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Studies on the acceleration of the ripening process of dry sausage

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The acceleration and stabilization of the ripening process of dry sausage has again recently roused increasing interest. As it is known, in the USA P e d i o c o c c u s pure cultures have been in the use since 1957. Correspondingly in Europe M i c r o c o c c u s pure cultures have been used to some extent. These cultures have gained a limited use because they have to some extent fallen short of the expectations. On account of this, attempts have been made to develop combined mixed cultures (NURMI 1965). It was shown that when lactobacilli were added to dry sausage mixture the decreasing of the pH value of the sausage was distinctly accelerated and at the same time the development of the desired consistency and slicing quality was greatly speeded up. When also micrococci together with lactobacilli were added, the color and flavor faults caused by lactobacilli could be prevented (NURMI 1965).

In addition to the investigations into the use of bacterial pure cultures, experiments have been made with substances having a lowering effect upon the pH value of dry sausage. Glucono-delta-lactone, GDL, has been considered as a suitable agent (SAIR 1961, 1963, 1964, 1965 and MEESTER 1964, 1965). The use of this method in the manufacture of meat products has been patented (SAIR 1964). GDL has been considered suitable also in the production of dry sausages. Sair has established that the GDL addition has no effect upon the normal bacterial growth in the sausage. GRAU (1965), too, has presented this opinion in his paper.

MEESTER (1964 and 1965) in his experiments used 1.0 per cent of GDL and in the corresponding control groups 1.0 per cent of clucose. The lactone sausages reached the pH value 4.90 after 16 hours and the glucose sausages after 88 hours the value 5.1. The pH value of the sausages of the lactone group remained the

same (4.9) 7 days after the preparation. During the same time the pH value of the glucose sausages had decreased to 4.8. He established that the flavor of the lactone sausages was good and that of the glucose group objectionably sour. The use of glucono-delta-lactone in other meat products too is permitted in some countries. Experiments have been made in some plants but the results regarding its useful effects have been inconsistent.

The purpose of the present investigation has been to shed more light on the effect of the GDL addition upon the ripening of salami type dry sausage compared with the effect of the addition of lactobacilli and micrococci.

I. MATERIALS AND METHODS

1. Materials

The ingredients and the method of production of dry sausage have been presented in a previous paper (NURMI 1965). Glucono-delta-lactone was used in six experimental series from which four were more closely examined. The amounts of GDL used were 0.5, 0.75 and 1.0 per cent of the sausage mixture. The bacterial addition used was 3-5 mill. lactobacilli and 5-10 mill. micrococci per gram of sausage mixture.

2. Methods

The sausages were examined as follows:

A. Organoleptic evaluation
   1. Consistency
   2. Color of slices
   3. Flavor

B. Physical-chemical examination

1. pH value
2. Consistency
   The determination of the consistency was done by using a tester developed and manufactured by Technische Hochschule, Karlsruhe, Germany.
3. Weight losses

C. Bacteriological examination

1. The number of bacteria on blood agar after 2 days at 30°C.
2. The number of lactobacilli on Rogosa agar (ROGOSA et al. 1951), 4 days at 30°C.
3. The number of micrococci on mannitol-salt agar, 2 days at 37°C.
4. The number of enterococci on Slanetz agar (SLANETZ and BARTLEY 1957), 2 days at 37°C.
5. The number of coliform bacteria on VRB (Violet Red Bile) agar, 1 day at 37°C.
6. The number of gram-negative bacteria on ammonium lactate agar, 2 days at 30°C.
7. The number of bacteria hydrolyzing gelatine on gelatine agar (STONE 1935 and AYRES 1960), 4 days at 30°C.
8. The number of lipolytic bacteria on tributyrine agar, 4 days at 30°C. The basic substrate was made according to JONES and RICHARDS (1952).

II. RESULTS

A. Organoleptic evaluation

1. Consistency

The consistency of the control group developed slowly. The development of the desired consistency was distinctly more rapid in the sausages with both lactobacilli and micrococci

addition. When 1.0 per cent of GDL was added the consistency developed rapidly during 2-3 days. After 7 days it was about the same in the sausages with lactobacilli+micrococci addition and with 1.0 per cent GDL addition. The loosening of the casing was often found as a disadvantage in the lactone sausages. In one experiment out of four the consistency of the lactone sausage was distinctly poorer than in the corresponding micrococci+lactobacilli sausage.

2. Color of the slices

When nitrate was used in the sausages of the lactone group no red color was formed. Therefore nitrite was used in the lactone sausages and nitrate in the others. On the other hand, it was found that the micrococci addition had a very favorable effect upon the color of the lactone sausages when these were prepared by using nitrate. This could be seen especially in the sausages with only 0.5 per cent GDL addition. In the lactone sausages with a nitrite addition the best color of the cut surface could be seen after 3 days. The sausages with lactobacilli+micrococci addition had, however, after 7 days as good color even though they were prepared by using only nitrate addition.

3. Flavor

The sausages of the control group ripened very slowly. In general, they could be considered completed only after 21 days. When a nitrate addition was used in the lactone sausages they usually got completely spoiled. A peculiar, strong flavor of rancid pork fat was generally found in them. A micrococci addition had usually a distinctly reducing effect upon this rancid taste. In the lactone sausages prepared with a nitrite addition a sweet, strange taste was often found. In the organoleptic evaluation this flavor was considered poorer than the flavor of the corresponding sausages of the micrococci+ lactobacilli group. The lactone sausages were ready to be eaten 10-14 days old and the micrococci+lactobacilli sausages 7-10 days old.

