td>
<td>529</td>
<td>158 (30%)</td>
</tr>
<tr>
<td>Pork loin, 6 lb</td>
<td>22</td>
<td>7 (32%)</td>
</tr>
<tr>
<td>Luncheon meat, 6 lb</td>
<td>418</td>
<td>119 (28%)</td>
</tr>
<tr>
<td>Luncheon meat, 10, 11 lb</td>
<td>79</td>
<td>37 (47%)</td>
</tr>
<tr>
<td>Beef and pork tongues, 6 lb</td>
<td>102</td>
<td>61 (60%)</td>
</tr>
<tr>
<td>Total</td>
<td>4,322</td>
<td>980 (23%)</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

The results obtained are presented in Table 1. It is indicated there that results of the incubation tests depended upon the length of time which elapsed from production of the consignments concerned. It is evident that the bacteria responsible for swellings in the products examined disappeared or lost their ability to produce spoilage during storage at 8°C. It must be pointed out, however, that in some rather rare instances, the percentage of swollen cans of a particular consignment was higher in the later incubation test than in the former one. This phenomenon probably occurred when the product was contaminated with an unusually high number of clostridia and/or when one or more factors in the preserving system was faulty. We found that in the consignments heavily contaminated with clostridia the time required for disappearance of these bacteria at refrigeration temperature was at least several months. It was also discovered that, occasionally, the post-processing cooling of cans was inadequate. This, perhaps, was the critical point that could be linked with more numerous swells appearing in the later incubation tests.

Our earlier observations carried out on many consignments of various cured canned pasteurized meat products indicate that the mesophilic clostridia such as C. perfringens, C. sporogenes, and C. oedematiens, and also B. cereus do not grow in these products at proper refrigeration temperatures. It was noticed that the cans containing low numbers of these bacteria autosterilized gradually and after 2-3 months the bacteria could not be isolated therefrom. Different observations, however, were made on C. bifermentans. This organism did not decrease in numbers and occasionally seemed even to multiply slowly.

Curran and Evans (4) reported that bacterial spores surviving heat processing in whole milk and stored below their growth temperature exhibited the phenomenon of deactivation. Pearce and Wheaton (12) presented data upon the apparent loss of viability of spores of thermophilic flat sour organisms surviving experimental processes in cream style corn, peas, and dog food which occurred during storage at 21.1°C for periods up to a year. Schmidt and Nank (16) also pointed out that deactivation of either mildly heated spores or the survivors of a process can occur under conditions preventing vegetative development. Results of their investigations emphasize the profound effect that storage temperature has upon the rate at which deactivation proceeds.

It is generally known that deactivation of bacterial spores in a food container leads to partial or complete sterilization. Probably spore deactivation occurred in the perishable canned meat products stored under refrigeration during our investigations, but the sphere of this phenomenon has not been determined.

Tompkin et al. (17) investigated the behavior of C. botulinum spores introduced into perishable canned cured meat stored at 4.4 or 10°C. They showed a decrease in the heat-sensitive cell count during the initial 2 weeks. After this initial decrease, their data showed no consistent pattern of decline in numbers of either spores or germinated cells through 16 weeks of storage. These authors stressed that protection against botulinal outgrowth decreases as perishable canned cured meat is stored at 10°C. In view of the above it is striking that these products have an excellent public health record although it is known that they are occasionally temperature-abused during their distribution or home storage.

Barnes et al. (1), Hall and Angelotti (8), and Goepfert and Kim (5) noticed that C. perfringens did not grow in meat and meat products even after extended storage at 15°C or below. At these temperatures vegetative cells remained stable or declined in counts. Traci and Duncan (18) pointed out that the initial decline in viability of cold-shocked vegetative cells of C. perfringens was often followed by further count decrease with additional exposure to low temperatures. Canada et al. (2) noted marked reduction in numbers of C. perfringens as a result of cold temperature. Our unpublished investigations regarding be-
behavior of *C. perfringens* and *C. botulinum* types A and E in a “natural” medium consisting of a ham extract and curing salts revealed that under refrigeration (4-8°C) these bacteria were gradually dying off in that environment. Some workers, however, did not find evident changes in quantities of *C. perfringens* during cold storage of foods (13); the spores in particular were able to survive for an extended time (6).

One of the important factors affecting the keeping quality of canned foods is their heat processing. Gross (7) carried out long-time storage experiments with naturally contaminated samples of luncheon meat processed at different F₀ values. He showed that no samples spoiled at 30°C after F₀ values of 0.2 - 0.6 and that surviving spores lost their viability during prolonged storage at that temperature. Riemann (14), in his experiments on luncheon meat with average contamination of the raw material of 82 bacillus spores and less than 3 clostridial spores per gram, also showed that the percent of cans containing viable organisms decreased during prolonged storage at 30°C.

It is known that the preserving system in canned pasteurized meat products is complex and the shelf stability of such products depends on various factors. Among the most important seem to be a sufficiently high temperature of pasteurization that will kill the vegetative cells and will injure the spores. According to Polish regulations the minimum internal temperature that should be attained in the center of the perishable canned meat products is 68.8°C. Other significant factors are as low as possible contamination with bacterial spores, the inhibitory action of curing ingredients, low temperature of storage, and the red-ox potential which is relatively high at the initial period of product storage. This preserving system, however, may break down if one or more of the above-mentioned factors fail to effectively protect the product from spoilage.

It should be stressed that the information about the behavior of bacteria, and particularly their spores, in such specific products as canned pasteurized meats which contain curing salts is rather limited. Spores of some bacteria may probably remain dormant for very long periods, but due to some circumstances sometimes germinate and spoil the product. Our observations indicate that storing perishable canned meats at low temperatures creates a chance for partial or complete elimination of *C. perfringens* and some other bacteria therefrom. On the other hand, *C. bifermentans* does not seem to decline in numbers under the same conditions. Behavior of sporeforming bacteria in these products during their storage is undoubtedly a complex and complicated matter. There are still many unknowns in the subject. Therefore information and determination of conditions under which various microorganisms would multiply in these kinds of foods requires further investigation.

REFERENCES