When I first saw the title of the subject, I was really concerned about the use of the term “analysis.” To me, the word “analysis” implies a step-by-step analytical procedure and, not knowing the backgrounds and capabilities of the people in the audience, I was concerned that my presentation might be too technical. With that in mind, this is going to be a general overview of four particular residue monitoring programs and what I consider to be the stimulus or impetus for residue monitoring programs. Food safety is considered by the food industry to be the topic of the 90’s and it’s a topic that I believe is the stimulus for residue monitoring programs. The four programs that I’m going to concentrate on are the Human Monitoring Program, the USDA Monitoring Program, the EEC’s (European Economic Community) new Monitoring Program and the Monfort Program.

Before describing each program, I want to introduce residue testing in a more general way. Residue analysis is relatively expensive and time-consuming, even when the process is automated as much as possible. Sample preparation has advanced from using aluminum beakers and rods to macerate tissue samples mixed with sand. Today, tissue sonicators are used to prepare samples and gel permeation chromatography is an example of a separation technique. There are sophisticated instruments for residue analysis, such as liquid chromatography, gas chromatography and mass spectroscopy, but the real chore in residue analysis remains separating the residue from the tissue.

One of the interesting aspects of residue testing is that when you find a residue, a positive response is not a positive. You must confirm a positive. Thus, data validation is quite important. To simplify the process, gas chromatographs are often set up to do dual column confirmation using columns of different polarities. One column is used to identify a residue and the second column would be used to confirm the presence of the residue.

The Human Monitoring Program is sponsored in part by the EPA and the United Nations’ World Health Organization. The program involves the monitoring of human breast milk from around the world for levels of pesticides, herbicides and PCBs. Other samples may also be examined. At any time in the U.S. that a death was investigated by a medical examiner or coroner, a piece of adipose tissue was removed from the body and sent to a laboratory at Colorado State University. For 12 years, I analyzed the samples for levels of residues or environmental contaminants.

The United States was divided into five geographical regions and, based on levels of residue in the adipose sample, it was possible to determine from where the person originated. Not necessarily what city or town the person came from, but at least what area of the United States. For example, people in New York City would have different residue levels than people from an agricultural area, such as the San Joaquin Valley of California.

Some examples of pesticide residues that have been found in breast milk and adipose tissue include DDT and heptachlor epoxide (a metabolite of heptachlor). We have found DDT levels of 5-40 ppb and DDE (a metabolite of DDT) levels of 20-90 ppb. This is despite the fact that DDT has been banned in this country for about 40 years. Heptachlor was once applied to pineapples in Hawaii and the tops were fed to livestock. The heptachlor epoxide residues remain in human adipose tissue, however. One other residue of note is PCB, which has been reported in levels as high as 7 ppm.

One of the main reasons why we find so much residue in humans when compared to animals is that people generally live for a much longer period of time. Humans may live for 72 years, whereas cattle are usually 2 years and less, lambs a year or less and hogs are under a year at slaughter. Animals are simply not around long enough to accumulate the residues in question. People, however, accumulate the residues and, even if they go on a diet to lose some weight, the residues will simply concentrate in the tissue that remains.

The Human Monitoring Program has suffered from a lack of funding in the United States under recent administrations. As availability of EPA grants diminished, activity in this area was sharply reduced and a number of chemists had to find other opportunities.

The USDA FSIS operates a National Residue Monitoring Program.
Program. This program is designed to detect, reduce and control residues of drugs, pesticides and other chemical or environmental contaminants in meat products destined for human consumption. The USDA gets its authority to analyze samples from the Federal Meat Inspection Act and the Poultry Products Inspection Act.

Livestock and poultry may be exposed to many compounds during their life cycle. Pesticides may be directly applied to animals and are used on crops that become animal feed. Drugs are used to treat a disease or to prevent illness. In the case of steroids or hormones, they are introduced to enhance production. Environmental contaminants may come from exhaust of passing automobiles that use lead-containing gasoline.

In the USDA program, samples of meat and poultry are collected at slaughtering establishments and sent to the USDA or contract laboratory to identify if any residues are present. There are three categories in the residue program. Monitoring is part of the national program wherein random samples are sent to the laboratory to provide trend data as to the occurrence of residue violations, if any. Surveillance occurs if there is evidence that there might be a residue or some kind of contaminant involved in an animal or carcass. Research is the third category and its purpose is development of methodologies to identify new residues or metabolites in animal tissues.

The definition that USDA uses for residue is any compound that is present in edible tissue that results from deliberate or inadvertent introduction into the animal. This includes the compound itself, its metabolites or any other substance. The key is that metabolites must be included and therefore laboratories can no longer monitor for only parent compounds. Clearly, a metabolite can be an indication that the parent compound was present at some point.

The analysis of metabolites is becoming a very big issue because the USDA works from a list of approximately 400 approved compounds. At present, there are probably 172 compounds for which there are methods of analysis. This leaves over 200 compounds for which methods are not even available.