B. Physical-chemical examinations

1. pH value (Figs. 1 and 2)

   a. Control group : the pH value decreased slowly especially during the first 2-3 days.

   b. GDL addition, 0.5 per cent : During the first two hours the pH value of the sausage mass decreased only 0.3 pH units remaining rather high during 14 days.

   c. GDL addition, 0.75 per cent : During the first two hours the pH value decreased 0.50 pH units on the average. After this no distinct decrease was found.

   d. GDL addition, 1.0 per cent : During the first two hours the pH value decreased 0.60-0.70 pH units on the average. After three days it fell to about 4.90 remaining the same during the experimental period (21 days).

   e. Lactobacilli+micrococci addition : In this group the pH value decreased considerably more rapidly than in the control group. Nearly the final value was reached already after the first five days.

2. Consistency (Fig. 3)

   a. Control group : The development of the consistency was slowest here.

   b. GDL addition, 0.5 and 0.75 per cent : An addition of 0.5 per cent of GDL improved the consistency to some extent and when 0.75 per cent was added, this effect was more distinct.

   c. GDL addition, 1.0 per cent : The effect upon the consistency was favorable. The readings of the tester were at a maximum in 14 days old sausages but decreased to some extent in 21 days old sausages.

   d. Lactobacilli+micrococci addition : Also the bacterial addition had a favorable effect upon the development of the consistency. In the 7 and 14 days old sausages the

readings were almost as high as in the corresponding experimental sausages with an 1.0 per cent lactone addition. In 21 days old sausages the readings were higher.

3. Weight losses

The weight losses (Table 1) were about similar in the control group and corresponding lactobacilli+micrococci sausages. The weight losses of the lactone sausages were 1-2 per cent higher in 10 and 14 days old sausages. In these sausages 1.0 per cent of lactone was used in three experimental series and 0.75 per cent in one series.

C. Bacterial examinations

The results of the lactone group are derived from four experimental series. Six sausage types were examined. The lactone additions were 0.5-1.0 per cent. In each series there were corresponding control sausages and lactobacilli+micrococci sausages.

1. Number of lactobacilli (Fig. 4)

The number of lactobacilli in the control group and lactone group reached about the same level. In the sausages with lactobacilli additions the number of these bacteria was considerably higher especially in the 3 and 7 days old sausages.

2. Number of micrococci (Fig. 5)

The lactone addition decreased very distinctly the number of micrococci. The difference could be seen already in the sausage mixtures which had to be kept in the refrigerator over night before the quantitative bacterial determinations could be made. When micrococci were added together with lactone, this addition had an increasing effect upon the number of micrococci during the whole experimental period.

Table 1.

Weight losses in different sausage groups.

Results derived from four experimental series.

Sausage group	Weight losses, per cent						
	Age of sausages, days	2	4	6	8	10	14
1. Control group		1.7	4.0	7.7	11.5	15.3	19.4
2. Lactobacilli + Micrococci group		1.4	3.8	8.3	13.2	15.7	20.8
3. Lactone group		1.4	4.6	8.7	13.0	17.9	22.4

3. Number of enterococci (Fig. 6)

The addition of lactone and also of lactobacilli and micrococci had a distinctly decreasing effect upon the number of streptococci compared with the number in the control group.

4. Number of coliform and other gram-negative bacteria.

These bacteria were not generally found in the experimental sausages except during the first three days. The number of these bacteria decreased in the lactone sausages more rapidly than in the control sausages during this time.

5. Number of lipolytic bacteria (Fig. 7) and bacteria hydrolyzing gelatine (Fig. 8)

The addition of lactone decreased very considerably the number of these bacteria compared with the corresponding numbers in control sausages. Also the lactobacilli+micrococci addition had a decreasing effect upon the number of these bacteria.

III. DISCUSSION

Increasing efforts have lately been made in order to reduce the time required for the ripening of dry sausages. When old methods of manufacturing are used it is not possible to shorten this period essentially without impairing the quality of the products considerably. The sausages to be sold should have a relatively good consistency and no raw flavor.

As is well known the bacteria play a very essential role in the ripening process of dry sausage. The decrease of the pH value and the following development of the consistency are mainly due to the formation of lactic acid. Also the enzymatic decomposition products of the proteins and fats have an influence upon the flavor.

Lactobacilli, pediococci and micrococci have been used in order to accelerate and improve the ripening process but their use has also certain disadvantages. In 1965 NURMI showed that by adding both lactobacilli and micrococci it was possible to eliminate these disadvantages and to speed up the ripening process essentially. Simultaneously with these experiments has elsewhere an additive, glucono-delta-lactone, been developed (SAIR 1964 and MEESTER 1964, 1965). This agent is claimed to accelerate essentially the manufacturing process of dry sausage, to decrease weight losses and to give the product a good aroma. This method is based upon a rapid decrease of the pH value during the first few hours to the value 5.0 which is normally the final pH value of a completed product.

