

## **Animal Studies Conducted on Monsanto's GM Roundup Ready (RR) Canola**

### **Animal Feeding Trials**

In an animal *GM* feeding trial, typically, feed derived from a *GM* crop and its non-*GM* counterpart is fed to animals. Various aspects of the animals may be measured to see if the *GM* variety has affected the animal differently.

#### **Human Health Variables**

Some animal studies look at human health variables, such as identifying the concentration of immune cells in digestive tract tissues, or assessing alterations in liver tissue profiles. They are quite detailed examinations of the health response in the animal to *GM* feed, and the findings may have some relevance to human health.

#### **Production Variables**

Animal feeding production trials typically proceed for a number of weeks or a few months. They are examining whether the animal will survive to slaughter, and the quality of the animal products. The outcomes of these studies may be helpful for animal producers.

The four published animal feeding trials conducted with Monsanto's *GM RR* canola all looked at 'production' variables. That is, the trials examined size of chicken breasts or tenderness of lamb chops or feed efficiency - how much feed per kg of carcass?

These four animal production studies have looked at trout, chickens, pigs and lambs/sheep, and they will be discussed below

#### **Other Variables**

Five other studies on *GM RR* Canola have been conducted by four collaborating Canadian Agricultural research institutions, looking at the more scientific aspects of the digestion of DNA in sheep and pigs. The culminating study found fragments of *GM* canola DNA in the digestive tissues of sheep and pigs and in the liver and kidney of pigs.

The line of inquiry follows an interesting course and is discussed briefly below.

### **Four Animal Production Trials with GM RR Canola**

A critical factor in these four studies is that Monsanto supplied the *GM* feed, and feed from the non-*GM* counterpart for comparison. Each of these studies depended on the integrity of this feed.

There is a great amount of detail in each study, and we are selectively reporting some of the details that concern us from a procedural or human health perspective. There is a lot of other detail that may be useful for people who are reading from other angles of interest. If you want to investigate this further we encourage you to read deeply into the full text of the studies - only selected results are published in the free abstracts provided on the web.

The full text of the chicken study is available free on the web, but the trout and lamb studies were bought at a price. Copyright conditions prevent us from publishing the studies on the web. You may be able to read the full text for free at a University with journal access - contact us if you'd like advice on how to do this. The full text of the pig study does not seem to be available, but we can deduce a few things about the study.

### **The Trout Study**

Brown PB, Wilson KA, Jonker Y, Nickson TE. (2003) Glyphosate tolerant canola meal is equivalent to the parental line in diets fed to rainbow trout. *J Agric Food Chem*. 51:4268-72  
<http://pubs.acs.org/doi/abs/10.1021/jf034018f>

The trout study was initially done in the early 1990's. It had been conducted by Monsanto with the support of Purdue University (Indiana) as a regulatory requirement imposed, we understand at this time, by Canada. This study was described in detail in material provided by Monsanto to Food Standards Australia New Zealand (then ANZFA).

Information on the growing of the seed, and on the processing of the seed into meal for the feeding study is buried in a 440 page document. The manner in which the canola meal was produced for this trial was outrageous.

It is not the place to detail this astonishing record here. In short, the different GM and non-GM varieties were grown side by side in plots at a number of sites in Canada. The feed used in the trials was grossly contaminated, so much so that the trials had to be repeated. The seed was reported to have been 'mixed'. Protocols had been specially changed for the processing of the seed into meal, leading to the toasting of meal at excessive levels of heat "at the option of the Sponsor" (Monsanto).

The contamination of the GM varieties was later acknowledged and poor results for the GM canola (the variety now planted in Australia) were explained away by the authors on the basis of "overcooking" the meal...

"Proximate analysis of each sample prior to formulation into test diets showed a markedly lower nitrogen solubility [...] indicative of differential processing (overcooking) of [the RR canola sample], and may explain differences noted in this study."

The trial was repeated but with far more adverse effects on fish production values. Weight gain was halved, feed efficiency and protein efficiency ration declined. Death rates weren't high but they tripled, and we have to ask the question - what did Monsanto do to the feed (the second time) to produce these highly adverse results?

The study did not detail any aspects of seed and meal production for the repeated trial.

