MARCH 2013

PEANUT OFF-FLAVOUR FACT SHEET

GRDC
Grains Research & Development Corporation
Your GRDC working with you

NORTHERN REGION

PEANUT OFF-FLAVOURS

In 2008, earthy, musty off-flavours were detected in peanuts in North Queensland, which led to over $1 million of product downgrades. The problem has not been recorded, or studied, anywhere else in the world except North Queensland. GRDC-funded research has discovered the major cause of this off-flavour contamination. The GRDC has developed guidelines for a number of pre-harvest and post-harvest practices to minimise the risk.

What causes off-flavour contamination?

Microorganisms called actinomycetes can grow on stored peanuts. These actinomycetes produce volatile compounds that contaminate the stored nuts, and cause the musty, earthy off-flavours.

Actinomycetes can grow over a wide temperature range of 10 to 60°C, and stored nuts can develop the problem when kernel and nut-in-shell moisture content is more than 12 per cent. (See Technical appendix).

Contamination of peanuts can occur in the field during the growing season and also during post-harvest storage and handling. Actinomycete spores are prevalent in the environment and occur on dirt adhering to peanut pods, in foreign material accompanying pods (dirt, sticks and other plant debris, including immature potatoes) and in storage bins. Post-harvest off-flavour contamination of peanuts is always a risk if temperature, humidity and pod moisture conditions are conducive to the germination and growth of actinomycete spores.

Wet conditions at the time of harvest can encourage the growth of actinomycetes, and increase the chance of crop contamination. A long interval from cutting to thrashing (more than five days) in combination with poorly aerated windrows (which prevent the plant and pods from drying rapidly down to safe moisture, that is, less than 10 per cent pod moisture within two to four days) can lead to conditions ideal for microbial growth.

KEY POINTS

- Off-flavour contamination in North Queensland peanuts can cause major product downgrades, resulting in large financial costs for growers and processors.
- Off-flavour is caused by odorous (volatile) compounds that can diffuse into, and contaminate, clean peanuts, particularly while peanuts are in storage.
- Microorganisms called actinomycetes that grow on peanuts and other organic material in crop windrows can produce these volatile compounds.
- Actinomycetes are present everywhere in the environment but only produce off-flavour compounds under certain conditions such as high temperature or high relative humidity.
- Growth of these microorganisms after digging of the crop can be reduced by making sure peanuts are rapidly dried to safe pod-moisture content after harvest.
- Post-harvest, peanuts should be stored in clean and secure on-farm storage bins to prevent growth of microorganisms, and delivered to the buying point as quickly as possible.
- Rapid and low-cost analytical techniques to detect off-flavour compounds are being developed to help manage this problem.

PHOTO: PEANUT COMPANY OF AUSTRALIA

Extraneous material coming out of shellers post storage contains a large amount of organic matter, potentially available for actinomycetes to grow on.

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | **T** +61 2 6166 4500 | **F** +61 2 6166 4599 | **E** grdc@grdc.com.au | **W** www.grdc.com.au

PHOTO: PEANUT COMPANY OF AUSTRALIA

A peanut crop planted after a potato crop in North Queensland, showing many immature potatoes left after harvest, and potential for high levels of actinomycete inoculum in the peanut crop.

PHOTO: PEANUT COMPANY OF AUSTRALIA

A thrasher, capable of harvesting large volumes per day, ensures short digging-to-thrashing intervals.

In years where wet conditions prevailed during the harvesting period, up to 30 per cent of peanut loads delivered to the buying point had detectable levels of volatile compounds in pods. In dry harvest years the compounds were undetected.

Best mangement practice

Minimising off-flavour pre-season

Block preparation, selection and rotation

Ideally, blocks should have had good crop rotation (to avoid peanut following peanut, as actinomycete levels can increase dramatically). There is some evidence that peanuts following potatoes may have a higher risk of being contaminated with off-flavour volatile compounds

A genus of actinomycete, *Streptomyces* (present in immature and/or decomposing potatoes), is known to produce the volatile compounds associated with off-flavour, which can lead to a high number of actinomycete spores in the soil. Immature potatoes left after harvest can be roughly the same size as mature peanut pods, and are sometimes harvested with the peanuts. *Streptomyces* on these immature potatoes can be transferred to storage bins, along with the potatoes, during harvesting.

Minimising off-flavour post-harvest

Several practices, outlined below, have been shown to reduce actinomycete growth post-harvest, and thus reduce the chance of off-flavour contamination.