The present investigations were carried out in order to compare the effects of lactobacilli+micrococci and lactone addition upon the characteristics of dry sausage and especially upon the microbial flora. In this connection the results of MEESTER (1964, 1965) have partially been confirmed. When 1.0 per cent of GDL was added the pH value decreased swiftly 0.70 pH units on the average. The consistency developed rapidly during 2-3 days. Corresponding values were reached during 5-7 days by using the addition of lactobacilli+micrococci. When GDL was used the addition of nitrite was necessary in order to prevent the development of color and flavor faults. The addition of micrococci together with 0.5 per cent of GDL had an improving effect upon the formation of color also in nitrate sausages.

In the investigations carried out it was not possible, however, to show like in MEESTER's (1964, 1965) studies that the lactone sausages would have had the characteristic good flavor of dry sausage and that the control sausages would have had an objectionably sour flavor. In his experiments the difference between the pH values of the lactone and control sausages was only 0.1-0.2 units. In the present investigations, on the other hand, the lactone sausages were shown to have a strange sweetish flavor.

According to SAIR and GRAU the addition of lactone does not have any effect upon the normal microbial flora of dry sausages. However, when according to MEESTER's investigations the decrease of the pH value is quite considerable, from 6.0 to 4.9 during a few hours, it would seem natural that such a rapid change in the pH value should have an effect upon the bacterial flora. In the present investigations it was also shown that already the addition of 0.5 per cent of lactone but especially the addition of 0.75 and 1.0 per cent of lactone had a very distinct effect upon the development of the bacterial flora of the sausages. For example, the number of micrococci remained very low in the lactone sausages during the whole experimental period (21 days) and a considerable increase was noted only in the number of lactobacilli.

Different bacteria have an essential effect upon the characteristics including the flavor and when lactone is used the activity of other bacteria than lactobacilli decreases essentially. It also is possible that when the bacterial flora consists almost solely of lactobacilli, these bacteria can give cause to faulty products. It might be possible to eliminate these disadvantages by adding together with lactone bacterial pure cultures, e.g. micrococci which have been shown to prevent the faults caused by lactobacilli.

SUMMARY

The effects of the addition of glucono-delta-lactone (GDL) and of lactobacilli+micrococci upon the characteristics of dry sausage were examined and compared. The investigations gave the following results:

1. The addition of GDL (1.0 per cent) improved considerably the development of the consistency. Corresponding results were obtained by adding lactobacilli together with micrococci

2. When GDL was used, a loosening of the casing was seen in the sausage. A peculiar sweetish taste foreign to dry sausage was noted

3. The addition of GDL had a very essential effect upon the bacterial flora of the sausages. It decreased considerably the number of several bacteria characteristic of dry sausage. The number of e.g. micrococci remained very low during the whole experimental period. The number of lactobacilli, on the other hand, increased quite essentially.

ZUSAMMENFASSUNG

Der Einfluss von Glucono-Delta-Lactone (GDL) und von Lactobazillen- und Mikrokokkenzusatz auf die Eigenschaften der Rohwurst sind in Vergleich gestellt worden. In den Untersuchungen ergab sich die Feststellung, dass

1. GDL-Zusatz (1 %) die Erzeugung von Konsistenz erheblich förderte. Ein ebensolches Ergebnis wurde durch Zusatz von Lactobazillen zusammen mit Mikrokokken erzielt

2. Bei Anwendung von GDL wurde bei den experimentellen Würsten Loslösen des Darmes sowie der Rohwurst fremder, süsslicher Geschmack wahrgenommen

3. GDL-Zusatz wirkte äusserst wesentlich auf die Mikrobenflora der Wurst ein. Er setzte die Zahl etlicher für Rohwurst typischen Bakterien wesentlich herab. Die Zahl der Mikrokokken z.B. blieb die gesamte Dauer der Herstellung hindurch äusserst niedrig. Die Zahl der Lactobazillen hingegen stieg beträchtlich an.