### The Chicken Study

[MADGE recently received the Monsanto data for this study, and will shortly be updating this section.]

Taylor ML, Stanisiewski EP, Riordan SG, Nemeth MA, George B, Hartnell GF (2004) Comparison of broiler performance when fed diets containing roundup ready (Event RT73), nontransgenic control, or commercial canola meal (vol 83, pg 456, 2004). Poultry Science 83:1758 <http://ps.fass.org/cgi/reprint/83/3/456>

Monsanto conducted this study. Monsanto prepared the canola meal for the GM variety and its (reportedly) non-GM counterpart, and for comparison brought in six additional commercially produced canola meals.

Because of the great difference between the non-GM counterpart and the commercially produced meals, it appeared again that the non-GM and GM seed or meals had been considerably overcooked. Moisture levels were very low, probably explaining higher apparent protein and fat levels in the GM and non-GM counterpart varieties prepared by Monsanto.

The different preparation may be able to account for the dramatic difference in deaths between the chickens fed the commercial meal and the chickens fed the Monsanto prepared meals. The study acknowledged...

“The differences in mortality between commercial reference diets and test and nontransgenic control diets may be attributable to differences in processing at the 2 facilities.”

As a result of the very high number of deaths, the breast weight per pen and the breast weight/feed intake was significantly lower for the Monsanto processed feeds, but these results were not presented in the study - they had to be deduced from the other data.

The results presented by Monsanto were expressed in terms of the chickens that actually survived and appeared healthy at slaughter time - they did not account for the lost production as a result of the very high number of deaths. This is not a fair presentation for farmers concerned at economic levels.

There were deaths, and there were animals killed due to their unhealthy condition. Animals were also described as having been 'removed'. I'm not sure that all of these removals were included in the mortality table.

As a study on the effect of genetically engineered feed it can't be viewed with any credibility. The difference between the Monsanto produced non-GM feed and the commercially produced non-GM feeds indicates strongly that something was wrong, and that whatever produced this effect may have overridden any GM effects that may have otherwise been observed.

Furthermore, the animals were fed very large amounts of both corn and soy without mention of whether these were *GM* varieties, containing the same *GM* genes as the *GM* RR canola.

Reading this study, a chicken farmer would best conclude that he/she should not feed his chickens on Monsanto-prepared feed.

### **The Lamb/Sheep Study**

K. Stanford<sup>1</sup>, J. L. Aalhus<sup>2</sup>, M. E. R. Dugan<sup>2</sup>, G. L. Wallins<sup>1</sup>, R. Sharma<sup>3</sup>, and T. A. McAllister<sup>3</sup>  
;Effects of feeding transgenic canola on apparent digestibility, growth performance and carcass characteristics of lambs; Can. J. Anim. Sci. 2003 83: 299-305; <http://pubs.nrc-cnrc.gc.ca/aic-journals/2003ab/cjas03/jun03/cjas02-056.html>

This study was financially supported by Agriculture and Agri-Food Canada, the Canadian Food Inspection Agency, and the Canada/Alberta Livestock Trust. Researchers from three agricultural research institutions in Canada co-authored the study.

Monsanto was acknowledged for providing the *GM* and non-*GM* counterpart canola meal for this study.

Again, as for the chicken study, this meal contained proportionally high amounts of protein and fat, and contained a very high percentage of dry matter. It may have been from the same seed material used for the chicken study, but this can't be determined from the information provided.

Again, the lambs fed on the Monsanto-prepared meal had significantly disadvantageous results. The clearest result is that the carcass yield grades were significantly reduced for these groups.

This study did not look at any variables that could be related to human health, but did give a nice description of the study of lamb chops, and part is described here to highlight the irrelevance to human health and safety...

"A 2.5cm chop was cut from the posterior end of the [sheep bit] and the remaining portion was vacuum packaged and held overnight at 4degC . The chop was weighed, placed on absorbent pads in Styrofoam retail steak trays, overwrapped with oxygen-permeable film [...] and held for 2d at 2degC to determine drip loss.

"At 48h post-mortem, the posterior end of the [sheep bit] was trimmed, 48-h pH recorded and two 2.5-cm chops were removed. One chop was exposed to air for a minimum of 20 min before colour was assessed. [...]"

