The effect of vacuumpackaging on some sliced processed meat products judged by organoleptical and bacteriological analysis

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Vacuumpacking of sliced processed meat is a method which is increasingly used in Sweden as in many other European countries. This method makes packing and distribution more rational, as the meat products can be sliced and packed at the factory. Also a better quality has been claimed for the vacuumpacked meat, compared with ordinary handling at comparable storage conditions. On the first hand, better resistance of the natural colour is obtained, as the changes in colour in stored meat products are essentially a reaction maintained by oxygen. Also oxidative rancidity is dependent on oxygen and therefore expected to be checked when the oxygen is depleted from the packages.

Lowering of the pressure of oxygen at the moment of heatsealing can also be expected to influence the growth of the associated microflora and thereby the keeping quality from bacteriological and organoleptic point of view. However, this has been questioned by some research workers dealing with the subject. Thus, Leistner (1956, 1957) found a certain checking and a qualitative change of the microflora in vacuumpacked meat products but the differences were small and according to his opinion insignificant from the commercial point of view. Linderholm (1960), who investigated the keeping quality of vacuumpacked sliced meat products on the Swedish market, could not find any difference in total bacterial counts between stored vacuumpacked and non-vacuumpacked products. He claims that a better bacteriological quality should not be pointed out as an essential advantage of vacuumpacking. Considerable differences between total bacterial counts in vacuumpacked and non-vacuumpacked ground lamb has on the other hand been reported by Halleck et al., and Brown and Schmucker (1960) working with bacon also noticed clear differences between vacuumpacked and non-vacuumpacked samples stored at 28 - 32°F (-2 - 0°C). Qualitative changes in the microflora have also been reported by Allen and Foster (1960), who found a dominance of Lactobacillus sp. in vacuumpacked sliced meat.

Our problem in these experiments was to elucidate the effect of vacuumpackaging on the keeping quality of some meat products, judged by organoleptical and bacteriological analyses. The growth rate in vacuumpacked

and non-vacuumpacked samples has been tested at different storage temperatures. The significance of the level of the associated microflora at the time of packing has also been investigated. We were also interested to get information about any possible qualitative changes in the microflora of vacuumsealed packages compared with non-vacuumpacked.

Organoleptic examination

The meat products were cut in slices and put into cellophane-polyethylene bags. One part was heatsealed at atmospheric pressure and the other part at a vacuum of 3 mm Hg. The vacuum sealing apparatus used is constructed and described by Bosvik (1960).

In the first experiment wieners, salt cured meat and German sausage stored at -1.5, 0, +3, +6 and +15°C were used. Samples were examined at intervals and the storage time when sour smell could be noticed was determined. The result showed that sour smell could be traced earlier in non-vacuumpacked samples for all types of meat products investigated and at all storage temperatures (Table 1).

In the next experiment odor and appearance were judged using a five degree scale. Highest score (5) was assigned to the fresh product. The same meat products and storage temperatures as in the first experiment were used. The result showed that off-flavor could be noticed earlier in samples packed at atmospheric pressure, compared with vacuumsealed (Table 2a, 2b, 2c). It might be pointed out that off-flavors, especially at higher storage temperatures, can be noticed at an earlier stage than changes in appearance.

In figure 1a and 1b the average score for odor and appearance, respectively during a 14 days storage time has been plotted against the storage temperature for vacuumsealed samples and for samples sealed at atmospheric pressure. The vacuumpacked samples have a higher average score both for odor and appearance at all temperatures tested. The differences between vacuum and non-vacuumpacked are especially significant for cured salt meat.

Bacteriological examination

Total bacteria counts in the samples were determined by means of platings in tryptone-glucose agar with the addition of brom cresole purple as indicator. The bacteria counts given usually constitute the average of 4 samplings. The samples were homogenised in 100 ml of sterile water for 30 seconds by means of a homogenizer. Adequate dilutions were made and mixed with 15 ml agar. The plates were incubated at 20°C for 4 days before counting.

Experimental series I.

Sliced salt cured meat, sliced German sausage and wieners were vacuumpacked, and the counts of bacteria in the vacuumpacked samples were compared with samples sealed at atmospheric pressure. Examinations were carried out after different times at different storage temperatures. The result is shown in Table 3. It appears from the Table that the total number of bacteria in practically all cases is lower in the vacuumpacked samples than in corresponding samples kept at atmospheric pressure. In figure 2, the time required for a sample of German sausage to reach a bacteria count of $10^6/g$ has been shown as dependent on the storage temperature for vacuumpacked samples as well as for samples sealed at atmospheric pressure. The times in the respective cases have been estimated from the growth curves. Significative differences between vacuum and non-vacuum were noticed at all experimental temperatures, except at -1,5°C. The magnitude of the deviation is naturally dependent on the experimental conditions. In the experiment demonstrated in figure 2 the initial infection was about 20.000 bacteria/g, which is probably rather normal under commercial conditions for products of this type.

Experimental series II.

To obtain better defined experimental conditions this series and the one following were carried out with a sausage which was produced at our laboratory the day before the experiments were started. The sausage had the following composition: 4.3 kg veal meat, 3.0 kg pork meat, 1 kg lard and 15 g NaCl. The veal- and pork meats were mixed in a chopper during 5 minutes. 5 kg of this mixture was removed and the rest mixed for 5 minutes with the lard and the salt. The mixture was stuffed firmly in artificial sausage skins, and the sausages were put into a waterbath at 80°C for 45 minutes, followed by storage at 0°C for 20 hours. The sausages were then sliced and packed. (The slicing apparatus was desinfected with 70 % alcohol.) 3 slices were put in each package, and the weight of the package was about 30 g.

