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The Application of Glucono Delta Lactone in Meat Products

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SUMMARY

New perspectives for accelerated production and quality improvement of meat products are offered by the application of glucono delta lactone.

Addition of this lactone to emulsions for cooked comminuted products gives more rapid and improved cure color development, caused by increased acidity of the meat mass. As examples the manufacture of a bologna type cooked sausage and of canned luncheon meat has been described.

In raw fermented sausages, the desired pH fall during the early stage of ripening can be artificially accelerated by adding lactone instead of sugar to the meat mass, thus preventing bacteriological risks and shortening production time. This was demonstrated by the manufacture of a salami type sausage.

ZUSAMMENFASSUNG

Die Anwendung von Glucono-delta-Lacton bietet neue Möglichkeiten für Beschleunigung der Herstellung und Qualitätsaufbesserung von Fleischwaren.

Durch Zusatz von Lacton zum Brät von Brühwurst und Wurstkonserven wird die Umrötung wegen der Säurebildung beschleunigt und verbessert. Als Beispiel ist die Herstellung von Brühwurst und von Luncheon Meat in Dosen vorgeführt worden.

In Rohwurstzeugnisse kann die erwünschte pH-Wertsenkung im ersten Reifungsstadium durch Zugabe von Lacton statt Zucker zum Wurstgemisch künstlich beschleunigt und gesteuert werden. Ein bakteriell bedingter fehlerhafter Ablauf der Fermentierung wird dadurch verhütet und die Bearbeitungszeit verkürzt. Es wurde als Beispiel die Herstellung einer Dauerwurst beschrieben.

1) NO₂ 2) Malen? 3)

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1. INTRODUCTION

A very important factor in the manufacture of meat products is the pH of the raw meat materials and of the products derived thereof, whether comminuted or not.

It is well known that pH plays a decisive role in water- and fat-binding of meat proteins. Raw hams, for instance, having a relatively high pH value, will give less jelly on cooking than hams with lower pH. Fat- and jelly-separation on cooking of comminuted meat products will be reduced when emulsions with a higher pH are processed.

The pH is also a major variable in the curing process, a relatively lower pH value giving a more rapid and more effective formation of the cure color pigment nitrosylmyoglobin, and probably influencing the color fading on exposure to light.

As both pH effects - on binding or on color respectively - are acting in opposite direction, application of the effects to improve product quality, gives difficulties. So the addition of acids to a sausage emulsion in order to get a better colored product, will result in "breaking" of the emulsion because of loss of binding capacity of the proteins.

In 1963, our attention was drawn to the possibilities of glucono delta lactone (GDL), put forward by Sair (9). This lactone, a well known food additive (particularly as acidulant in chemically raised bakery products) slowly hydrolyses in cold watery medium, and more rapid at elevated temperatures, to an equilibrium mixture of gluconic acid and its delta- and gamma-lactones, thereby lowering the pH (6). When GDL is added to a meat mass during emulsification, lactone hydrolysis and pH fall are so slow that a good emulsion can be ready before loss of emulsifying and water binding capacity will be noticeable. During the following stage of processing, viz. the smoking and/or heating of the emulsion, however, most of the GDL is converted; in this phase color development will be accelerated and improved by the increased acidity. According to publications and patents around this new possibility (some of which are given in: 1, 2, 3, 4, 8, 9, 10, 11, 12), the GDL additive has been used mostly in combination with ascorbate or erythorbate. Recently an amendment on the United States Federal Meat Inspection Regulations has been prepared, to allow the addition of GDL to frankfurters and bologna sausage (13).

At the request of Pfizer (Nederland) N.V., Rotterdam, we investigated in an informative test the profits of GDL in a standard type smoked cooked sausage (bologna type) and in a canned sterilized luncheon meat. Some results are described in the following paragraphs.

During this investigation, another possible application of GDL occurred to us, viz. its use in the processing of raw fermented sausage products such as the salami type, the saveloy (cervelate), the "plockworst", the "snijworst" and similar types.