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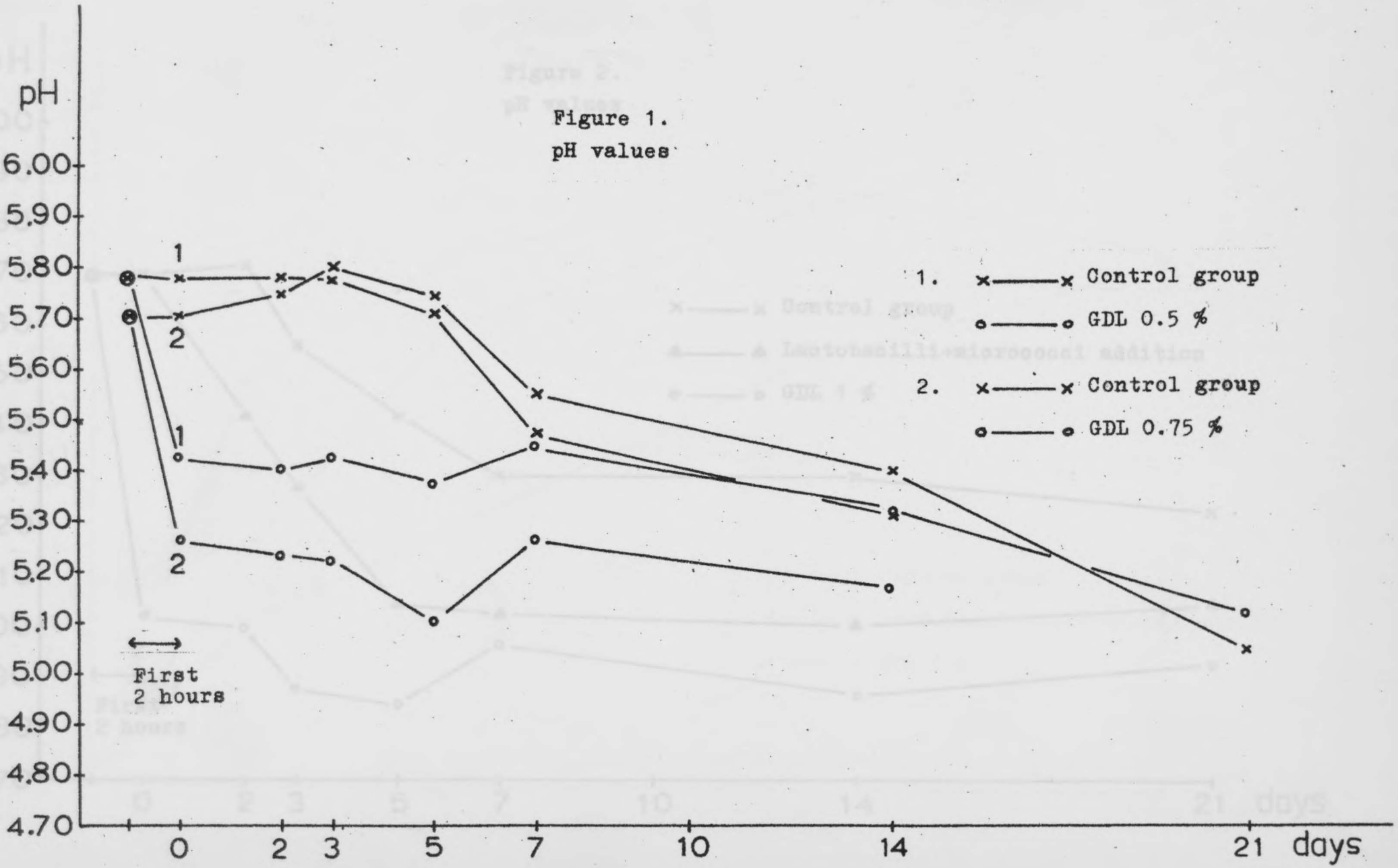