The following experimental sections were included in the experiment: sausage slices dipped in sterile water, sausage slices dipped in a suspension of Bacillus sp., sausage slices dipped in a suspension of Achromobacter sp. and sausage slices dipped in a homogenized suspension of vacuumpacked sausage, high in bacteria count. Half of the samples in each experimental section were heatsealed under vacuum (3 mm Hg or 0.005 atm. pressure). The other half of the samples was heatsealed under atmospheric

pressure. Slicing and sealing was carried out at room temperature, but none of the samples were kept at this temperature for more than 30 min. At the start 3 samples were taken from each experimental sections for bacteriological analyses. The rest were incubated at +5°C.

The bacteria counts made at intervals, were made on tryptone, glucose agar. Even in these experiments there was a clear indication that the microflora was developing slower in vacuumsealed bags, compared with samples packed at atmospheric pressure (table 4).

Experimental series III.

The same type of substrate as described earlier was used in this experiment as well. A sausage was produced which at the start of the experiment had about 500 organisms per gram. The sausage was cut in slices and packed in cellophane-polyethylene bags. One part was heatsealed at atmospheric pressure and the other at 3 mm Hg (0.005 atmospheres). The samples were divided into 3 parts which were stored at 0°, +3°, +5°, 15°, 21°C respectively. Samples were taken at different intervals depending on storage temperatures. The results of the bacteria counts are shown in table 5. As might have been expected, the temperature is the determinative factor for the growth rate of the microflora. Very clear is also a difference in the bacterial numbers between vacuumpacked and non-vacuumpacked samples (figure 3). This difference is noticed at all storage temperatures investigated. The growth curves indicate a longer lag phase in vacuumpacked samples compared with samples packed at atmospheric pressure.

Qualitative changes in the microflora during storage

The qualitative changes which take place in the microflora of vacuumpacked samples during storage compared with similar samples without vacuum at the same temperatures were also examined.

From platings carried out in connection with the determination of total bacteria counts, representative colonies were picked from the countable dilutions. Isolations were made from platings at the start of the experiment, after a couple of days of storage, and at the end of the storage period from vacuum-packed as well as from non-vacuumpacked samples. Of the approx. 300 isolates obtained the most predominate types were determined as to their genus according to the Manual of Methods for Pure Culture Study of Bacteria.

Commercially produced processed meats usually possess a heterogeneous initial microflora, which is dependent on the product in question and on the basic microflora present at the place of production. The samples examined in this work also showed a high and rather heterogeneous initial flora. Common for all samples was, however, the fact that one type of microorganism predominated, varying with the product handled. Predominating organism in sliced salt cured meat was Micrococcus sp., in sliced German sausage it was Lactobacillus sp., and in wieners Bacillus sp. Samples of the laboratory produced sliced sausage with a low initial bacteria count showed an almost homogeneous microflora consisting of Bacillus sp.

Vacuum packaging and storing of these samples brought about a considerable change qualitatively in the predominating microflora. During the storage period, the originally predominating flora was partly or completely suppressed and replaced by other bacteria types, obviously more microaerophilic in nature. This phenomenon could be observed in the commercially produced samples as well as in the laboratory produced samples.

The new predominating microflora varied somewhat with the type of the product. In samples of sliced salt cured meat, wieners and sliced laboratory produced sausage the predominating organism was Lactobacillus sp. and in sliced German sausage Achromobacter sp. was found to predominate. Similar samples non-vacuumpacked and kept in storage at the same temperatures showed no qualitative changes in the microflora during the storage time. The predominating microflora was in this case identical with the initial flora observed.

Figure 4 shows the qualitative change that took place during storage based on the microflora isolated throughout the experiment.

The significance of the initial bacterial numbers in the samples

It is known that the bacterial growth in stored samples is influenced by the initial number of bacteria. From the growth curves of 7 experiments with vacuumpacked and non-vacuumpacked samples, the correlation between initial bacterial numbers and growth was calculated. In figure 5 the time for a sample with a certain initial bacterial number to reach a bacterial count of 5×10^5 organisms/g is shown. As seen from the curves, there is a clear indication that the checking of growth in vacuumpacked samples is more predominant when the samples have a low bacterial count at the time of packing.

Discussion

Our results showed that if flavor ratings are used as a criterium, vacuumpacked sliced processed meats maintain their acceptability over a longer period than samples packed at atmospheric pressure, this being true for all storage temperatures tested. (Table 1, figure 1a, 1b).

For fresh meat, similar effects have earlier been reported by Brown and Schmucker (1960), who established an increase of flavor ratings in stored vacuumpacked bacon, and by Hallock et al.(1958) for ground lamb.

The temperature is the most important parameter for the growth of the bacterial flora in prepacked, processed meat and vacuum-packaging does not prevent growth at any storage temperature examined. However, the bacteriological analyses show consistently a lower bacterial level in samples from evacuated sealed bags, compared with bags sealed at atmospheric pressure. (Table 3, figure 2 and 3). The increased keeping quality is suggested to a certain extent to depend on checked growth of the bacterial flora in the vacuum-sealed samples.

The bacteriological analyses of vacuumpacked processed meat and meat packed at atmospheric pressure, respectively, showed that the initial bacterial count was important for the bacterial growth. In our experiments we had a fairly low level of viable bacteria at the start. The effect of the initial number on the bacterial growth was different in vacuumpacked samples and in samples packed at atmospheric pressure. In both cases the initial numbers are correlated with the bacterial growth at a certain time. The results (figure 3 and 5) also indicate that the effect of vacuumpackaging of bacterial growth is most pronounced at low initial level of the microflora.

The dominant initial microflora of the processed meats used in these experiments was a mixture of Bacillus sp., Micrococcus sp. and Lactobacillus sp. This flora was relatively constant in composition during cold storage in cellophane-ethylene bags heat-sealed at atmospheric pressure. But in vacuumpacked samples there was in salt cured meat and wieners a striking shift to almost a pure culture of Lactobacillus sp. and in German sausage to a Achromobachter sp. This is partly in agreement with results reported by Allen and Foster (1960), who found a dominance of Lactobacillus sp. in vacuumpacked sliced cold meat.