- When windrows remain wet due to rain after cutting, fluffing is essential to improve aeration and ensure rapid dry down of pods in order to minimise any actinomycete growth on and around the pods.
- Short digging-to-thrashing intervals (three to five days) can minimise the time that pod/kernel moisture is in a range suitable for actinomycete growth (that is, more than 15 per cent pod moisture). Windrows should not be left in the paddock for more than five days, as actinomycete growth on pods (and thus off-flavour contamination) is likely to occur. This is especially important in areas such as North Queensland, where post-harvest rainfall is likely.
- Thorough pre-cleaning of harvested pods removes extraneous matter including dirt, sticks, corn cobs, gherkins, immature pods and potatoes. If the product is not cleaned, build-up of extraneous materials can cause wet hot spots and subsequent off-flavour contamination in storage bins.
- Peanuts should be dried immediately after threshing and pre-cleaning with a continuous air flow of 200 litres per second at 50 to 65 per cent relative humidity. The ideal maximum depth of peanuts in the drying bin is two metres, with pod moisture loss not exceeding 0.5 per cent per hour. Final pod moisture should be less than 10 per cent before storage.

Minimising off-flavour in storage

Store only after drying

Peanuts should only be stored after they have been dried down to a pod moisture content of below 10 per cent.

Store in secure, aerated bins

If peanuts are going to be stored on-farm, they need to be in secure and aerated storage bins that prevent leakage/ingress of moisture. Moisture can lead to development of microbial hot spots and off-flavour contamination.

Generally, on-farm storage after July will result in a high risk of actinomycete growth and potential off-flavour contamination due to increasing ambient temperature and relative humidity.

Temperatures above 25°C and relative humidity of more than 70 per cent are highly conducive to actinomycete growth. Storage above these limits is discouraged.

Shell early and store in cold rooms

Peanut processors can minimise the risk of off-flavour development by making sure pods are shelled and subsequent cold storage of kernels is completed as soon as possible following harvest.

Shelling is recommended before the end of July in order to avoid rising ambient temperature and relative humidity after this time.

PHOTO: PEANUT COMPANY OF AUSTRALIA

A peanut crop with well-inverted and aerated windrows allows rapid drying after wet weather at harvest.

PHOTO: PEANUT COMPANY OF AUSTRALIA

Peanut drying silos allow pods to dry down to safe moisture content for storage.

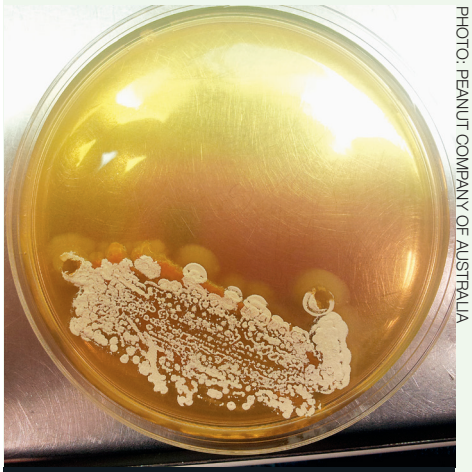
TECHNICAL APPENDIX

The main cause of off-flavours in peanuts

Two volatile organic compounds produced by actinomycetes are responsible for the characteristic odour of moist soil and can also impart many unpleasant musty, mouldy, earthy off tastes to drinking water and food products. They are 2-Methylisoborneol (2-MIB) and geosmin (GSM).

2-MIB has been detected in peanuts, and can be detected easily in the parts-per-trillion range. GSM has not been detected in peanuts in these trials. Where environmental conditions have been conducive to actinomycete growth, 2-MIB appears to be the main off-flavour compound over this period in North Queensland peanuts.

PHOTO: PEANUT COMPANY OF AUSTRALIA



A typical actinomycete strain, isolated from peanut pods in North Queensland and grown in the laboratory.

How is off-flavour-causing 2-MIB produced?

2-MIB is a volatile compound produced by actinomycetes and other species of bacteria and fungi.

Microbial studies in North Queensland peanut production areas have recently identified more than 50 different actinomycete species. They appear to occur widely in the environment, as these species have been isolated from peanut-producing soils, as well as in peanut pods and kernels.

Airborne actinomycete spores have also been collected from peanut storage bins even where no peanuts were in storage. This indicates that these bacterial spores are likely to be present in most storage areas on a permanent basis.

What is the mechanism of 2-MIB contamination in peanuts?

While direct infection of peanut pods/kernels by actinomycetes may lead to 2-MIB contamination, it is likely that the major mechanism of off-flavour contamination is by 2-MIB volatiles diffusing from microbial hot spots into clean peanuts. Controlled chamber experiments have clearly demonstrated that 2-MIB produced from these hot spots can permeate the peanut shell and contaminate clean product.

This process can occur within days to weeks, depending on the level of actinomycete infection of peanuts and associated environmental conditions of temperature and humidity (see below). Importantly, contamination can occur both pre-harvest, and/or post-harvest.

Technical key points

The off-flavour-causing volatile compounds are difficult and expensive to measure.

Growers and processors need faster, more efficient and more cost-effective methods of testing for volatile compounds in peanuts to reduce product loss by early detection.