Figure 1.
pH values

Figure 2.
pH values

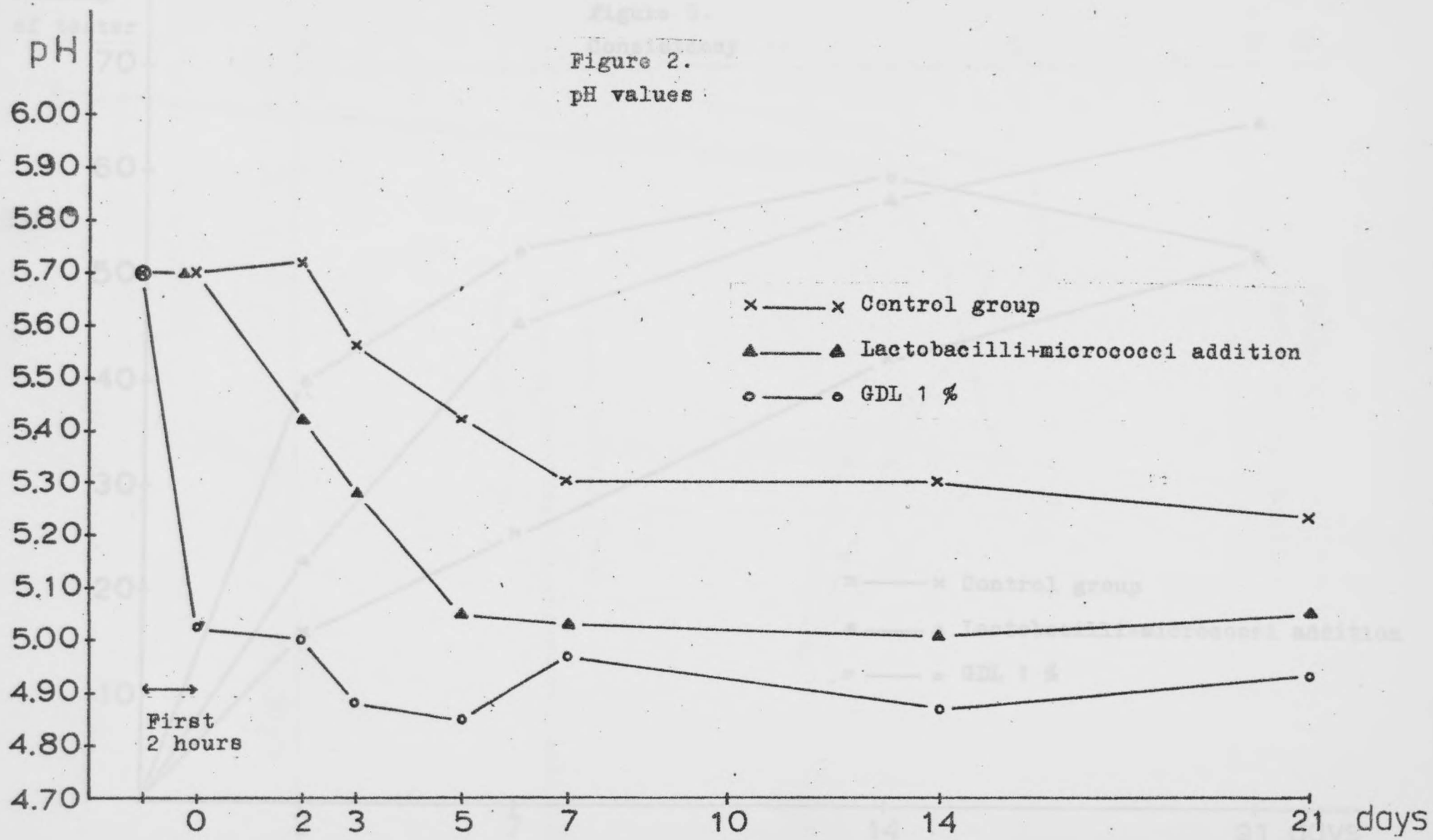

Figure 3.
Consistency

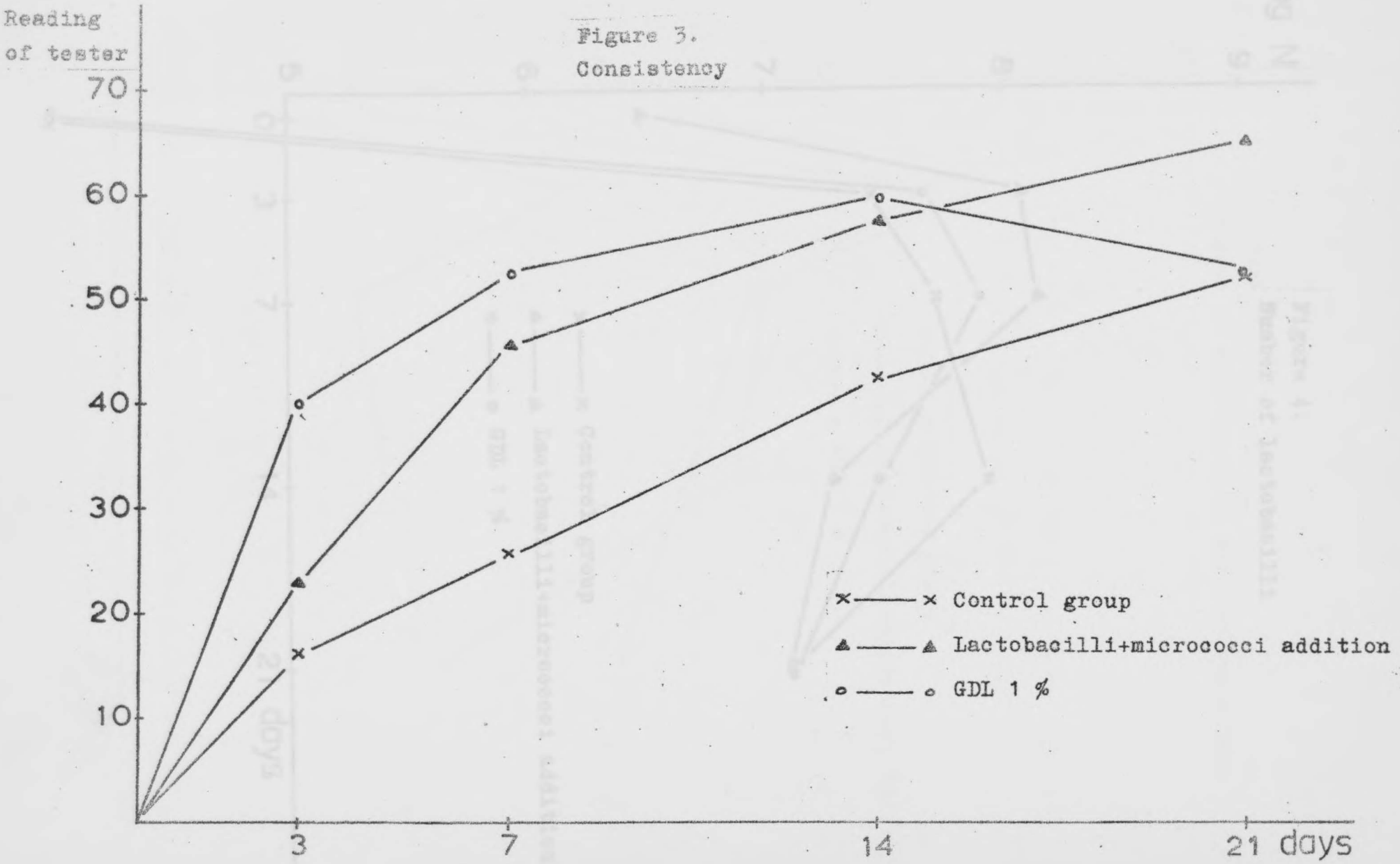