In our experiments, only a few anaerobes ($<10/g$) were represented in the initial bacterial flora and in no case we could recognize growth of anaerobes in vacuumsealed bags. The possible risks of growth of pathogenic anaerobes in vacuumpacked meat products was not studied in this in-

vestigation. The failure of anaerobes to develop in our experiments might, however, indicate that other factors than oxygen pressure are determining growth of anaerobes in these types of meat products and under the conditions studied. The tendency of Lactobacillus to dominate in vacuumpacked meat might also be a factor of importance to prevent growth of anaerobes owing to the ability of Lactobacillus sp. to lower the pH.

Summary

Some sliced processed meat products have been shown to hold a higher quality during cold storage when vacuumpacked (3 mm Hg) in heat-sealed cellophane-ethylene bags, compared with packaging at atmospheric pressure. Appearance, organoleptic acceptibility and bacterial growth were used as criteria for quality.

The microflora was changed in vacuumpacked samples from a mixed population of Bacillus sp., Achromobacter sp. and Lactobacillus sp. to an almost pure culture of a Lactobacillus sp. or Achromobacter sp. during cold storage.

It is claimed, that in addition to the retardation of physical and chemical changes, the reduced growth of the microflora also might account for the higher quality of the vacuumpacked meat samples under the experimental conditions employed.

Homogeneous?

Göteborg, 30th of June 1960
1646/60-Hg

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Table 1. Storage periods in days until noticed sour smell at different temperatures of processed vacuumpacked and non-vacuumpacked meats, judged organoleptically.

Storage temp. °C	Wieners		Salt cured meat		German sausage	
	Vacuum[x)]	Non-vacuum[xx)]	Vacuum[x)]	Non-vacuum[xx)]	Vacuum[x)]	Non-vacuum[x]
-1,5	>21	>21	>21	>21	>21	14
0	>21	>21	>21	7	>21	12
3	>21	15	>21	4	14	4
6	14	6	21	4	8	4
15	6	2	6	2	2	2

x) Vacuumpacked at 3 mm Hg

xx) Packed at atmospheric pressure

Table 2 a. Organoleptic scoring of wieners stored at different temperatures with and without vacuum sealing

Storage time days	-1,5°C				0°C				3°C				6°C				15°C			
	Vacuum[x]		No vacuum[xx]		Vacuum		No vacuum		Vacuum		No vacuum		Vacuum		No vacuum		Vacuum		No vacuum	
	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance
2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5
3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	3
4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	2
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	5	2	1
8	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	2	5	1	1
9	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	1	5	3	2
10	5	5	5	5	5	5	5	5	5	5	4	4	4	5	4	4	3	5	4	2
14	5	5	5	4	5	5	5	4	5	5	4	4	4	4	3	4	2	4	2	1
M =	5.0	5.0	5.0	4.9	5.0	5.0	5.0	4.9	5.0	5.0	4.8	4.8	4.8	4.9	4.4	4.3	3.4	4.9	3.0	2.1

x) Vacuumpacked at 3 mm Hg

xx) Packed at atmospheric pressure

Odor, scoring: 5 = Normal
4 = Slightly sour, musty
3 = Sour - musty
2 = Distinctly sour, musty
1 = Strongly sour and musty

Appearance, scoring: 5 = Normal
4 = Slightly pale
3 = " discoloured
2 = Distinctly discoloured
1 = Green-yellow coloured

Table 2 b. Organoleptic scoring of sliced salt cured meat stored at different temperatures with and without vacuum sealing

Storage time days	-1.5°C				0°C				3°C				6°C				15°C			
	Vacuum x)		No vacuum xx)		Vacuum		No vacuum		Vacuum		No vacuum		Vacuum		No vacuum		Vacuum		No vacuum	
	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance
2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2	4
3	5	5	4	5	5	5	4	5	5	5	4	5	5	5	4	5	4	4	1	3
4	5	5	5	4	5	5	3	4	5	5	4	4	5	5	4	4	5	5	0	4
6	5	5	4	4	5	5	4	4	5	5	4	4	5	5	4	4	1	5	0	4
7	5	5	4	4	5	5	4	4	5	5	2	4	4	5	1	4	1	5	0	4
8	5	5	4	4	5	5	4	4	5	5	4	4	5	5	2	4	1	3	0	4
9	5	5	4	3	5	5	4	3	5	5	1	2	5	5	1	2	1	5	0	0
10	5	5	3	2	5	5	2	2	5	5	2	2	5	5	1	2	1	5	0	2
13	5	5	2	2	-	4	2	2	5	5	1	2	5	5	1	2	1	5	0	2
14	5	-	3	2	5	5	3	2	5	5	2	2	5	-	1	2	1	-	0	2
M =	5.0	5.0	3.8	3.5	5.0	4.9	3.5	3.5	5.0	5.0	2.9	3.4	4.9	5.0	2.4	3.4	2.1	4.7	0.3	2.9

x) Vacuumpacked at 3 mm Hg

xx) Packed at atmospheric pressure

Odor, scoring: 5 = Normal
4 = Slightly sour, musty
3 = Sour - musty
2 = Distinctly sour, musty
1 = Strongly sour and musty

Appearance, scoring: 5 = Normal
4 = Slightly pale
3 = " discoloured
2 = Distinctly discoloured
1 = Green-yellow coloured

Table 2 c. Organoleptic scoring of sliced German sausage stored at different temperatures with and without vacuum sealing