"Both chops were cooked to a final internal temperature of 75degC as measured by a spear-type temperature probe inserted into the mid-point of the chop and monitored [...]. Chops were cooked in groups of eight on an electric grill [...]. Upon removal from the grill, the chops were sealed individually into polyethylene bags, and immediately immersed in an ice/water bath to prevent further cooking [...]"

This is a food production study. It is not a human health safety study.

### **The pig study**

J. L. Aalhus\*1, M. E. R. Dugan1, K. A. Lien2, I. L. Larsen1, F. Costello1, D. C. Rolland1, D. R. Best1, and R. D. Thacker1 Effects of feeding glyphosate-tolerant canola meal on swine growth, carcass composition and meat quality. ; J. Anim. Sci. 2003. 81:3267;  
<http://jas.fass.org/cgi/content/full/81/12/3267>

A full-text version of this study does not appear to have been written up as a study for peer review, but the authors of the study came from one of the Agriculture and Agri-Food Canada research centres and the University of Alberta, Edmonton Canada.

MADGE has asked the authors for full study detail which may arrive, but until then must report only from an abstract. The same feed groups applied as for the lamb study, and we expect that the feed provided by Monsanto was identical to that provided for the lambs. No data was given for moisture content or protein and fat levels.

As for the chicken and lamb studies there were significant differences between the pigs fed on the commercially prepared canola meals, and those fed on the Monsanto-prepared meals.

"Average daily gains, daily feed intakes, and feed conversion efficiencies were similar when feeding the PAR and RRC diets, but some differences from the COM diets were notes ( $P \geq 0.05$ )." The abstract didn't report the direction of difference. As for the lamb study there were differences in the carcass and meat quality evaluations, but didn't say what they were.

This was another food production study.

### **Five other studies using GM RR Canola**

These studies were conducted by researchers at four Canadian agricultural research institutions in various collaborative combinations. One of the studies had three Monsanto staff on the authorship.

The studies were conducted in series, with the general intent being to identify the true fate of GM DNA in animals, and to determine whether it would be taken up by body tissues or by bacteria (and other microflora) in the digestive tract.

The series did not make any findings that the GM DNA had been taken up by digestive microflora, but the final study found that GM DNA was present in digestive tissues in sheep and pigs, and in the liver and kidney of pigs.

### **Alexander et al (2002)**

Alexander TW, Sharma R, Okine EK, Dixon WT, Forster RJ, Stanford K, McAllister TA. Impact of feed processing and mixed ruminal culture on the fate of recombinant EPSP synthase and endogenous canola plant DNA. FEMS Microbiol Lett. 2002 Sep 10;214(2):263-9;  
[http://www.ncbi.nlm.nih.gov/pubmed/12351241?ordinalpos=8&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed\\_ResultsPanel.Pubmed\\_DefaultReportPanel.Pubmed\\_RVDocSum](http://www.ncbi.nlm.nih.gov/pubmed/12351241?ordinalpos=8&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum)

This study looked at what happened to GM DNA at various stages of feed processing. It determined that full lengths of one of the new GM genes could be found through all stages, from whole seed to processed meal in pellets.

It also looked at how rapidly the GM DNA was digested by extracting ruminal fluid from a Jersey steer. GM DNA was detected for up to 8 hours for meal and 4 hours for mixed diet.

Further, it found that plant DNA was rapidly degraded upon its release into rumen fluid.

#### **Sharma et al (2004) (abstract only)**

Sharma R, Alexander TW, John SJ, Forster RJ, McAllister TA. Relative stability of transgene DNA fragments from GM rapeseed in mixed ruminal cultures. Br J Nutr. 2004 May;91(5):673-81.  
[http://www.ncbi.nlm.nih.gov/pubmed/15137918?ordinalpos=7&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed\\_ResultsPanel.Pubmed\\_DefaultReportPanel.Pubmed\\_RVDocSum](http://www.ncbi.nlm.nih.gov/pubmed/15137918?ordinalpos=7&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum)

This study looked at the presence of GM DNA in buffered ruminal contents, and looked for evidence that GM DNA had been taken up by bacteria.

