

Meat technology update

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Taints in meat

Meat flavour is influenced by on-farm factors such as species, animal age and sex, fat amount and composition, feed type (e.g. pasture species and grain ration content) and post-slaughter factors such as chemical taints, bacterial off-flavours, and rancid off-flavours that may develop during extended frozen storage.

This update deals with chemical and pasture feed taints.

Chemical taints

Disinfectant-like taints

Chlorophenols continue to be the most troublesome examples of this taint. Whilst chlorophenols have been used as preservatives in paper, board and adhesives, they can also be formed in virtually any situation where organic materials containing phenols are treated deliberately or accidentally with chlorine-based bleaching solutions or sanitisers.

The chlorophenols have disinfectant-like tastes, detectable in water in concentrations ranging from 0.04 parts per billion (ppb) for 2, 6-dichlorophenol to 30 ppb for pentachlorophenol (PCP). The chlorophenols are soluble in most organic solvents and are slightly soluble in water.

Chlorocresols share the disinfectant-chemical taste of the chlorophenols, and may have even lower taste threshold values. The disinfectant-like odour of 6-chloro-*o*-cresol can be smelt at 0.1 ppb, and a taste threshold as low as 0.05 ppb in biscuits has been recorded. Traces of chlorocresols may be present as impurities in cresolic disinfectants, so these must be avoided in meat plants.

Musty or mouldy taints

Food Science Australia work has shown that the most likely causes of mustiness are the chemicals called chloroanisoles. These have very potent odours and can be detected at extremely low concentrations in foods. In strongly flavoured foods such as sultanas, they can be detected down to levels of 100 nanograms per kilogram, which is equivalent to one gram of salt in 10,000 tonnes of sultanas. It is because of the sensitivity of the human palate to chloroanisoles that they are a problem.

Chloroanisoles are microbial products resulting from the conversion of the closely related chlorophenols, which are the usual chemical sources. Fungi - which are present in timber, fibreboard and paper - convert chlorophenols into chloroanisoles. The fungi are not growing in the food itself, but food in close proximity to these products takes up the chloroanisoles during storage or transportation.

Some causes of the above chemical taints

General

Phenol ('phenyl' solution), cresol (cresylic acid-type creosote) and phenol-modified hypochlorite sanitising solutions should never be used. Similarly, phenolic and cresolic 'denaturing' agents should only be used with extreme caution. Timber which has been treated with creosote, phenyl or PCP and related preservatives should be excluded, and plastics and paints based on phenol or phenolformaldehyde resin are suspect. Chlorophenol-based fungicides and algacides should not be used to control moulds, fungi or algae and alternatives should be sought.

It is not necessary for the meat to contact these chemicals physically to become tainted. The vapour produced when sanitising a floor or drain with them may be quite sufficient to permeate the work area and contaminate the meat at the parts per billion level, which is enough to produce an objectionable taint. Overseas, pork carcasses hanging in a chiller were contaminated with 6-chloro-*o*-cresol vapour from a sanitising liquid (cresolic disinfectant) used to clean a drain.

In another notable episode, a quantity of inedible offal had been left at an abattoir over a hot weekend and by Monday morning maggots had gained access to several meat-handling areas. To rectify the problem, the affected areas were liberally washed down and disinfected with a solution containing a cheap, farm-grade disinfectant, unsuitable for use in edible product preparation/processing areas. Work resumed but later in the week complaints were received from a large number of consumers about a disinfectant-like odour and taste in minced meat and beefburgers prepared in the edible product area. Analysis of the meat showed that 6-chloro-*o*-cresol was responsible for the taint and its origin was traced to the cheap and unsuitable disinfectant used to clean the inedible product preparation/processing area. After the processing areas had been cleaned, a quantity of the residual offending

compound volatilised into the air and was then absorbed by the fat of the meat. In another case, a drain cleaner and degreaser used in a meat plant contained 6-chloro-*o*-cresol and resulted in the contamination of meat and meat products throughout the processing plant.

There are a number of other examples of 6-chloro-*o*-cresol tainting which have arisen from the mixing of cresol with hypochlorite bleach, either as a cleaning formulation or by inadvertent introduction of the two chemicals into water used in food processing.

Processing contamination

The reaction of chlorine with phenol during processing is a source of chlorophenols in foods, e.g. when phenol reacts with super-chlorinated water or with hypochlorite. The phenol can come from a trace component in a raw material or a residue in a piece of equipment made from, or treated with, a phenol-based paint, resin or plastic.