Storage time days	-1.5°C				0°C				3°C				6°C				15°C			
	Vacuum[x]		No vacuum[xx]		Vacuum		No vacuum		Vacuum		No vacuum		Vacuum		No vacuum		Vacuum		No vacuum	
	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance	Odor	Appearance
2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	2	4
3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	3	4	2	2
4	4	5	5	5	4	5	5	5	4	2	4	4	1	2	2	4	1	1	1	2
5	5	5	5	4	5	5	5	4	4	5	4	4	4	5	4	4	2	5	2	4
7	5	5	5	4	5	5	5	4	5	5	2	4	4	5	2	4	2	5	2	2
8	5	5	5	4	5	5	5	4	4	5	4	4	3	2	3	4	1	2	1	2
9	5	5	5	4	5	5	5	4	5	5	2	4	4	5	1	4	1	1	1	1
10	5	5	5	4	5	5	4	4	4	5	2	4	2	5	2	4	1	1	1	1
11	5	5	5	4	5	5	5	4	5	5	2	4	4	5	2	4	1	1	1	1
12	5	5	5	4	5	5	4	4	4	5	2	4	3	5	2	4	3	-	1	1
14	4	5	2	4	4	5	3	4	2	5	1	4	3	5	1	4	1	1	1	1
M =	4.8	5.0	4.7	4.3	4.8	5.0	4.6	4.3	4.3	4.7	3.0	4.2	3.5	4.5	2.5	4.1	1.8	2.3	1.4	1.9

x) Vacuumpacked at 3 mm Hg

xx) Packed at atmospheric pressure

Odor, scoring: 5 = Normal
4 = Slightly sour, musty
3 = Sour - musty
2 = Distinctly sour, musty
1 = Strongly sour and musty

Appearance, scoring: 5 = Normal
4 = Slightly pale
3 = " discoloured
2 = Distinctly discoloured
1 = Green-yellow coloured

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Table 3. Logarithm of bacteria counts at different storage conditions for wieners, salt cured meat and German sausage, respectively

Temperature	0°C		3°C		6°C		15°C	
Time (days)	Vacuum	No vacuum	Vacuum	No vacuum	Vacuum	No vacuum	Vacuum	No vacuum
Wieners								
0	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
2					4.4	4.3	6.8	7.0
3	4.2		4.5	4.4				
4					4.6	4.4	8.0	8.2
5	4.4	4.1	4.5	4.7				
7					5.0	5.1	8.5	8.5
8		4.4	5.4	5.6				
9					7.4	6.7		8.5
10	4.7	4.8	6.2					
14	4.9		7.2	7.7	7.8	7.9	8.5	8.7
21	5.9	6.3	7.8	7.2				
Salt cured meat								
0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
2					5.2	5.7	7.9	8.0
3	4.7	4.6	4.9	4.8				
4					5.1	7.1	7.9	8.7
6	5.0	5.4	5.1	6.6				
7					5.3	7.4	8.0	8.8
10	5.3	5.7	6.6	7.0				
13					6.4	7.9	7.8	10.0
14	5.9	5.9	6.9	8.7				
21	6.6	7.4	7.2	8.0				
German sausage								
0	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
2					5.0	5.8	6.4	6.9
3	4.9	5.0	5.4	5.6				
4					5.7	6.6	7.7	8.0
5	5.0	5.1	5.2	6.9				
7					6.8	7.0	8.0	8.2
10	5.9	6.9	6.8	8.1				
14					7.2	8.4	8.2	7.6
21	6.7	7.8	8.0	8.3				

Samples vacuumpacked at 3 mm Hg

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Table 4. Bacteria counts in vacuumpacked and non-vacuumpacked samples inoculated with different organisms at the time of packaging

I = not inoculated

II = inoculated with Achromobacter sp. isolated from stored, vacuum-packed German sausage

III = inoculated with Bacillus sp. isolated from stored, non-vacuum-packed German sausage

IV = inoculated with a mixed flora obtained from German sausage

Days at 5°C	Log Bacteria Counts							
	I		II		III		IV	
	Vacuum	No vacuum	Vacuum	No vacuum	Vacuum	No vacuum	Vacuum	No vacuum
0	2.6	2.6	3.8	3.1	3.1	3.2	3.6	4.0
3	2.6	-	4.0	4.8	3.1	3.3	4.5	5.1
10	2.5	4.2	5.5	7.0	4.0	4.3	6.8	6.6
17	2.3	5.0	7.2	8.0	4.7	7.3	7.5	7.8
21	2.6	5.8	7.1	7.9	5.8	-	7.8	8.0
28	-	-	7.9	8.2	5.9	-	-	8.2
56	6.0	7.7	8.3	8.6	6.7	8.0	8.0	10.0

Samples vacuumpacked at 3 mm Hg

Table 5. Logarithm of bacteria numbers at different storage temperatures.

Storage time	0°C		3°C		5°C		15°C		21°C	
Hours	Vac.	No vac.	Vac.	No vac.	Vac.	No vac.	Vac.	No vac.	Vac.	No vac.
0	2.7	2.7	2.7	2.7	2.7	2.7	2.3	2.3	2.3	2.3
2							2.6	2.6	3.4	3.6
10										2.7
12										3.9
14										5.4
16									3.6	5.1
18									3.7	5.3
20									3.8	5.5
22										6.1
24							3.5	4.7		6.5
44									6.5	7.5
68									7.4	8.0
72	2.7	2.7	2.4	2.6	2.5	2.5				
96							4.5	6.8		
144							6.1			
168							6.6	6.7		
240	2.5	2.3	3.3	3.4	2.1	3.9				
408	1.7	1.8		5.4	4.7	6.1				
528	1.7	2.0	4.1	5.8	4.7	7.6				
720	1.9			6.6		7.3				
984			4.8	5.8	7.0	7.9				
1176	2.3	6.7	6.7	6.6		8.1				

Samples vacuumpacked at 3 mm Hg

Figure 1 a.

The average score for appearance during 14 days storage at different temperature.