Figure 4.
Number of lactobacilli

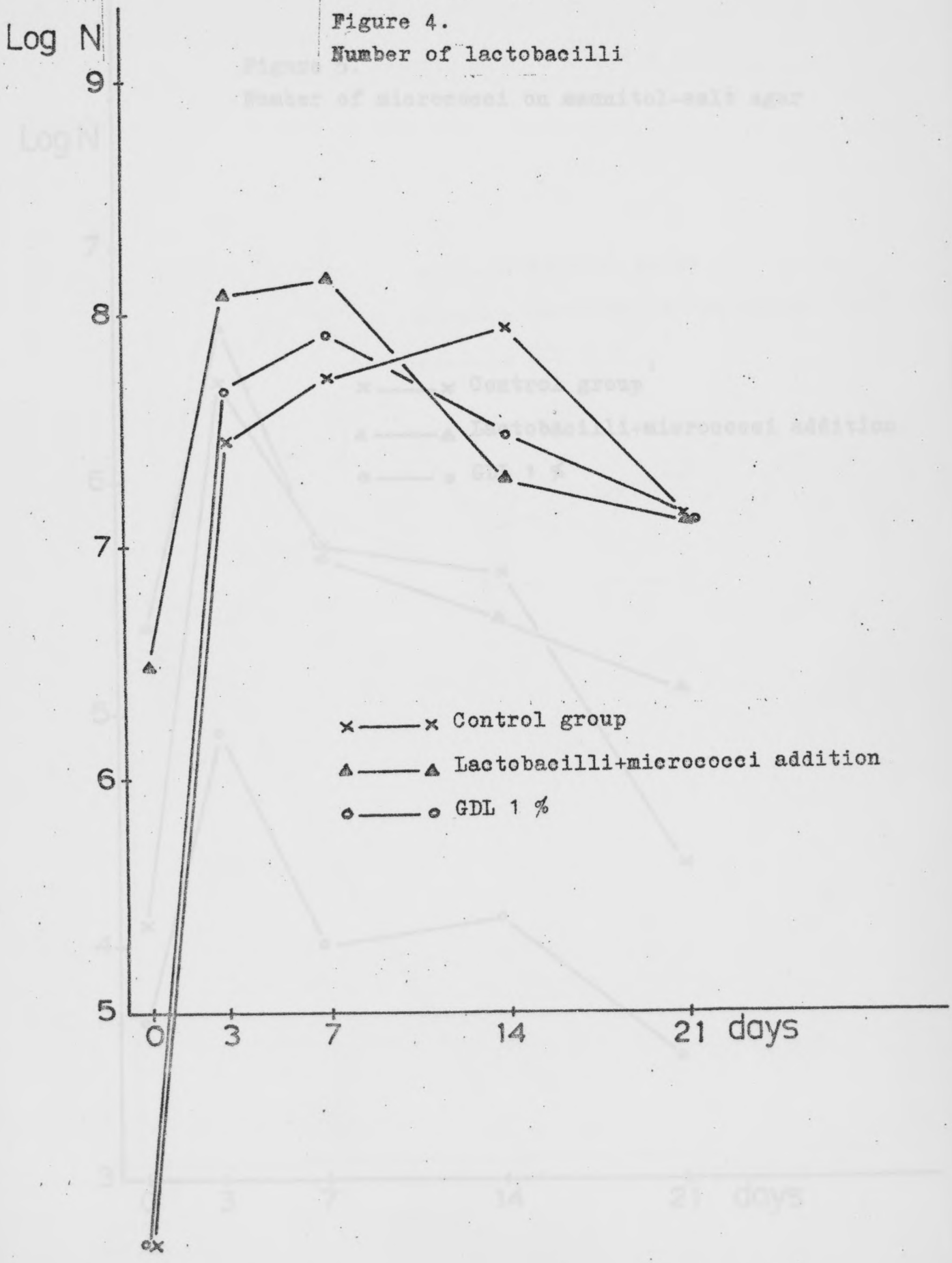

Figure 5.
Number of micrococci on mannitol-salt agar