In these products too the pH is very important. It is essential that the pH of the original sausage mix (mostly around the value 6 or more) decreases in the ripening process, partly causing the required firmness and sliceability, and also preventing spoilage. In current procedures this pH fall is caused by bacterial and/or meat-enzymic formation of mainly lactic acid from the carbohydrates naturally present in meat (glycogen) or from added sugars (e.g. glucose). The rate of pH fall is strongly determined by the development and activity of the bacterial flora in the sausage. The ultimate pH value reached too depends on it, but also on nature and quantity of the available sugars.

This bacteriological variable being involved, the risk of failures and spoilage is rather great. Often the pH does not (or insufficiently) fall, whereas sometimes souring occurs. It is tried to prevent this, and simultaneously to accelerate this ripening stage, by curing the sausages in brine or by "perspiring" ("Schwitzen") them, both at elevated temperature which is common practice in The Netherlands. Starter cultures are also used, consisting of one or more bacterial strains with suitable properties. Addition of acids to the sausage mix in order to obtain the desired pH level, gives loss of binding and consistency.

GDL is an excellent agent to achieve artificially the desired type of pH fall in these products. On mixing the sausage ingredients, the decrease of pH will start slowly, and afterwards proceeds more rapidly than biologically occurs, thus preventing spoilage. Some results of the addition of GDL to one example of raw fermented sausage products (the salami type "snijworst") are given in the following paragraphs (5, 7).

2. PROCEDURE AND RESULTS

2.1. Cooked comminuted products

Based on a current standard formula a sausage emulsion was made and divided into three portions. In two portions 0.25 and 0.50% GDL respectively (calculated on the amounts of meat and lard) were added, after being dissolved in a small amount of water shortly before. One portion did not receive GDL in order to serve as a control. Part of each portion was encased and subsequently smoked and pasteurized as cooked sausage. Another part was canned and sterilized as luncheon meat.

Shortly after the preparation the GDL products were compared with the controls. No differences in appearance and texture were observed; no fat was separated. Both types of the GDL products tasted a little bit sour in comparison with their controls; they were judged as "more fresh" (but not disagreeable). Slices of the cooked sausage and luncheon meat with 0.25 % GDL had a slightly better color than the controls. Optimum color was found in the products with 0.50 % GDL, the color difference with the controls being rather large. To study the color fading, slices of all products were exposed to light in an open cooled display case. Significant differences in rate of fading could not be observed, however. Consequently the products with GDL remained better in color than the controls during the whole period of exposure.

After 4 days of storage (the luncheon meat at room temperature, the sausages cooled) all products were examined once more. The results fully agreed with the afore-mentioned.

In table 1 the average pH values and nitrite contents of the emulsion (just prepared) and of the sausages and luncheon meats with and without GDL (after one day of storage) are given.

Table 1. Mean values of nitrite content and pH in emulsion, cooked sausage and luncheon meat

	control	with 0.25 % GDL ^{x)}	with 0.50 % GDL ^{x)}
pH in			
emulsion	6.1	5.9	5.8
cooked sausage	6.1	5.8	5.6
luncheon meat	6.2	6.0	5.8
% nitrite in			
emulsion (added)	0.010	0.010	0.010
cooked sausage (residual)	0.0053	0.0039	0.0028
luncheon meat (residual)	0.0047	0.0036	0.0022

x) calculated on meat and lard

2.2. Raw fermented sausages

In a preliminary test we investigated how much GDL would be necessary to obtain the desired pH decrease in a salami type sausage ("snijworst"). Portions of minced beef (cooled to 0 °C) were mixed with 0.5, 1.0 and 1.5 % of GDL, and stored at room temperature, together with a control portion without additive. At regular intervals the pH values of the mixtures were measured. Results are given in table 2.