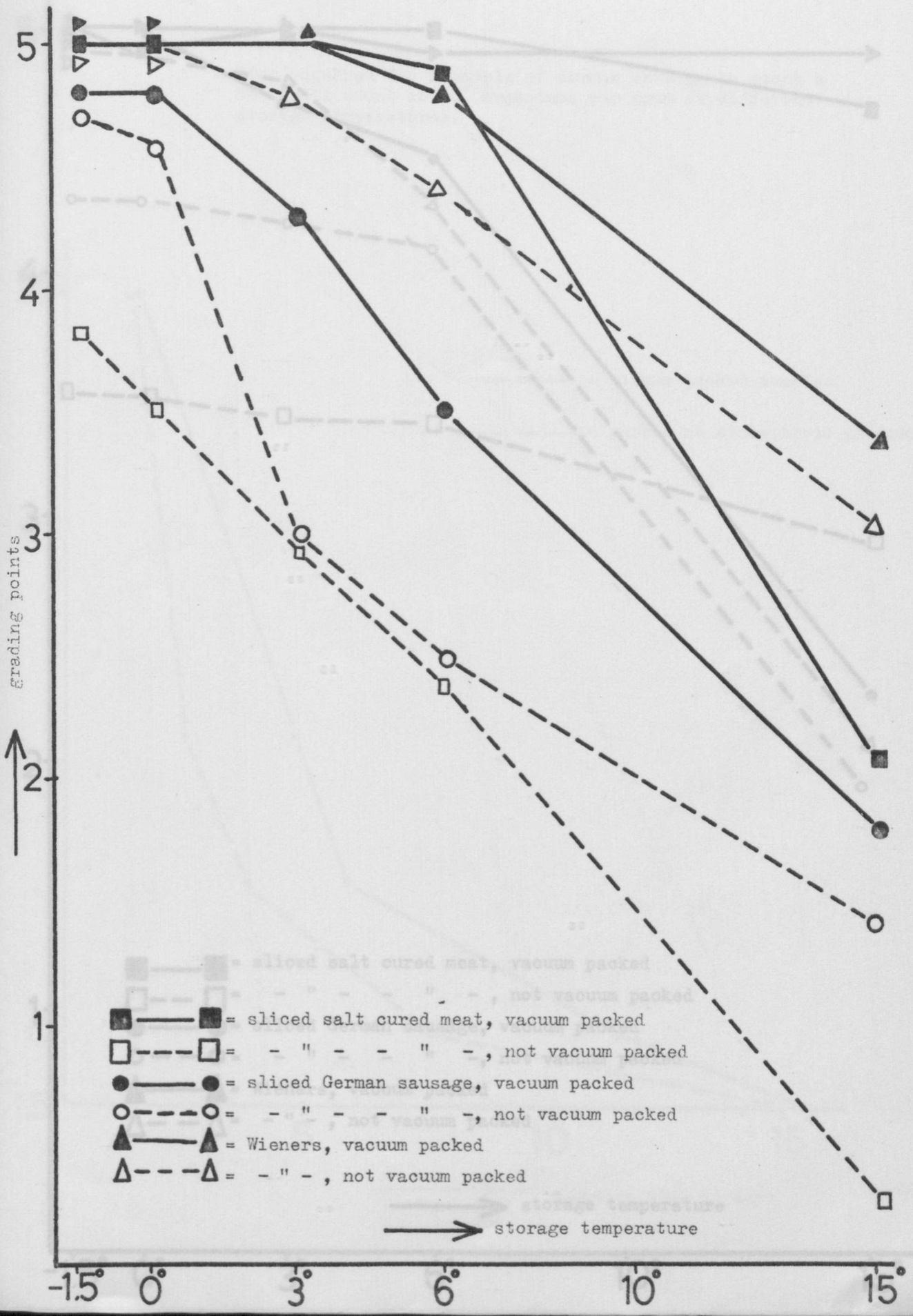

Figure 1 b.

The average score for odor during 14 days storage at different temperature.