Phenolic-based resins and paints, used as protective coatings in storage tanks and water filtration vessels, may serve as sources of phenolics. In one case, the water in a storage tank became contaminated with phenols from the breakdown of the bonding resin of the fibreglass lining. Subsequent use of hypochlorite to clean the processing equipment resulted in residues of chlorophenols in the processing lines and contamination of the food. Another particularly interesting case involved the use of live steam for sterilisation: ligninsulphonate in a boiler additive gave rise to traces of phenol.

A chlorinated water supply is an essential food safety component in many processing plants and hypochlorite is still one of the best sterilising agents available to the food industry. However, where hypochlorite has been used to sterilise equipment, residues should be removed to prevent possible reaction with sources of phenol. Furthermore, the hypochlorite should be stored in containers that have not been treated with phenol-based resins or plastics as the hypochlorite itself can become

contaminated with chlorophenols.

In those factories where super-chlorinated water is used for processing, lignin-based preparations should not be used in the boilers when sterilisation or heating involves direct steam injection since this may lead to chlorophenolic-type taints.

One case of chloroanisole taint in meat resulted from a phenolic-containing product being in contact with damp insulation in a chiller.

Sources from packaging

Packaging materials prepared from wood pulp, such as fibreboard cartons and multi-wall paper sacks, can be major sources of chlorophenols and chloroanisoles in non-hermetically sealed food if chlorine bleaching of wood pulp for paper manufacture is used. Sufficient chlorophenols and chloroanisoles are then provided from bleached paper or board packaging to taint a food or beverage it contains. However, in Australia, bleached white paper is manufactured using peroxide. Moreover, it is possible to purchase packaging materials manufactured from unbleached Kraft pulp, which has extremely low chlorophenol levels. Chlorophenol-free adhesives are also available. These materials should be used wherever there is a danger that chloroanisoles could be produced in the packaging during storage or transportation, i.e. in the presence of 12 to 14 percent moisture levels in the packaging.

Transporting hazards

Wooden pallets, shipping container floors and truck floors are all potential sources of chlorophenol and chloroanisole contamination. The source of these compounds can be traced to fungal action on chlorophenol-based wood preservatives and chlorophenols formed by the reaction of hypochlorite sterilising agents with the timber.

Chlorophenol-based fungicides are still used to preserve timber for use both as flooring in containers and in the manufacture of pallets. Some chlorophenols can be converted within

a few days to chloroanisoles, provided conditions are favourable to the growth of the fungi. Timbers most frequently treated with chlorophenol preservatives are softwoods, such as pine. Pallets and floors manufactured from this material should always be regarded as suspect unless guaranteed chlorophenol-free by the suppliers of the timber. The cleaning of softwood pallets and floors with hypochlorite solutions can yield appreciable quantities of the problem chlorophenol. Hardwoods are less susceptible to this reaction.

Wet hides, in some overseas countries, are still treated with bactericides containing the convertible chlorophenols. Liquid dripping from the hides contaminates the floor of the container creating a situation favourable to production of the corresponding chloroanisoles. When spillages of chlorophenols onto pallets and floors are added to this list, combined with the ease with which chlorophenols are converted to chloroanisoles, it is not surprising that mustiness sometimes occurs in non-hermetically sealed food that is either stored on timber pallets or is transported in general purpose shipping containers. The shrink-wrapping of palletised goods can exacerbate the problem by trapping odours if the pallet is the source of the contamination.

To prevent the occurrence of mustiness from any of these sources, it is necessary for the food industry to specify that any equipment it hires has been designated for food use only. If such equipment is not available, it is essential that the industry demands that pallets and containers supplied for its use have not been treated with chlorophenol preservatives, used to carry chemicals or noxious materials such as hides and/or cleaned with hypochlorite solutions.

Environmental sources

New packaging materials can be contaminated with chlorophenols and chloroanisoles during storage and transportation if they are held in an environment polluted with these compounds. Containers manufactured from polymers or metal cans with varnished or polymer-coated

inner surfaces are most susceptible to air-borne contaminants which can be readily adsorbed onto these surfaces. Once the container is filled, the chlorophenols and chloroanisoles dissolve into the food or beverage. The major cause of such problems is a chloroanisole whose origin has been traced to materials such as slipsheets and spacers that initially contained chlorophenol used in stacks. Fungi again are responsible for the conversion of chlorophenol to chloroanisole. Other major sources of contamination are non-refrigerated shipping container floors and timber pallets.

