

pH Measurement in the Acidification of Fermented Sausages

Lowering pH or increasing acidity of meat has become main hurdle against pathogenic bacteria in sausage making. pH is used in the course of fermentation process in order to produce microbiologically stable product that has a pH value of 5.3 or less.



Introduction

The process of fermenting and drying is believed to be one of the oldest techniques for preserving meat. This results in a characteristic flavoured sausage with a lowered pH and a reduced water activity that makes the final sausage stable with long shelf life, even if not being subjected to heat treatment.

Fermented sausages are a class of chopped or ground meat products that, as a result of microbial fermentation of a sugar have reached a pH of 5.3 or lower and have undergone a drying/aging process to remove 15-25% moisture. They are classified according to moisture content—dry (e.g., Pepperoni, Salami) or semi-dry (e.g., Summer sausage, Thuringer, Cervelat, Landjaegar).

After mixing the ingredients and stuffing into casings, sausages are placed in an environment with controlled temperature and humidity. At this fermentation stage, the pH of the sausages decreases due to lactic acid bacteria that produce lactic acid from metabolizing sugar. Lactic acid bacteria such as *Lactobacillus* or *Pediococcus* are either naturally present or added as starter cultures. Aside from bacteria, chemical acidulants such as glucono-delta-lactone

and citric acid can also be added to rapidly increase acidity and create an extra margin for safety. The pH drop causes the proteins to give up water, resulting in a drying effect that creates an environment unfavorable to spoilage organisms. Drying continues after the fermentation stage and more moisture is removed from the sausage.

Fermented sausages should attain a pH of 5.3 or lower within the proper time frame in order to control the growth of pathogenic bacteria such as *E. coli* 0157:H and *Staphylococcus aureus*. During the fermentation of sausages to a pH 5.3, it is necessary to limit the time during which the sausage is exposed to temperatures exceeding 15.6°C, otherwise the product will spoil, even though the recommended pH was attained. This time frame is temperature dependent and these are the criteria (tables shown are guidelines in developing fermentation process):

Time in C degree-hours above 15.6°C	Maximum Chamber Temperature
Less than 665	Less than 33°C
<555	33-37°C
<500	Greater than 37°C

Degrees are measured as the excess over 15.6° C, the critical temperature at which staphylococcal growth effectively begins.
Degree-hours = temperature in excess of 15.6° C (deg) x time (hours)

The pH of every batch of sausages should be periodically checked and recorded during fermentation to ensure that the pH reaches 5.3 or lower within the required period. The LAQUAtwin pH meter can be used by home sausage-makers or meat processing plants for monitoring the pH of their sausages.

Constant Temperature Fermentation		
Degree (C)-hours limit for the corresponding temperature	Chamber Temperature	Maximum hours to pH 5.3
	°C	
665	24	78.9
665	26	63.8
665	28	53.6
665	30	46.2
665	32	40.5
555	33	31.8
555	34	30.1
555	35	28.6

This table provides maximum hours that a product may be fermented at a given constant fermentation temperature to obtain pH 5.3. Example: At 26°C constant temperature, a sausage must reach pH 5.3 within 63.8 hours or less. Those hours can also be calculated for any temperature.

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Method

Test the meter's accuracy regularly and if necessary, calibrate the LAQUAtwin pH meter using 4.01 and 7.00 pH buffers according to manufacturer's instructions.

Sample Measurement

This method is based on the Australia New Zealand Food Standards Code - Standard 1.6.2.

1. Mince a representative portion of the sausage and place that portion in a stoppered bottle with twice its weight of water then shake.
2. Place a portion of the liquid into the sensor. Record the pH and temperature once stabilized.
3. Clean the sensor with soap and warm water to remove oily residues and/or protein cleaning solution to remove proteins. Rinse the sensor with water and blot dry with soft tissue.

To obtain accurate results, a uniform temperature should be maintained for the standard buffer solutions and samples. The test should be made at a temperature between 20-30°C, the optimum is 25°C.

Average Characteristics of Australian UCFM processes and products*

Characteristic	Salami (range of variation)	Mettwurst (range of variation)
Composition (lean % : fat %)	80.4 : 19.6 (70:30 - 90:10)	83.25 : 16.75 (70:30 - 96:4)
NaCl (%)	2.45 (2.0 - 3.3)	2.02 (1.3 - 2.8)
Nitrite (ppm)	284 (145 - 490)	211 (35 - 490)
Final pH	4.72 (5.0 - 4.4)	4.66 (4.8 - 4.4)
Fermentation time (hrs)	49 (24 - 72)	42 (18 - 72)
Fermentation temp. (°C)	23.3 (18 - 28)	28.6 (17 - 40)
Ripening time (days)	14.8 (1-30)	5.3 (0 - 28)
Ripening temp. (°C)	14.1 (4 - 32)	18 (0 - 40)

*Derived from data supplied by ANZFA reflecting current Australian uncooked comminuted fermented meat product formulations
(Source: Ross, T., and Shadbolt, C.T., Predicting Escherichia coli inactivation in uncooked comminuted fermented meat products. University of Tasmania. Meat and Livestock Australia.)

a moisture/protein ratio of 1.9:1 or less. The two main factors contributing to the safety and stability of these products are low pH and reduced water activity. The product must reach pH 5.3 or below (or other validated pH) within a specified period to control the growth of pathogenic microorganisms including Staphylococcus aureus and pathogenic E. coli.

References and Suggested Reading

1. Marianski, Adam and Marianski, Stanley. The Art of Making Fermented Sausages. 2nd ed. USA: Book Magic, 2009.
 2. New Zealand Food Safety Authority. Guidelines for the Production of Uncooked Comminuted Fermented Meat (UCFM) Products. July 2009
 3. Good Manufacturing Processes for Fermented Dry & Semi-Dry Sausage Products. The American Institute Foundation. October 1997
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Results and Benefits

Fermented sausages such as salamis have been associated with food-poisoning outbreaks globally due to pathogenic microorganisms. In light of this, it is of utmost importance to be in strict compliance with the regulatory guidelines for fermented sausages. In the USA, the Food Safety and Inspection Service requires that the shelf-stable dry sausages be nitrite cured, fermented, smoked, reached a final pH of 5 or less and have

pH Pocket Meters Lineup

pH 11



pH 22



pH 33



Features

Flat pH sensor with automatic temperature compensation offers quick and direct measurement of fresh meat and meat products

Applications include

Fresh Meat Selection, Processed/ Fermented Meats, Meat Processing Quality Control, Food Safety, etc

LAQUAtwin Pocket Ion Meters Lineup



pH
Acidity and alkalinity

COND
Conductivity and TDS

Na+
Sodium Ion

K+
Potassium Ion

NO₃⁻
Nitrate Ion

Ca²⁺
Calcium Ion

Salt EC
Salt (NaCl)



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