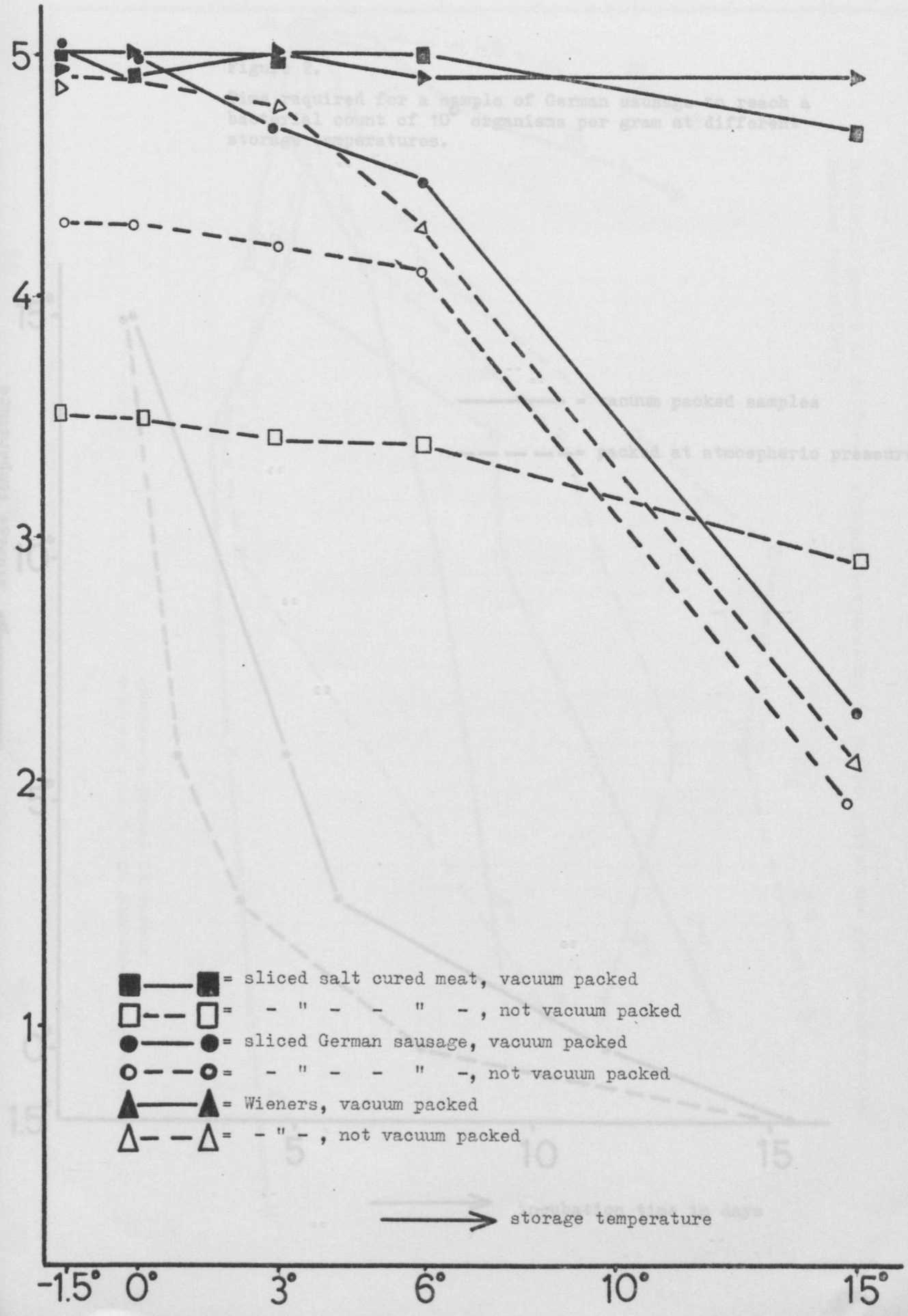

Figure 2.

Time required for a sample of German sausage to reach a bacterial count of 10^6 organisms per gram at different storage temperatures.

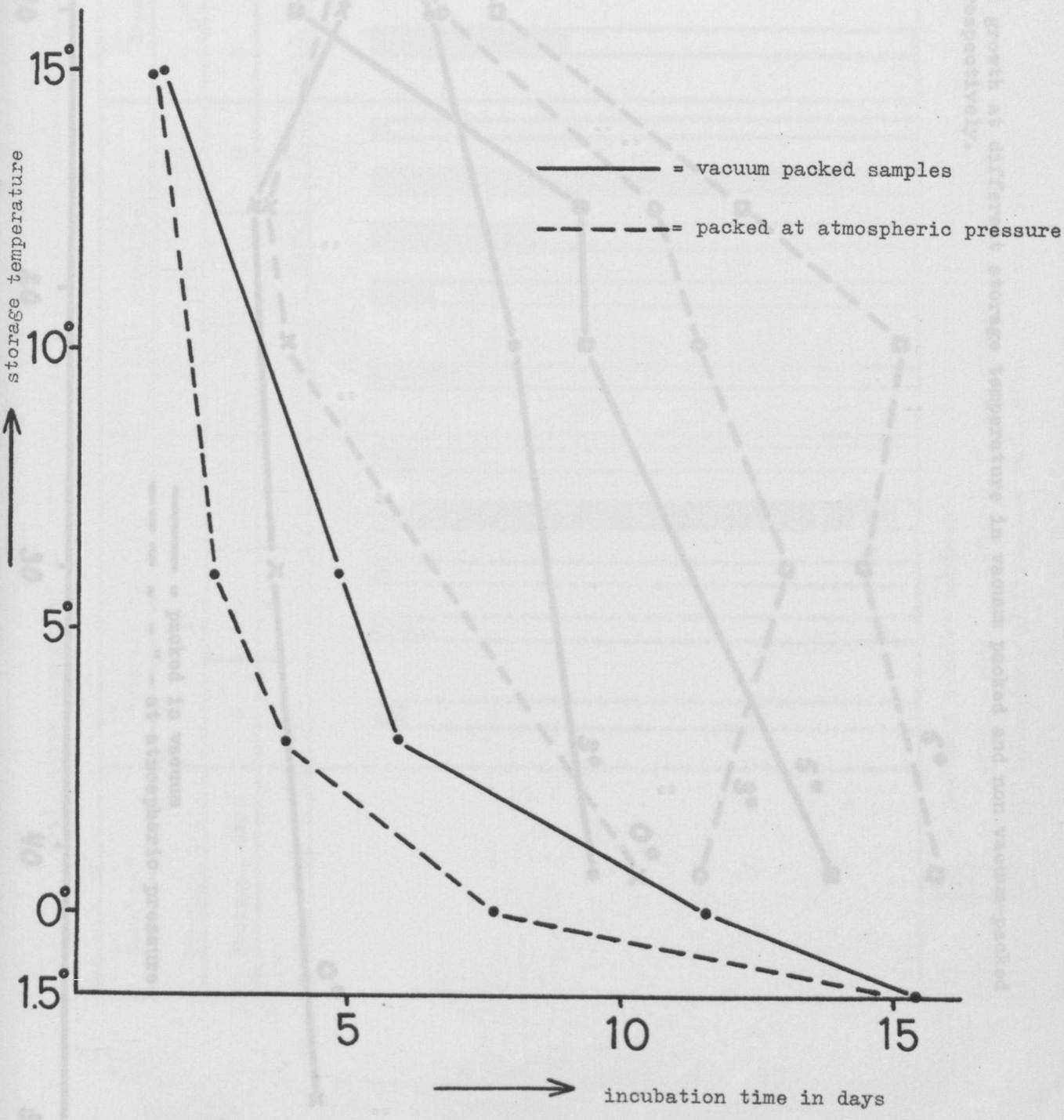

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Figure 3.

Bacterial growth at different storage temperature in vacuum packed and non vacuum-packed samples respectively.

