Assessing meat quality after ammonia leaks

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Results for today; Ideas for tomorrow

Ammonia leaks in cold storage meat refrigeration systems do not happen very often, but when they do, they can be costly as well as hazardous.

Four papers/articles identify the complexity of assessing the damage caused to product by ammonia, recommend several ways to assess ammonia damage, and include procedures for the salvage of exposed products.

Procedure to follow in the event an ammonia leak occurs

If a heavy ammonia leak should occur, the meat or offal should be removed from the room as soon as possible. Ammonia is toxic if breathed, causes burns and is irritating to the eyes, skin and respiratory system. Precautions must be taken, including use of breathing apparatus and skin and eye protection, if it is necessary to enter an atmosphere that contains ammonia.

Meat should be moved to storage that is free of ammonia and does not hold other products. A sampling plan should be established to assess the damage. The sampling plan needs to take into account the product type, the form of the product and the packaging used. Some packaging materials are better barriers to ammonia than others.

Ammonia gas is approximately three times more soluble in ice at -30°C than in water at 0°C. However, diffusion of ammonia into frozen tissue is many times slower than in non-frozen tissue. In frozen product, it is likely that there will be localised areas of high concentrations of ammonia at the product surface. High gas concentrations and/or long exposure times would be expected to affect frozen tissue to a similar degree to that demonstrated on non-frozen tissue. Whether contamination occurs before or after freezing would matter little in determining the future storage life.

Signs of spoilage due to ammonia

Spoilage due to exposure to ammonia will be obvious if the meat smells of ammonia when cooked or the pH is 1.0 to 1.5 pH units above normal. For meat or offal to develop such obvious signs of contamination, the ammonia concentration must be relatively high (>15 ppm) and/or the exposure time relatively long (>120 min). If you have access to them, it is possible to make short-term measurements of the ammonia concentration with Dräger tubes, either manually or automatically using an accuro gas detection pump.

Apart from the effects of obvious contamination, little is known regarding the effects of less easily detected ammonia contamination on meat, particularly after a period of frozen storage. However, meat processors should also be aware that contamination with even low levels of ammonia would greatly hasten development of rancid flavour.

Effect of packaging type

The packaging material has an influence on the degree of ammonia contamination in meat. Stockinette and hessian allow ammonia through, as does fibreboard. In fact, corrugated fibreboard has been demonstrated to hold ammonia and contribute to continuing contamination even after the product has been removed from the leak-affected area. Polyethylene (assuming a good seal) limits the degree of ammonia contamination but is a poor barrier. Because of the increased surface area, pieces individually wrapped in polyethylene (cuts or offal) will be more affected than bulk-packed product. Most types of barrier film protect vacuum-packed meat from ammonia.

Methods to assess meat quality

Assessment of ammonia damage to determine whether food is fit for human consumption is based on tentative methods because published information and data are limited. It is recommended that different measurement methods be considered rather than one specific test parameter and that the contaminated product test data be compared with control (normal) product data. The test methods are discussed below.

1. Sensory test

Taste and odour tests are used to determine if the level of ammonia contamination is detectable, when compared to a

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control (normal) product. The worst-case situation (i.e. surfaces) should be sampled, if applicable.

This is the most reliable method when panellists trained to detect small differences in aroma and flavour attributes are used for sample assessment. The recommended analysis is called a difference test in which a group of panellists attempt to identify a sample that is different from a control sample.

The analysis comprises of three samples; the control sample, labelled C, and two test samples, labelled with two different codes. One of the test samples is from the same chiller as the control sample and the other test sample is from the affected chiller. The panellists must not know which test sample is which. They are asked to identify which sample is different from the control sample. For the test to be valid, they must pick one.

If the flavour of the meat from the affected chiller has not been affected by ammonia, some members of the panel will pick one sample while some will pick the other as being different from the control. If there is a different flavour in one test sample, all or the vast majority of the panellists will identify this sample to be different. The panel should have a minimum of 7 people for the results to be statistically valid but the recommended number is 12.

A comprehensive procedure for sensory assessment, with details on how to analyse the results can be obtained from the Meat Industry Services Section at Food Science Australia.

If you have doubt about your ability to undertake a satisfactory in-house assessment, there are sensory laboratories experienced in food analyses of this kind.

2. Measuring the pH

It has been found that the product may be acceptable if the pH value of the contaminated product does not exceed the control (normal) product by more than 1.0 pH unit, depending on the nature of the food.

However, if ammonia contamination is suspected, it is most unlikely that traditional use of pH as a measure of contamination will be useful. pH changes of 0.5 units caused by ammonia will drastically reduce the subsequent frozen storage life. Therefore, pH should not be used as a measure of ammonia contamination, since a pH rise of 0.5 unit, or even 1.0 unit, is within the normal range of ultimate pH values found in meat.

New Zealand tests (Hagyard *et al.* 1993) showed that ammonia could be tasted in the meat even when virtually no increase in pH occurred. Therefore, any significant leak of ammonia is likely to change the quality of the meat, and the only true way to assess whether the product is acceptable is by sensory evaluation, not by pH change. In a study of ammonia absorption into frozen meat, ammonia could be detected in the meat by smell immediately after exposure. After a while, the ammonia could not be smelt, but could be tasted.

References:

Anon (1981) Assessing ammonia damage to food. Food Development 15: 46-47.

Goodfellow, S. J., Bordeaux, F. M., Masters, B. A., Brown, W. L. (1978) Assuring quality after ammonia leaks. Food Product Development, 12 : 32-35.

Hagyard, C., Cummings, T., Martin, A. (1993) Effect of ammonia exposure on subsequent rancid flavor development in lamb, Journal of Muscle Foods, 4: 245–251.

Ireland, T L, 'Ammonia Contamination of Lamb', *Assuring Meat Quality,* 60-61, Frozen Meat Section, MIRINZ.