HOT-BONED AND TRADITIONALLY-CHILLED BEEF AS RAW MATERIAL FOR THE PRODUCTION OF CONTROLLED ATMOSPHERE RETAIL PACKS - COMPARISON OF SENSORY AND MICROBIOLOGICAL PROPERTIES

LIS BUCHTER

Danish Meat Research Institute, Roskilde, Denmark

INTRODUCTION

In Denmark at least three meat factories produce fresh meat packed in controlled atmosphere packs (C.A.-packs) for retail distribution. The preferred gas has been 80% O_2 + 20% CO_2 so far as this mixture secures a stable bright red colour in the meat.

The C.A.-packed meat is usually labelled to be sold within 4-7 days after packaging. To obtain this long keepability in oxygen rich atmospheres it is absolutely necessary to combine strict hygiene and rigid temperature control throughout production, storage and sale. In this connection it should be mentioned, that the Danish Veterinary Authorities have worked out special regulations for C.A.-packed meat, and that all steps in the production and sale of such meat are closely supervised, as is the case with all new production methods. The hygienic standard of meat to be used for the production of C.A.-packs is very important, and procuring raw materials of sufficiently high and uniform quality can be a problem, especially in the case of beef, where meat for steaks and goulash type dishes should be aged before it is cut and packed for retail distribution.

This paper describes an experiment, financed by the Danish Livestock and Meat Board, in which two sources of aged, vacuum-packed beef were compared as raw materials for C.A.-packed steaks and meat cubes, i.e.

1) traditionally chilled beef

2) hot-boned beef

MATERIALS & METHODS

The production of the raw materials and the C.A.-packs took place under commercial conditions, whereas the storage and evaluation of the C.A.-packed meat was carried out at the Meat Research Institute.

The traditionally chilled beef came from a plant that usually delivered beef to the C.A.-packaging factory. Carcasses were chilled at approx. 4°C and cut into wholesale cuts 2 days post mortem. The semimembranosus (SM) and longissimus dorsi (LD) or quadriceps (QM) muscles were vacuum-packed and stored at 2°C until 8 days post mortem. This meat is described in the following as T-1 (traditional, aged 1 week).

The hot-boned meat came from another plant. Carcasses were deboned within 1½ hrs. post mortem. The wholesale cuts were immediately vacuum-packed and chilled slowly during the first 24 hrs. The chilling was such that the temperature in the meat was close to 15°C at 10 hrs. post mortem and close to 10°C at 17 hrs. post mortem. 24 hrs. after slaughter the meat was transferred to 2°C for further chilling and storage. Two types of hot-boned meat was used i.e. cuts aged to 7 days post mortem and cuts aged to 14 days post mortem. These types of meat are in the following described as H-1 (hot-boned, aged 1 week) and H-2 (hot-boned, aged 2 weeks).

The experiment was divided in two series, which were planned so that the results from the first series were available before the second series was started. In the first series steaks were cut from LD and meat cubes from SM. Except for hot-boned LD, the aged, vacuum-packed muscles were trimmed for old surfaces, fat, etc. to give the C.A.-packed meat a high quality appearance. The total number of muscles involved were 30 LD and 30 SM divided equally between T-1, H-1, and H-2. The choice and treatment of the raw materials in the second series aimed at giving less expensive products than those produced in the first series. Steaks were cut from SM and meat cubes from QM. None of the aged muscles were trimmed before being cut into steaks and meat cubes. The second series included a total of 18 SM and 18 QM.

Production conditions and evaluation techniques were identical for the two series. Steaks were cut by hand and meat cubes on a machine. The packaging took place on a Tiromat WA 430 L machine. The net weight of the meat in the packs varied between 250-400 g, which filled up less than 50% of the volume in the packs. The composition of the injected gas was 80% O_2 and 20% CO_2, but as the degree of vacuum drawn before injection was moderate a certain amount of N_2 was left in the pack. All packs in each of the two series were produced within 3 hrs., whereafter the packs were transferred to the Institute and stored on trolleys in well-controlled chilling rooms. The following schedules for storage were investigated:

2°C throughout the storage period
4°C throughout the storage period
2°C for 4 days, thereafter 6°C (2/6°C)
4°C for 4 days, thereafter 6°C (4/6°C)

0 days, 4 days, 7 days and 11 days after packaging the freshness of the meat was evaluated by sensory and microbiological methods on three packs from each type and treatment (max. 72 packs per day).

The appearance of the meat in the unopened packs and the smell of the meat on opening was evaluated by a professional 4 member panel. The scale used to evaluate the appearance was as follows.