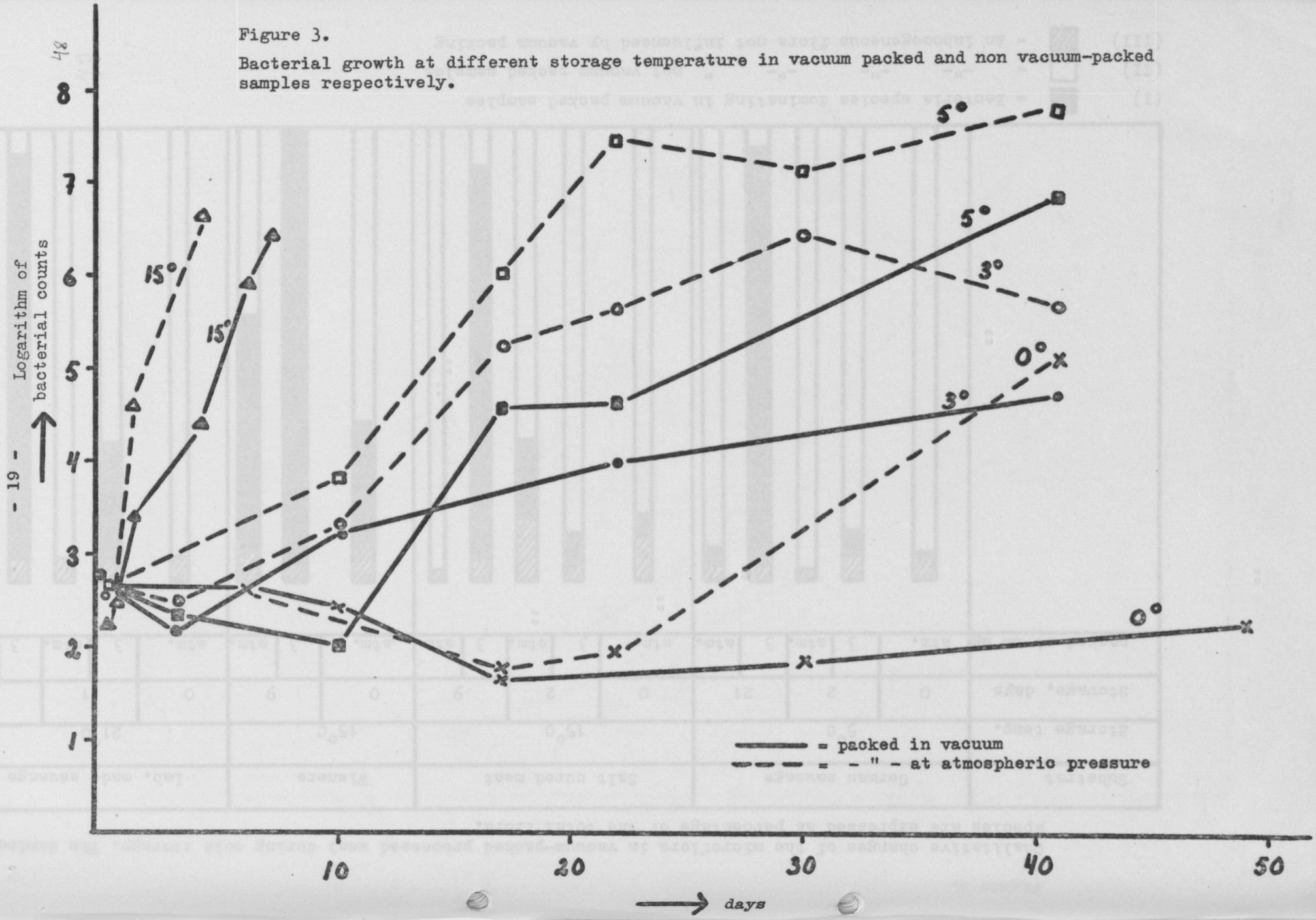
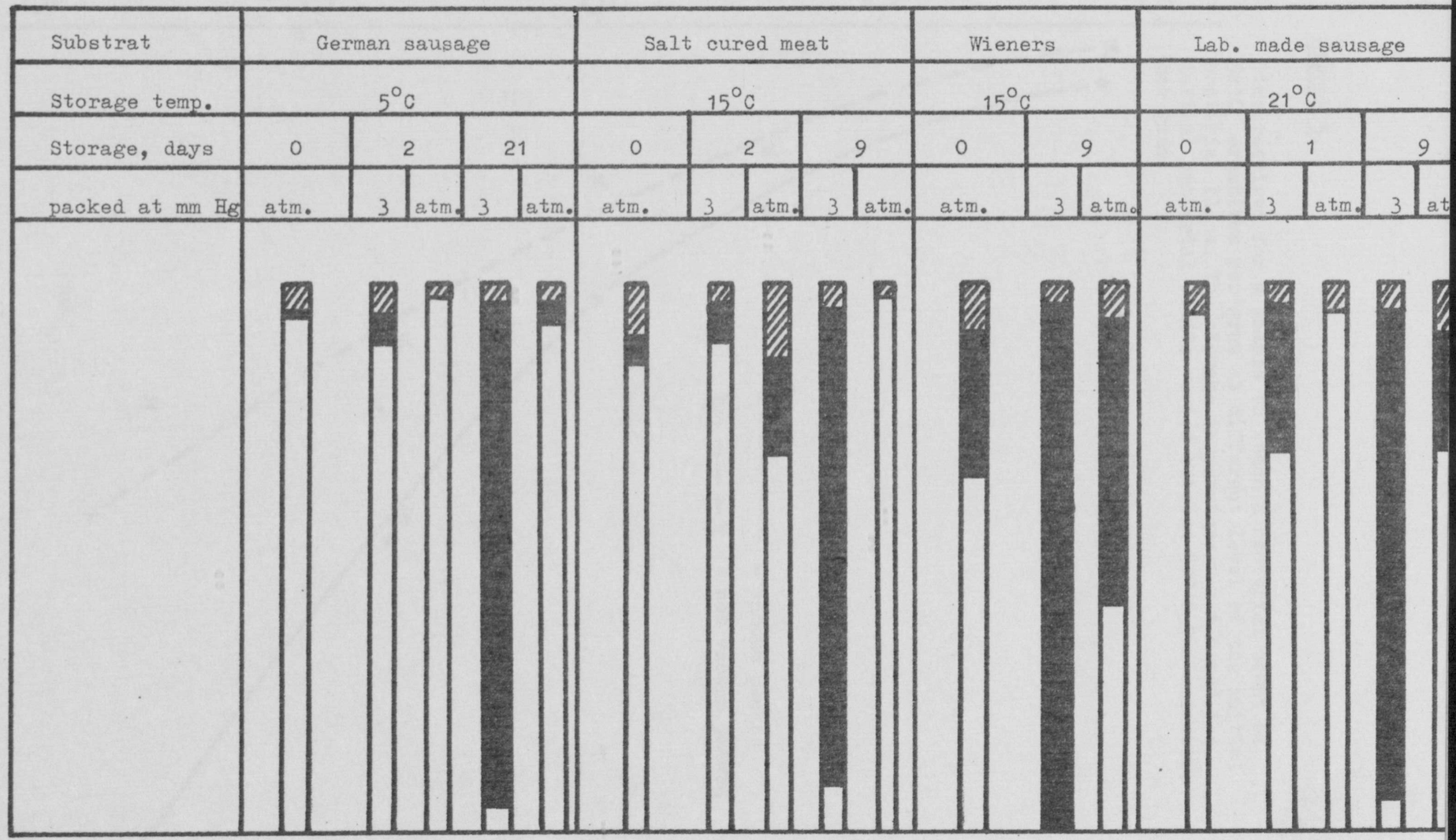


