TTT - the influence of packaging

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Introduction

The storage life of frozen foods depends on the storage temperature and on the PPP's (Product, Process, Packaging). In some of the first TTT-experiments at Albany the packaging of poultry and pre-cooked poultry products was found to have a very great influence (Hanson et al, 1959, Klose et al, 1959). In Denmark several experiments have shown that a good package, i.e. low permeability and good mechanical properties may more than double the storage life of frozen meat products compared with a somewhat inferior, yet commercially used type of packaging. However, in other cases a better packaging has only very little influence on the storage life (Jul,1969,Bøgh-Sørensen,1981). Many of the Danish TTT-experiments were designed to get more knowledge about the storage life characteristics of commercial frozen meat products, and to test the influence of the packaging material, so as to make the laboratory able to advise the frozen meat industry on the packaging of their products.

Two TTT-experiments are described:

1. Hamburgers and pork tenderloin in retail packages.
2. Pork chops in catering packages.

Experiment No. 1

Hamburgers, with soyprotein added, were selected from a normal production. Retail cartons (plastic lined paperboard) with 4 hamburgers placed in a pouch (0.03 mm PE), with 6 retail cartons in a master carton, were blast frozen.

Other hamburgers were frozen in paperboard cartons in stacks of 4 hamburgers with paper-rondels between them. After blast freezing for 1.5 h the hamburgers were vacuum packed 4 pieces in each pouch of PA/PE-laminate, and returned to the freezer.

58 Pork tenderloin were packed, as commercially often used, in MSAT (cellophane, laquered on both sides with nitrocellulose) wrapped around one tenderloin and afterwards closed, using a hot plate for part sealing.

The same number of tenderloins were vacuumpacked in the above described PA/PE-pouches.

Blast freezing was carried out with 12 tenderloins in a master-carton.

Samples were stored in outer cartons at -10° C, -18° C and -24° C, and evaluated with monthly intervals by the lab.'s trained taste panel, the first time two days after freezing. The 12 panel members gave scores (-5/+5 hedonic scale) for taste, texture and overall impression of hamburgers, and for taste, texture and juiciness of pork tenderloin.

Preparation. The hamburgers were "grilled" from the frozen state on a pan with butter added, and cooking loss was calculated. This varied very much, but seemed less in vacuumpacked than in carton/plastic packed, and independent of storage time and temperature.

The pork tenderloins were thawed, browned and braised.

Packaging materials. The characteristics of the packaging material are shown in the table below:

Plastic-material	Thickness mm	O_2-permeability ml/m^2. 24 h.atm. at 20° C	WVTR g/m^2. 24 h. at 37° C, 90% r.h.
MSAT	0.028	1200	63.8
Vacuum pouch (PA/PE-laminate)	0.10	336	6.0
PE	0.03	900	19.0

Results and discussion

Definition of storage life

Stability time (Stab. time) is the storage time at a given temperature until the average score has declined 1 point in a -5/+5 hedonic scale, judged by our trained taste panel. Stability time is often about the same as HQL (High Quality Life), or JND (Just Noticeable Difference).

Acceptability time (Acc. time) is the time until the average score has dropped to -1 in a -5/+5 scale, see above. Acc. time is by and large the same as is often referred to as PSL (Practical Storage Life) although the definition is different.

Resulting storage life. For each taste panel session the average scores for each sample are calculated and plotted in score/storage time diagrams (Bøgh-Sørensen, 1981). From such diagrams both stab. time and acc. time can be determined.

For hamburgers the score for overall impression declined fastest and therefore was the critical organoleptic factor with respect to storage time. For pork tenderloin it was the score for taste.

The storage times determined can be seen in table 1 and 2.

Table 1. Stability time and acc. time for hamburgers.

Storage temperature	Packaging	Stability time (days)	Acc. time (days)
- 10° C	Carton + plastic	80	210
	Vacuum pouch	240	365
- 18°C	Carton + plastic	275	>700
	Vacuum pouch	485	>700
- 24° C	Carton + plastic	360	>700
	Vacuum	630	>700

Table 2. Stability time and acc. time for pork tenderloin.