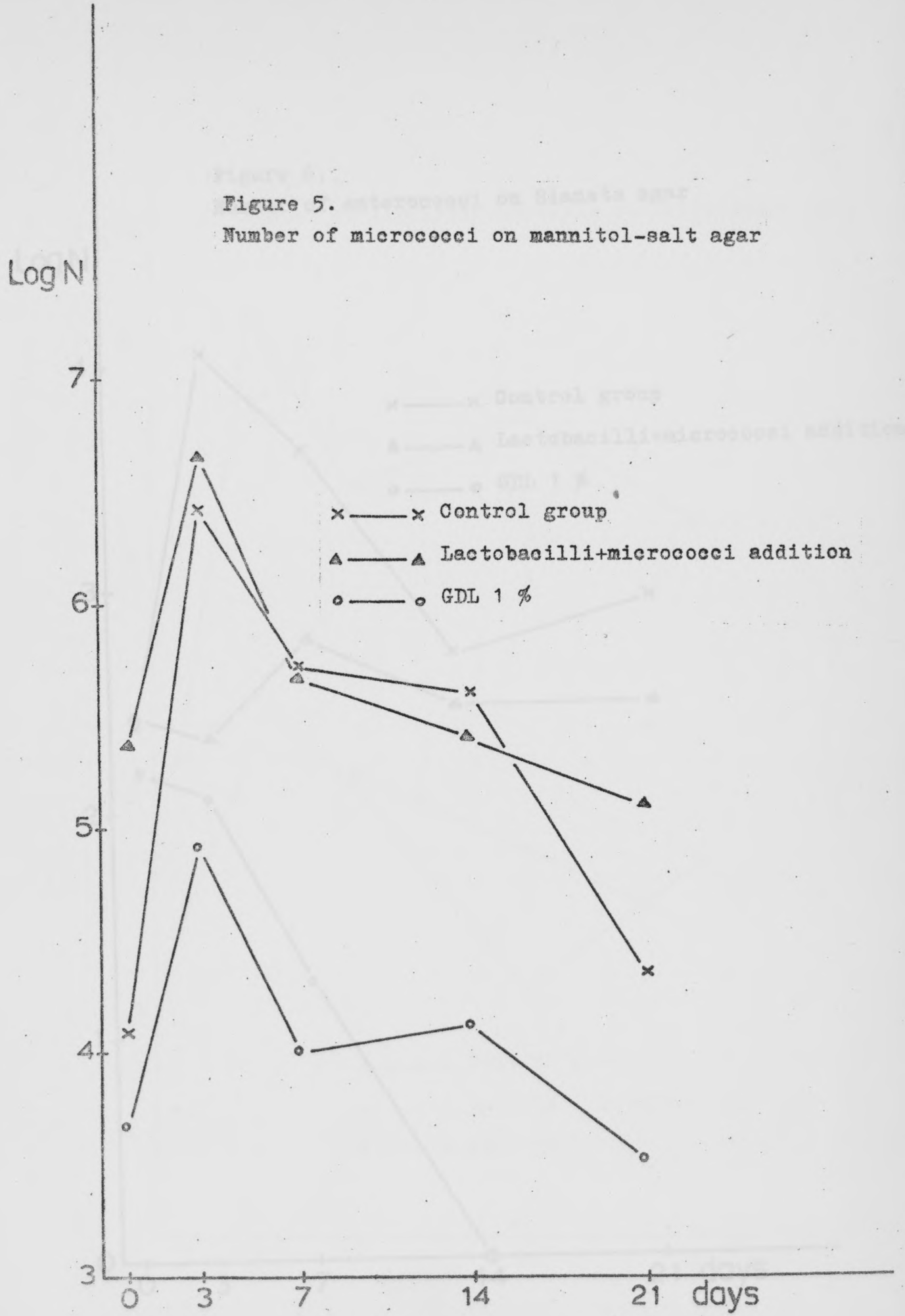

Figure 6.
Number of enterococci on Slanetz agar

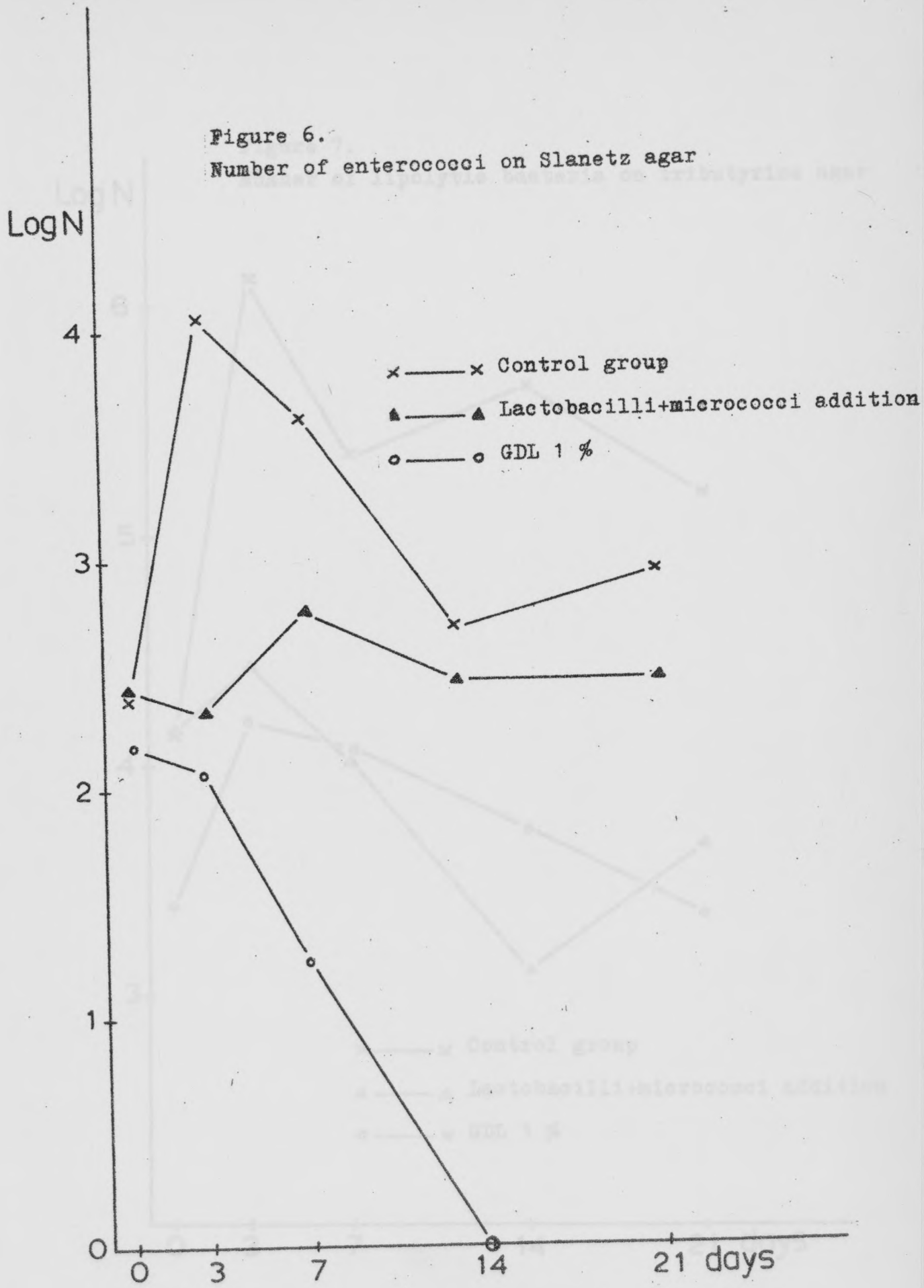

Figure 7.