It found that GM DNA persisted in ruminal contents for at least 48 hours depending on feed type, but did not determine that GM DNA had been taken up by bacteria over that 48 hour incubation.

#### **Alexander et al (2004)**

Alexander TW, Sharma R, Deng MY, Whetsell AJ, Jennings JC, Wang YX, Okine E, Damgaard D, McAllister TA (2004) Use of quantitative real-time and conventional PCR to assess the stability of the cp4 epsps transgene from Roundup Ready (R) canola in the intestinal, ruminal, and fecal contents of sheep. Journal of Biotechnology 112:255-266  
[http://www.ncbi.nlm.nih.gov/pubmed/15313003?ordinalpos=6&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed\\_ResultsPanel.Pubmed\\_DefaultReportPanel.Pubmed\\_RVDocSum](http://www.ncbi.nlm.nih.gov/pubmed/15313003?ordinalpos=6&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum)

Monsanto had three co-authors on this study.

This study had two purposes: first to examine the stability of DNA in various digestive fluids of sheep, and secondly to assess the stability of one of the GM genes during incubation with digesta from the sheep small intestine.

The study found that the digestion of plant material and release of GM DNA can occur in the sheep small intestine. It found that free GM DNA is degraded more quickly at higher pH levels. It determined that the rapid degradation of GM DNA reduced the likelihood that it would be taken up into the body of sheep.

It is worth noting that the study gratefully acknowledged "The Natural Sciences and Engineering Research Council of Canada (NSERC)-Monsanto industrial scholarship to Trevor W Alexander and the NSERC fellowship to Ranjana Sharma [..]", the two principal researchers in this line of study. Such a scholarship sounds a cautionary warning for the independence of the findings.

#### **Alexander et al (2006)**

Alexander TW, Reuter T, Okine E, Sharma R, McAllister TA. Conventional and real-time polymerase chain reaction assessment of the fate of transgenic DNA in sheep fed Roundup Ready rapeseed meal. *Br J Nutr.* 2006 Dec;96(6):997-1005.  
[http://www.ncbi.nlm.nih.gov/pubmed/17181873?ordinalpos=4&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed\\_ResultsPanel.Pubmed\\_DefaultReportPanel.Pubmed\\_RVDocSum](http://www.ncbi.nlm.nih.gov/pubmed/17181873?ordinalpos=4&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum)

This study specifically focused on quantifying the persistence of *GM* DNA at various points in the sheep digestive tract, using both a forage-based or concentrate-based diet containing *GM* RR canola. The presence of *GM* DNA in blood was also tested.

Whole *GM* genes were detected for up to 13 hours after the last feed of *GM* diet, and *GM* fragments were detected for up to 29 hours in ruminal and digestive fluid. *GM* DNA was not detected in faeces, blood or microbial DNA. *GM* DNA was not amplifiable in ruminal and digestive fluid supernatant fractions.

#### **Sharma et al (2006)**

Sharma R, Damgaard D, Alexander TW, Dugan ME, Aalhus JL, Stanford K, McAllister TA. Detection of transgenic and endogenous plant DNA in digesta and tissues of sheep and pigs fed Roundup Ready canola meal. *J Agric Food Chem.* 2006 Mar 8;54(5):1699-709  
<http://pubs.acs.org/doi/abs/10.1021/jf052459o>

This study looked for the presence of *GM* and non-*GM* DNA in the tissues of sheep and pigs. High copy ordinary plant chloroplast DNA was detected in the esophagus, rumen, abomasums, small intestine and large intestine of the digestive tract tissues of sheep, and in the duodenum and cecum of pigs.

It was also found in the liver and kidney of sheep, and in the liver spleen and kidney of pigs.

Fragments of the low copy *GM* DNA were found in the digestive tract tissues of sheep and pigs previously mentioned. Fragments were also found in the liver and kidney of pigs.

The authors concluded that *GM* DNA may be found wherever non-*GM* DNA may be found in animal tissue, but that its detection depended on the *GM* concentration of the animal feed, the sample size of the tissue being examined, and the sensitivity of the tests and the size of the fragments being sought.

This has very wide-ranging implications that won't be discussed here.