Description	Points for appearance
Appearance on day of packaging	1
Fine fresh	2
Slightly unfresh	3
Diffusely discoloured	4
Totally discoloured	5

Microbiological determinations were only carried out on packs containing meat cubes. Approx. 5 meat cubes from the central part of the top layer in each pack were removed aseptically and pounded in a stomacher. Dilutions were plated for:

Total viable count on DIFCO 0479 Plate Count Agar. Incubation at 20°C for 5 days.
Lactobacillus on OXID CM361 MRS AGAR. Incubated in 5% CO_2-atm. at 30°C for 5 days.
Brochothrix thermosphacta on Gardners S.T.A.A. medium. Incubation at 20°C for 5 days.
Pseudomonas on Merck 10230 GSP Agar. Incubation at 20°C for 5 days.

RESULTS

A summary of the results of the subjective evaluations of the appearance of the meat in the packs is given in Figure 1. It should be noted that the results in the figure represent the average of packs stored at 2°C, 4°C, 2/6°C and 4/6°C. A description of the appearance and smell is given in the following.

The freshly packed meat (day 0) had an almost unnatural bright colour and the meat smelled like fresh-cut meat.

4 days after packaging the colour in the packs was more natural but still fresh in all packs. At this time the meat had lost its natural odour and there was hardly any smell in the packs at all.

7 days after packaging all packs in the first series were still fully acceptable. The general impression of the packs from the second series was that only packs stored at 2°C were fully acceptable, while packs stored at higher temperatures had started to fade and develop visible amounts of metmyoglobin. In both series experienced judges could detect slight amounts of oxidized organic compounds in the meat odour but no putrid smell was present in any of the packs.

11 days after packaging most packs in the first series had faded but only a few packs had developed discoloured spots. In the second series only packs produced from T-1 or H-1 and stored at 2°C were comparable in freshness to those found after the same storage time in the first series. Many packs stored at higher temperatures, and especially H-2 packs showed serious discolouring. In both series oxydized and rancid off-odours were beginning to develop in the packs, but putrid smells were rare, excepts in packs stored at 6°C in the second series.

In both series the keepability of the steaks and meat cubes were of the same order despite the differences found between the two series. A comparison of keepability in packs produced from T-1, H-1 and H-2 raw materials led to a slight preference for H-1, which on the average had the most stable appearance after long storage times.

The results of the microbiological determinations are summarized in Figures 2 and 3, which show the average of logarithmic counts of packs stored at 2°C, 4°C, 2/6°C and 4/6°C. In the first series (Figure 2), where the aged muscles were trimmed before being cut into meat cubes, it was noticable that Lactobacillus constituted approx. 50% of the total count throughout the storage. B.thermosphacta developed at moderate speed and Pseudomonas only increased 10 times during the full storage period.

Figure 3 shows the corresponding figures from the second series, where none of the aged muscles were trimmed before they were cut into meat cubes. The total counts in the second series were not significantly different from those found in the first series but this time Lactobacillus amounted to less than 10% of the total flora. Initial counts of B. thermosphacta were similar to those found in the first series, but the average growth rate was considerably higher in the second series. Pseudomonas counts were as in first series.

Comparing the different types of raw materials, differences between T-1 and H-1 could only be found for B.thermospacta, where the count on average was a little higher on T-1 than on H-1. Differences were however small in the second series. The counts of B. thermosphacta and Pseudomonas on H-2 did not exceed those found on H-1.

The results presented here are only part of the results found in the total investigation. Thus it should be mentioned that determinations of fecal Streptococci, Staphylococcus aureus and Eschericia coli (44°C) were carried out by the laboratory in the C.A.-packaging factory. The results showed that none of these bacterial types gave any problems in the packs produced for the experiment.

Additional investigations at the Institute included measurements of % drip in the packs, pH in drip from meat cubes, colour measurement with a Hunter Lab instrument on steaks from the second series, and taste panel evaluations on steaks and meat cubes. The main results of these examinations were as follows: % drip loss for H-1 was slightly higher than for T-1, Hunter SI values closely corresponded to the visual judgement of appearance, and taste panel evaluations showed that the flavour especially in steaks had already decreased after 4 days of storage. On long storage times the decrease in flavour was less pronounced in H-1 than in T-1 and H-2.