Although the USDA is responsible for operation of its residue monitoring program, there are two other federal organizations involved with residue analysis of meat and poultry. The EPA establishes the acceptable levels or tolerance levels for residues of pesticides and chemicals. The FDA establishes the tolerance for action levels for the residues of animal drugs.

The USDA ranks the compounds that they monitor in four categories from A to D. If a compound is rated as belonging in the A category, it is a compound of greatest concern. These are generally compounds that possess a high health hazard or a high likelihood of residue occurrence. Examples of antibiotics in the A category include sulfamethazine and other sulfa drugs. Pesticides in the A category include DDT, aldicarb (a carbamate pesticide), heptachlor and heptachlor epoxide. Hormones that fall into category A include estradiol, estradiol benzoate and Alar (a plant growth regulator).

For all of 1990, only 0.3% of the 40,000 samples that were collected by the USDA showed violative levels of pesticides, drugs or environmental contaminants. Generally speaking, there is no residue problem in terms of chemical residues, pesticides or drugs in meat or poultry.

**EEC Residue Testing Program**

The next program is the EEC Residue Testing Program. In 1989, the Europeans in the EEC imposed a ban on the sale of products from animals given anabolic steroids. In 1990, EEC-approved slaughter plants received a memo detailing the guidelines involved in their residue testing program.

The Europeans identified a number of compounds or environmental contaminants as allegedly being present in American beef and therefore would no longer accept these products into the EEC. Examples of compounds that were identified included DES, zeranol, trenbolone acetate, MGA, thyrostats, tranquilizers, beta-blockers, clenbuterol, lead and cadmium. The thyrostat was eventually identified as 2-thiouracil and the tranquilizers were azaperone and propiopromazine.

In response to the EEC’s action, a number of studies were conducted to determine if there were violative levels of residues in beef for export. In results that were summarized for the presentation, no residues other than organophosphates, chlorinated hydrocarbons, DDE, lead and cadmium were detected. None of the residues detected were in violation. The largest quantity measured was 27 ppb for DDE and yet the violative level is 5 ppm. Lead and cadmium were naturally occurring materials found in the liver and kidney.

**Monfort Program**

The last monitoring program is the one that is being conducted at Monfort. The Monfort corporation has a commitment to a total food safety program and therefore they monitor a large number of samples. Pesticides and herbicides are monitored because the animals may come in contact with these through the crops that are fed to the animals. They monitor for antibiotics which are used in the herd health program and hormones which are used to enhance production. Trace metals such as lead, cadmium, chromium, arsenic, selenium and mercury are monitored because treated human waste, liquid or solid, may be used as irrigation water or land-applied fertilizer. Human waste may include toxic metals due to canned foods, cooking in metal pans or the drinking water, but studies have shown that no bio-accumulation of metals occurs through the food chain. The water that the animals drink is also monitored, especially for nitrate and pesticides.

At Monfort, there is also a select-supplier program wherein farmers who supply feed for the Monfort feedlots must have their products tested for residues. This represents one way to reduce exposure of livestock to unnecessary chemical residues. Another part of the residue testing program at Monfort is the use of the LAST, or Live Animal Swab Test, for animals at the Monfort feedlot. The post-mortem STOP test, or Swab Test On Premises, is also part of the program to determine if antibiotic residues are present. At Monfort pork plants, the SOS (Sulfa On Site) test is a regular part of the monitoring program.
In summary, Monfort has taken a very positive and proactive stance on chemical residue monitoring. There are no federal regulations that require Monfort to monitor its own product, but they go ahead and analyze approximately 7,000 samples a month. This compares favorably to the 1990 figure of only 40,000 samples evaluated by the USDA. Clearly, Monfort is committed to food safety and takes steps to assure that meat is free of residues and is as wholesome as possible.

Discussion

P. Lewis: In your sampling of animals, can you take one animal from one specific pen? Is that enough?

M. Aaronson: It's a random sampling and the number varies. It could be one, it could be more. It depends on the pen or if there are any specific circumstances involved with that particular pen — something that we're aware of. What you need to keep in mind is that the purpose of the monitoring program is to accumulate the data and to monitor any trends so that it would stick up like the Empire State Building if a problem occurred.

Lewis: I understand that some grain producers are analyzing soils for a certain number of years, and then are selling their feed from this and saying there is no residue. Do you have any data to indicate that if you are taking soil samples versus feed samples from a specific land that you get good checks in the soil samples for pesticides or herbicides? Or do you not have that data?

Aaronson: We don't have data on that. I'm sure there's a lot of data available on soil, but I don't know.

C. Kastner: You mentioned organophosphates. Where are you going with the metabolite or the secondary breakdown products of organophosphates? How important do you consider them to be?

Aaronson: Once again, we consider the metabolites to be a major issue, although the list that I put up just contained the parent compounds. We do analyze for the metabolites of the organophosphate compounds. In some cases, we will not find the parent compound but find its metabolite, which is an indication that the parent compound did exist at one time.