Storage temperature	Packaging	Stability time (days)	Acc. time (days)
- 10° C	MSAT	60	180
	Vacuum pouch	60	180
- 18° C	MSAT	160	540
	Vacuum pouch	220	700
- 24° C	MSAT	>700	>700
	Vacuum pouch	>700	>700

Accurate determination of storage life as defined was not possible as the scores differed considerably, also between two "identical" samples at the same session. However, table 1 shows clearly that a better packaging, i.e. vacuum packaging results in a much longer storage life of hamburgers. It also shows that the improvement in stability time is 200% at -10° C, but only about 75% at -18° C and -24° C.

For pork tenderloin which has a very low fat content the better packaging results in only slight improvement. Also, the score after 27 months at -24° C was about the same as the score immediately after freezing.

It was surprising that the storage life for the hamburgers was so long. The carton plus PE-pouch is obviously a good packaging.

In quality control carried out by The Danish Meat Products Laboratory, Ministry of Agriculture, these two products often get downgraded because of dehydration on the surface, sometimes even freezer burn, although the quality control inspects the products normally only 1-3 weeks after production. The only explanation is that the "normal" packaging for both products is not good enough to withstand the influence of handling, i.e. freezing, internal distribution, and shipment to the laboratory.

This experience does suggest, however, that it is not enough to use a packaging material with rather low permeability. It is equally or more important to use a package with satisfactory mechanical properties.

The difference between the results of this experiment and experiences from practice emphasizes that TTT-experiments should not be carried out without the inclusion of some sort of handling, and also some sort of temperature fluctuations as they are found in the freezer chain.

Experiment No. 2

A. Frozen pork chops from the neck loin were catering-packed in a paperboard cartons with 20 pork chops about 100 g each in a PE-pouch and with a sheet of PE between the 4 layers. 9 cartons.

B. 9 cartons were packed as A, but a PA/PE-laminate (the same as in experiment No. 1) was used instead of PE.

C. Frozen pork chops were vacuumpacked in PA/PE-pouches (same material as in B) with 4 chops in each pouch.

After freezing, the samples were stored at -12° C, -18° C or -30° C. Taste panel sessions were held after 4, 8 and 10 months, each time with 4 evaluations with weekly intervals; 5 chops of A and B were used in each evaluation, adding up to 1 catering-pack. The samples were placed at -18° C the day before sensory evaluation; the appearance was judged after 1 hour at room temperature, whereafter the chops were prepared, on a griddle-plate. The taste panel gave scores (-5/+5 hedonic scale) for taste, if possible for both meat and fat, and overall impression.

Results and discussion

The acc. times found were based on the average scores for overall impression, as these were practical the same as for taste. The definition of acc. time was the same as in exp. No. 1.

Packaging	Acc. time (months) at:		
	-12° C	- 18° C	- 30° C
A. Carton + PE	3	7	9
B. Carton + PA/PE	4	7	10
C. Vacuum packaging	8	10	>12

It should be mentioned that some vacuumpackages (C) had developed leaks; the meat in such packages received the same or even lower score than that in packagings A and B.

It can be concluded that these pork chops from the neck loin with their high content of internal fat are very susceptible to rancidity and after storage at -12° C very quickly get very low scores (-3 to -4) and notes of rancidity, oily taste, etc., if they are catering packed. It is not enough to replace PE with PA/PE-laminate, probably because so much air is trapped in the plastic pouch.

Only vacuumpackaging gives an acceptability time of 9 months or more at -18° C.

The appearance was very good for vacuumpackaged chops and for chops stored at -30° C. After 4 months at -12° C and -18° C ice could be seen on the surface of chops in package A and B; especially in package A the chops looked rather dry (dehydrated).

After opening the carton (package A and B) and taking out 5 chops there was a tendency for the panel to give lower scores for the remaining chops, especially at the last evaluation which took place 3 weeks after the first 5 chops were taken out. This might be a greater problem if the pork chops were vacuumpacked in a pouch with 20 pieces, and if more than a few days elapse between opening the pouch and using the last chops.

Thus it does not seem easy to suggest a packaging method by which a catering pack with 20 pork chops could have an acc. time of 9 months at -18° C, which is often desired.

The experiment emphasizes the well known fact that packaging should preferably fit tightly around the product. If not, it is of nearly no significance whether the packaging material is good or inferior.

References:

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