DISCUSSION

The idea of using gaseous mixtures to prolong the keepability of fresh meat is not new. However, only with the recent developments in packaging-techniques and -materials have these ideas gained practical significance. In a literature review from 1976 Qvist & Simonsen (2) conclude that the basic principles of the relative influence of O_2 and CO_2 on microbial growth and changes in meat colour are well established but need to be verified and developed in practice. The interest in the topic of meat packaging has been vivid and references to many of the research groups which have been working with vacuum or C.A. packaging can be found in a recent double paper by Seideman et al. (3), and by Christopher et al. (1).

The principle of the investigation described in the present paper can be considered as the consecutive application of two forms of controlled atmosphere packaging i.e. vacuum packaging, where the atmosphere is high in CO_2 and very low in O_2, followed by packaging in 80% O_2 and 20% CO_2. Viewed from this angle the composition and development of the microbial flora are well in accordance with the literature. The keepability of the meat in the 80% O_2 + 20% CO_2 C.A.-packs is not as long as that found in several other investigations but this can be explained by differences in storage temperatures, microbial counts, and threshold values for acceptability.

There are, however, several points in the results which cannot satisfactorily be explained, such as why the composition of the microbial flora was completely different in the first and second series, or why packs produced from H-2 in the first series had such an exceptionally good keepability.

The use of aged, hot-boned beef for the production of C.A.-packed meat has probably not been described previously. The results presented in this paper cannot serve as a proof that hot-boned meat is better or worse than traditionally chilled meat, because by altering slaughter hygiene or chilling programmes in one of the plants delivering the vacuum-packed cuts, microbial and sensory properties of the C.A.-packed meat can also be altered considerably.

However, the results do indicate that it is possible to produce vacuum-packed, aged, wholesale cuts from hot-boned beef which are just as suitable for the production of C.A.-packed meat as similar cuts from traditionally-chilled beef.

REFERENCES

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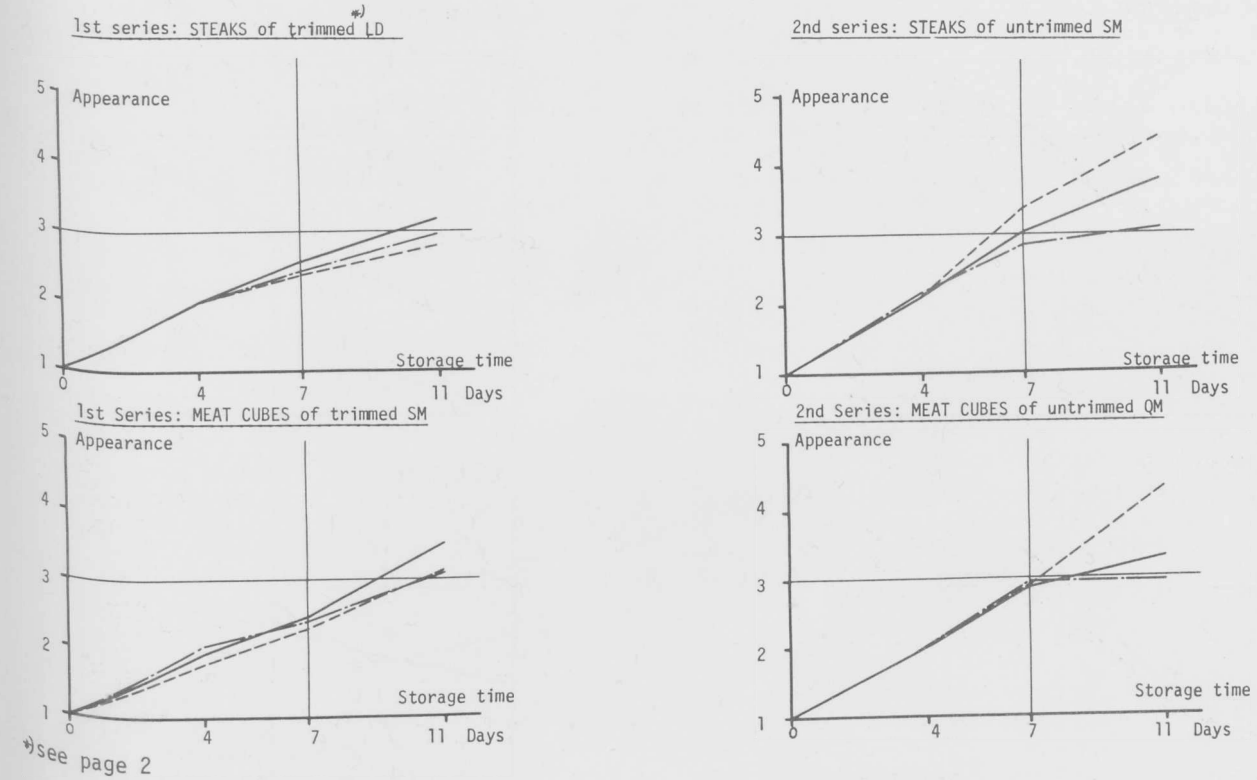
LB/AA