Number of lipolytic bacteria on tributyrine agar

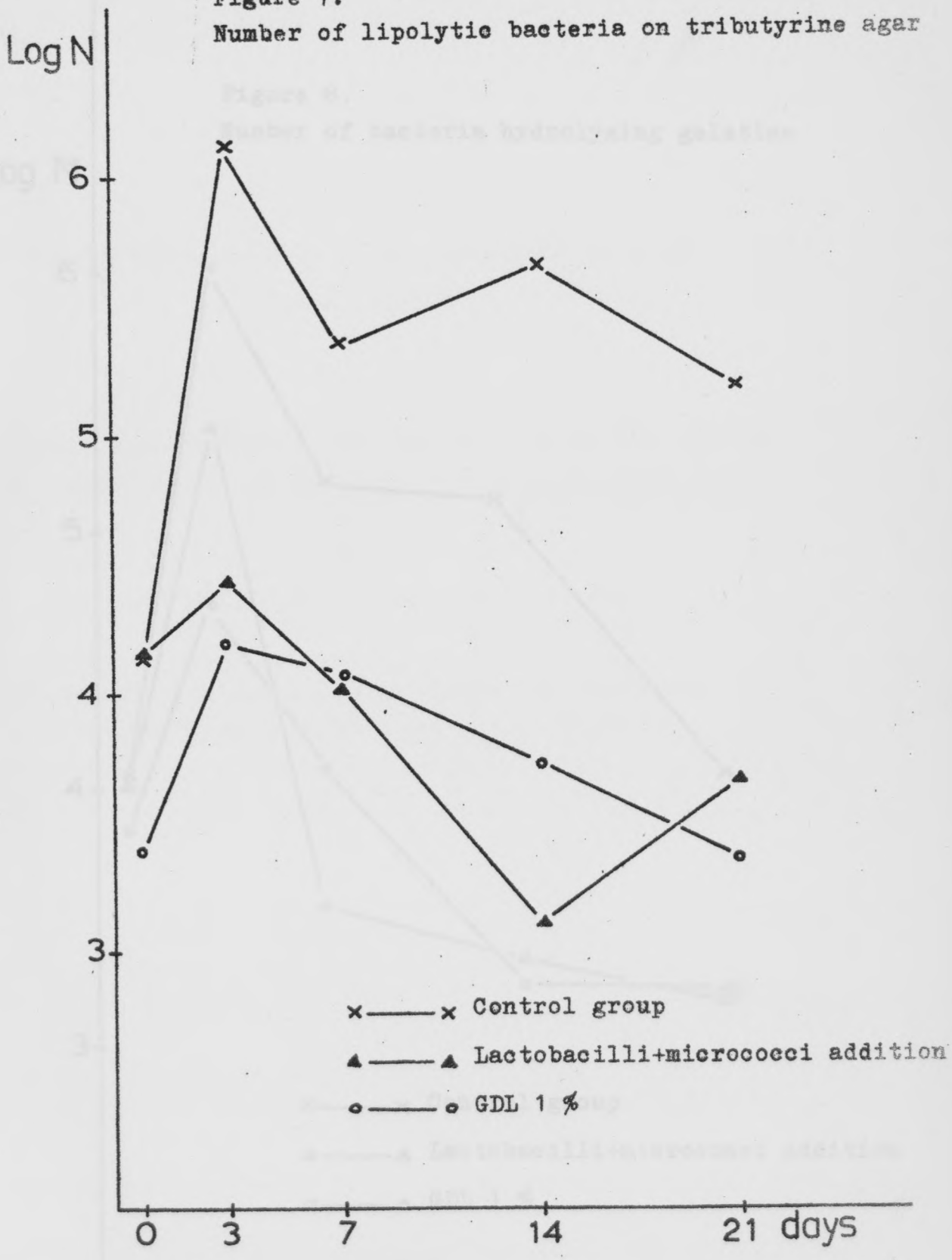

Figure 8.
Number of bacteria hydrolyzing gelatine