Timber shavings used in chicken runs are another environmental source of chloroanisoles. If the shavings have been taken from timber previously preserved with chlorophenols, under the environmental conditions present in the chicken runs, these compounds are very quickly converted into chloroanisoles. The chickens feeding from the litter ingest the chloroanisoles which are then either deposited in the fatty tissue of the birds or transferred into their eggs. The use of chlorophenol-based bactericides in chicken runs can also be the origin of mustiness problems in chicken meat.

Catty taints

An example of a catty taint occurred overseas in meat carcasses stored in a chiller which had recently been painted inside. The paint used was based on polyurethane and had been left for sufficient time to eliminate residual paint odours. The chiller was duly restocked with meat carcasses. When the room was opened after two days, an obnoxious catty odour was evident on the carcasses and in the room. The paint was suspected and careful examination of the paint solvent showed the presence of 0.4% mesityl oxide. None of the solvent components had low odour-threshold values and traces could not be detected by odour in the empty chiller; however, when the mesityl oxide impurity reacted with natural hydrogen sulfide in the meat, trace amounts of 4-mercapto-4-methylpentan-2-one were formed. The very low odour-threshold value of this compound resulted in the detection of the catty taint.

Conclusion

The amount of an off-flavour compound required to cause tainting is extremely small, but its financial consequences and loss of customer goodwill can be enormous. However, most taint problems can be avoided by taking relatively simple steps to ensure the control of chemicals in and around meat premises and the control of all materials coming into direct or indirect contact with meat.

Feed taints

There is no doubt that the diet of animals immediately prior to slaughter affects the flavour of the meat. In Australia, sheep and cattle may be grown to slaughter on native pasture, 'improved' pasture, or forage crops, with a proportion being lot-fed, and a variety of 'foreign' aromas and flavours have been detected in their meat. Research showed that meat from lambs grazing the legumes lucerne (*Medicago sativa*), silverleaf desmodium (*Desmodium uncinatum*), *Dolichos axillaris*, or *Glycine wightii*, even for short periods of time, could be significantly differentiated from that from control lambs grazing a pasture grass, when tasted by a trained sensory (taste)-panel. However, the alteration in flavour properties did not always produce a corresponding variation in acceptability of the meat, and it is probable that some of the differences are not detectable by a consumer panel.

Part of the work in Australia involved investigations into the length of time required to graze an animal on grass prior to slaughter to eliminate any foreign odours or flavours produced by grazing lucerne pasture. Starving lambs for up to 3 days prior to slaughter had no effect, but when the lambs were transferred to pastures for 7 to 14 days prior to slaughter the meat flavour was not significantly different from that of lambs grazed solely on phalaris. A second investigation - of meat from animals grazing lucerne - showed that both the duration of the grazing period and the season had an effect. The intensity of a characteristic lucerne taint described as a 'sharp' or 'pungent' odour, and a 'dirty' flavour, was found to increase with lengthened grazing

time on lucerne. A variation in 'taint' intensity was found in both four-week and continuous-lucerne grazing treatments. Maximum intensity occurred when the lucerne was grazed in the cooler months. A similar experiment on meat from sheep grazing rape (*Brassica napus L.*) confirmed the occurrence of a strong and unattractive foreign flavour and aroma. There was no significant difference in the acceptability of flavour of meat from animals grazing pasture or vetch, although vetch produced an intense meaty flavour. Meat from sheep grazing oats possessed a pungent odour and flavour, the flavour being only slightly, although significantly, less acceptable than that of meat produced on pasture.

New Zealand research established the presence of a significantly more intense aroma and flavour in meat from lambs grazed on white clover than from those grazed on perennial ryegrass. Subsequently, these differences were produced in the lean meat within 3 weeks and in the fat by 6 weeks. Some researchers considered that the 'clover taint' reported in New Zealand would not be readily detected by untrained tasters and would probably not induce any unfavourable comments from consumers.

The alterations in flavour attributes resulting from deliberate diet changes discussed have been detected by trained taste panels. It is not known if consumers would detect the differences. However, reports of taints in meat have come from the Australian meat industry when pastures infested with weeds have been grazed. In particular, two weeds common in Queensland, parthenium (*Parthenium hysterophorus*) and wild turnip weed

(*Brassica tournefortii* Gouan), have been suspected of causing detectable taints in raw meat and therefore rejection of carcasses. Investigations into the 'pathenium taint' have been carried out and they showed that transfer of lambs to uninfested pasture for 2 weeks prior to slaughter significantly reduced the level of this taint.

The Sensory Section of Food Science Australia, Werribee is currently conducting a project for the Department of Natural Resources and Environment (DNRE) of Victoria to determine the effect of three nutritional finishing systems - grain, grass and crop – on the sensory acceptability of the flavour and odour of lamb by Japanese consumers.

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