Figure 1: Appearance of meat in relation to storage time and type of raw material
(Average for packs stored at 2°C, 4°C, 2/6°C and 4/6°C)



*) see page 2

——— = T-1 —·——·— = H-1 ------- = H-2

Figure 2: Microbiological determinations on meat cubes from the first series
(Average log. count for packs stored at 2°C, 4°C, 2/6°C and 4/6°C)

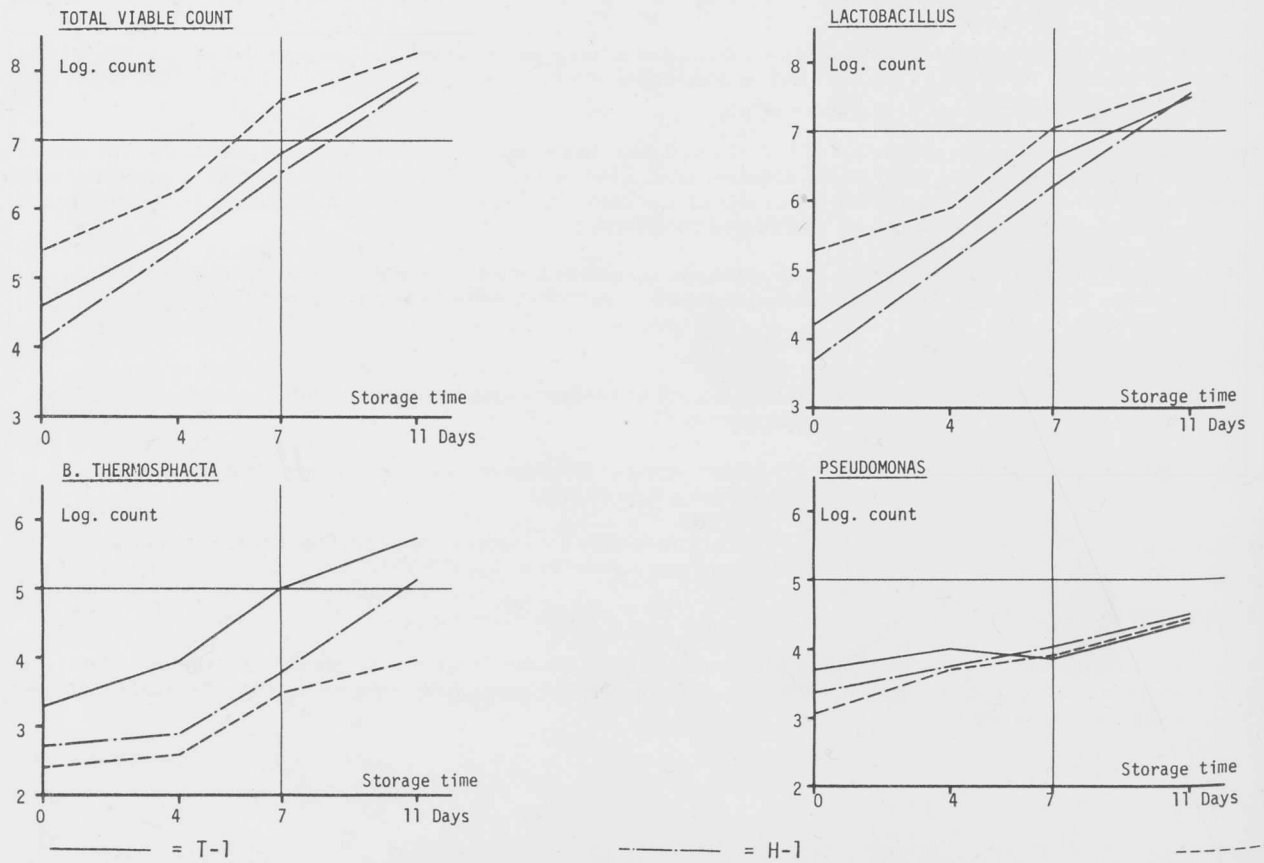


Figure 3: Microbiological determinations on meat cubes from the second series
(Average log. count for packs stored at 2°C, 4°C, 2/6°C and 4/6°C)