Table 2. Decrease of pH in minced beef with GDL

% GDL added	average pH, reached after					
	0 min.	30 min.	60 min.	90 min.	150 min.	190 min.
0	6.46	6.46	6.46	6.46	6.46	6.46
0.5	6.45	6.39	6.26	6.24	6.10	5.98
1.0	6.43	6.14	5.96	5.84	5.80	5.67
1.5	6.34	6.06	5.77	5.62	5.40	5.37

The pH of the control without GDL remained constant during over 3 hours, whereas it decreased in meat with GDL. This decrease took place at a quicker rate when more GDL was added. The 1.5 % level caused a pH fall of slightly over one pH unit in about 3 hours. This was considered sufficient for our purpose, viz. the processing of a salami type raw ripened sausage ("snijworst"). Therefore we decided to add 1.0 % of GDL to the sausage mix for this product, containing about 65 % of meat.

Proceeding from two parts of meat and one part of pork back fat, nitrite containing salt and seasonings, a sausage mix was prepared. To one portion of this mixture 1.0 % of GDL was added during comminuting; in comparison to other portions 0.5 % and 1.0 % of glucose were added instead of GDL. After encasing, sausages of each of these three series were cured in brine at 25 °C or "perspired" in high humidity at 28 °C (the usual techniques for acceleration of the ripening). Depending on the stage of maturation, the sausages were subsequently smoked and dried.

The initial pH value of the sausage mix was 6.1. After 16 hours' curing or perspiring, the pH of all GDL containing sausages had decreased already to the value 4.9. At this moment also the firmness and sliceability of these sausages were judged to be sufficient, whereas cure color development was satisfactory. Considering these results

the GDL sausages were then smoked and dried successively. Attractive products were obtained, with good taste, color, firmness, sliceability and binding between meat and fat particles.

The sausages with glucose, on the contrary, reached the same stage of ripeness only after 88 hours of curing or perspiring respectively, when the pH dropped to 5.2. Cure color of the sausages developed in 40 hours. These sausages too were then smoked and dried. During drying the pH of the products with 1.0 % of glucose decreased further to 4.8-4.7, giving an unacceptable sour taste. Other quality factors, except color, were slightly inferior to those of the GDL products. The 0.5 % glucose sausages maintained their pH value of 5.2, on drying, and were evaluated as inferior to all other products.

3. DISCUSSION

3.1. Cooked comminuted products

The results of the addition of GDL to pasteurized and sterilized products, given in 2.1., agree with the data from the literature cited. As was shown in table 1, the pH decreased proportional to the amount of GDL added. This was accompanied by a decrease in residual nitrite and improved cure color formation. In these exemplary products, cooked sausage and luncheon meat, optimum color was found after addition of 0.50 % GDL (calculated on meat and lard content). The more acid condition was not harmful for other quality factors. Improvement of color stability against exposure to light, as claimed in literature (e.g. 9) could not be observed, however.

As in our experiments the usual smoking and heating conditions for the products concerned were applied, no acceleration of cure color development had been noticed. It was demonstrated, however, by the rapid color formation in GDL containing raw sausages as shown in 2.2. As indicated in literature (1, 4, 12) this benefit might be highly important in normal or HTST (whether or not continuously performed) processing of comminuted meat products.

3.2. Raw ripened sausages

From the exemplary results given in 2.2. it is clear that the desired pH fall of raw sausages during the first period of fermentation may be accelerated artificially by addition of GDL instead of sugars to the sausage mix. The ultimately achieved pH value depends on the amount of GDL added. Besides giving considerable gain of time, bacteriological risks are prevented. Curing or perspiring at elevated temperatures, as done to accelerate the ripening process,

probably will be superfluous when GDL is used. Decay of quality was not observed.

Though not noticed in our GDL products, very short fermentation times may result in lack of typical flavour. This may be anticipated, however, by proper choice of seasoning. Perhaps also the addition of a small amount of sugar may be helpful. Adding of the usual full amount of sugar must be avoided, as otherwise souring will occur. It is evident that in rapid fermentation saltpetre curing must be replaced by use of nitrite.

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