Ongoing GRDC research is investigating a more rapid, cost-effective method of testing for these compounds.

... continued over page.

TECHNICAL APPENDIX CONTINUED

Although 2-MIB may be detected in peanuts, research has shown that it does not always correlate with off-flavour development in peanuts, as judged by a taste panel. This effect is thought to be associated with the level (or concentration) of off-flavour contamination, with ongoing research underway to better understand this observation. Because of this uncertainty, all peanuts coming out of North Queensland are taste tested by a qualified taste panel to ensure off-flavours are not present.

How are 2-MIB and GSM measured in peanuts?

The most common analytical method for 2-MIB and GSM is by high-speed solid-phase microextraction (HS-SPME) on a gas chromatograph mass spectrometer (GCMS). Extracting and analysing these compounds can be challenging due to their low odour-threshold levels, which are in the parts-per-trillion range. While detecting 2-MIB and GSM in water is relatively simple, there are specific challenges in peanuts where hundreds of other off-flavour volatiles are present that can potentially mask the presence of 2-MIB and GSM.

The HS-SPME analysis is time-consuming and the equipment required is very specialised and expensive, so a more rapid, low-cost test is required. New methods of testing are currently being developed by GRDC-funded research.

New methods for 2-MIB and GSM testing

A research team headed by Dr Alice Lee from University of New South Wales is exploring the potential of using a cheaper and more rapid system that uses antibody-based tests to analyse peanuts for 2-MIB. They are extending this work to GSM to test if the compound is present in, but undetected by, current tests.

The test is an enzyme-linked immunosorbent assay (ELISA). It is a rapid antibody-based test in which an antibody binding to a specific antigenic molecule can detect very low levels of compounds in a substance. In the ELISA being developed, if a peanut sample contains 2-MIB the antibody binds to it. The results can be read by detecting the level of binding.

Despite making some good progress, the ELISA research program has faced challenges in quantifying 2-MIB down to very low levels required in peanuts (of parts per trillion). Further research is being performed to improve the ELISA sensitivity by using chemiluminescence. The project team is hopeful that commercial testing of the ELISA will occur over the next two years.

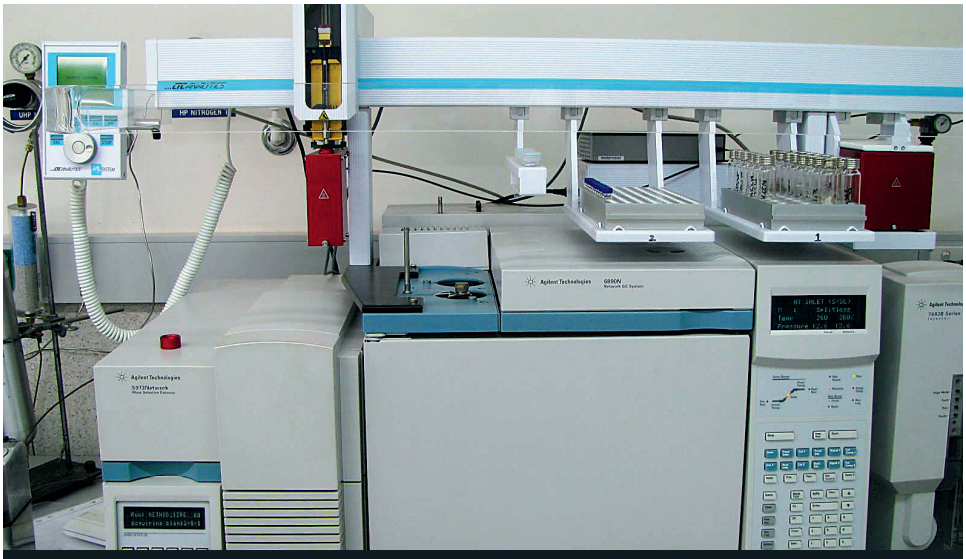


PHOTO: PEANUT COMPANY OF AUSTRALIA

A gas chromatograph mass spectrometer (GCMS) performing 2-MIB and GSM analysis.

Acknowledgments: Kylie Wenham, Jonathan Nowland, Dr Mirta Golic, Peanut Company of Australia; Dr Ipek Kurtböke, University of the Sunshine Coast, Faculty of Science, Health, Education and Engineering; Sung-Woog Kang, University of New South Wales, School of Chemical Engineering.

USEFUL RESOURCES

Visit the Peanut Company of Australia online www.pca.com.au

MORE INFORMATION

Dr Graeme Wright
Peanut Company of Australia
0419 735 036
gwright@pca.com.au

Dr Alice Lee
School of Chemical Engineering
University of New South Wales
02 9385 4363
alice.lee@unsw.edu.au

GRDC PROJECT CODE

PCA00002

PRODUCED BY **WWW.CORETEXT.COM.AU**