Figure 4.

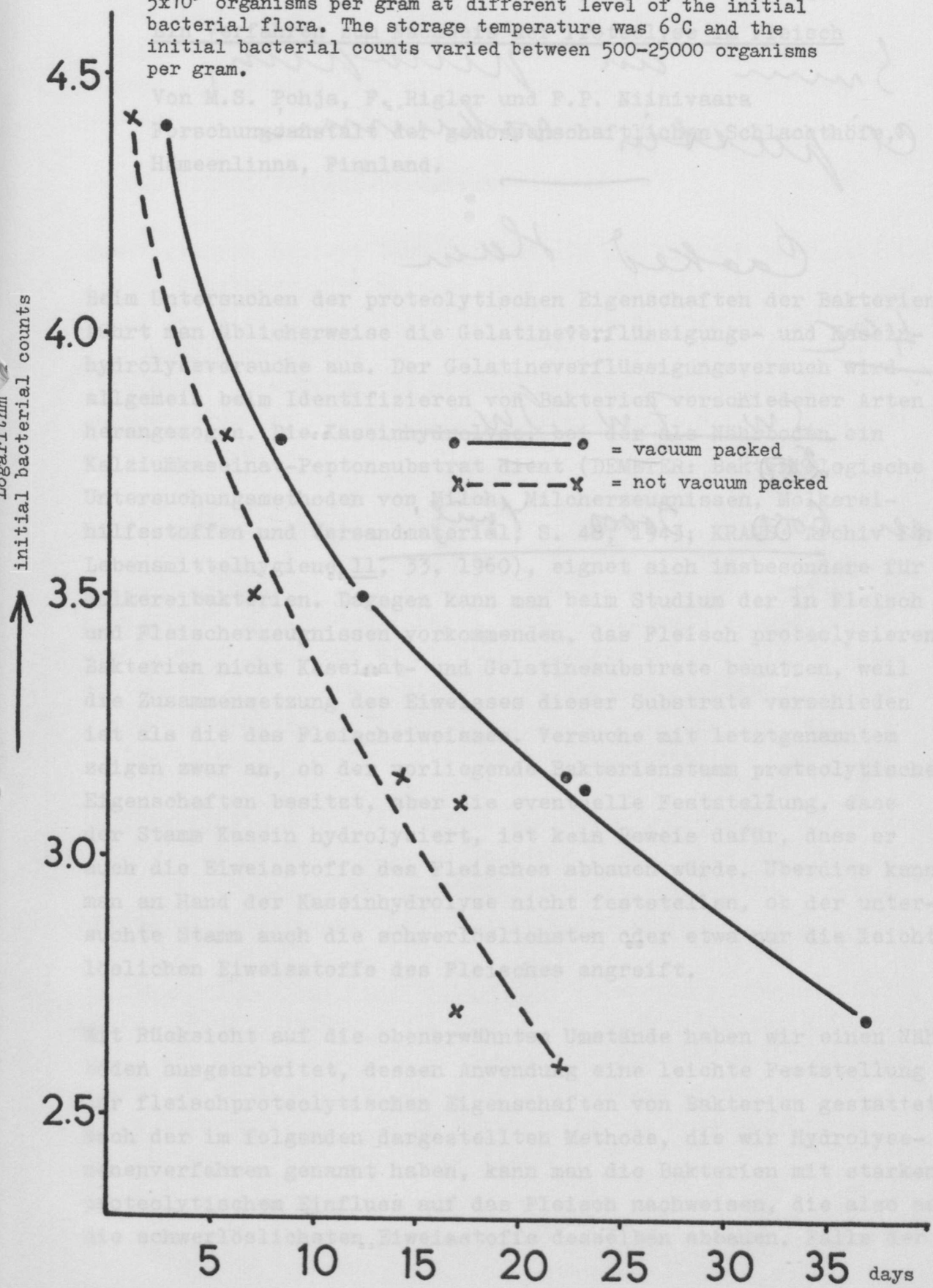
Qualitative changes of the microflora in vacuum-packed processed meat during cold storage. The dominant species are expressed as percentage of the total flora.



(I) ■ = Bacteria species dominating in vacuum packed samples

(II) □ = -"- -"- -"- " not vacuum packed samples

(III) ▨ = An inhomogeneous flora not influenced by vacuum packing

Figure 5.

Time required for a sample to reach a bacterial count of 5×10^5 organisms per gram at different level of the initial bacterial flora. The storage temperature was 6°C and the initial bacterial counts varied between 500-25000 organisms per gram.