Kastner: As far as the analytical procedures for organophosphates, are those well established for all of the metabolites?

Aaronson: No. In certain circumstances, the procedures do exist, but I would have to say I think that most don't exist. The tough part is the matrix that you're dealing with. It turns out, for instance, that probably the toughest matrix that we deal with is not animal tissue but either corn silage or green hay. So, I guess the answer to your question is no, the methodology is presently poor for metabolites.

Kastner: This question relates to mycotoxins. As we look for it in feeds, I'd like your opinion relative to the transferability from the feed to the tissue and what that means from the standpoint of human health concerns.

Aaronson: First of all, at Monfort we're not monitoring for the mycotoxins. It seems to be more of a problem for dairies than it is for the beef industry. Yes, we do sample our corn and silage, but it's just a yes or a no. I have never come across a yes. I can't carry it into animal tissue because I have never analyzed animal tissue for mycotoxins, so I cannot answer that question.

Schroeder: There's a few out here in the audience, as myself, who get involved with state fairs and carcass shows and that type of thing. We've seen over the past probably 6 to 8 years some pretty wild things going on with modification of carcass conformation, that type of thing, using some unapproved products. You've mentioned one or two. How many labs have the capabilities to do some testing for clenbuterol in the U.S. and what are the costs of some of those lab tests?

Aaronson: That's a tough question for me to answer; how many labs have the capability? I'm sure that there are a lot of laboratories out there that have the instrumentation capability to test for clenbuterol or some of those other compounds. Whether those laboratories have taken the time to do the method development in terms of taking clenbuterol out of tissue samples and applying that to the analytical instrumentation that they have, I don't know. I only know of two laboratories that are approved and are presently participating in the EEC residue testing program. Both of us are in this audience right now. That's not to say that there aren't other laboratories out there that can or can't do it.

In regard to cost, when somebody calls up and says 'I have this problem. What is it?', I'm not so sure you have enough money to pay for it. What I'd first like to do is sit down and talk to you to find out if you have any information that you can give me. If one has to deal with unknowns, for example antibiotic residues, then it would be nice to have a liquid chromatograph that's interfaced to a mass spectrometer. You could take all the drugs that are known to be used on animals, use them as standards, analyze by mass spectrometry, put the data into its memory, then take your unknown sample, shoot it in the mass spec and hopefully the computer will match it. In terms of mass spectrometry, you're talking about an instrument that's up in the $100,000 range and if you're lucky enough to get an analyst that can operate a mass spec, you're talking about a high-priced help.

You're talking in the neighborhood of $200-400 per sample. It's expensive.

Schroeder: Mike, is your laboratory willing to work with some of these fairs to do some testing to determine whether it's antibiotics or other growth promotants?

Aaronson: You bet, I have business cards . . . Yes, as a matter of fact, Monfort cooperates extensively with a number of fairs and the National Western Stock Show. We'd be happy to perform the analyses if there are any animals or something in question, for a fee of course. We would certainly work with anybody and offer that service.

G. Highfill: Our extension veterinarian in Oklahoma has become very active as far as putting on producer meetings to try to cut down illegal antibiotic use. As a part of that program, he's mentioned quite a few bill-backs. What's the largest bill-back you've been aware of as far as to a producer, and what was the violation?
Aaronson: None, up until this year. The show year hasn’t started yet for Monfort, but prior to this year Monfort has picked up the entire cost of testing show animals. We have not related that cost back to anybody yet.

Highfill: I'm sorry, I wasn't referring to show cattle, I was referring to regular slaughter cattle.

Aaronson: The only instance of bill-back is on the pigs for the SOS testing. We have not found a residue violation in cattle. In the case of the pigs, when the SOS test proves positive and so does the confirmation, and the laboratory proves that sulfanilamide is present, the producer pays a fee of $75. It's not necessarily the price that we charge for the test, but that's what was established as the penalty for the producer.

N. Webb: Mike, first I'd like to say that I'm appreciative of this excellent presentation you've made and want to thank you for that. The question I have is do you foresee or think the manufacturers of residues are going to assume any responsibilities for methods development?

Aaronson: To my knowledge, in order for a producer to get a pesticide, herbicide, antibiotic, hormone or whatever on the market, that producer has to go whichever federal organization a method of analyzing the compound that they are trying to introduce. I have yet to have the cooperation of anyone to get any methodology. To be honest with you, I have never tried to get it under the Freedom of Information Act, but manufacturers are very uncooperative in handing out that information. They would rather you spin the wheels trying to reinvent the wheel. When you speak to manufacturers, they consider it proprietary information, but I think it has to exist.

Schroeder: Mike, you alluded to the different classifications of compounds in your talk, and you talked about classification A. Could you expound on the other classifications and what they refer to?

Aaronson: Once again, it is a method of classifying compounds from A to D. D compounds are on the monitoring list, but have the least health effect and are least likely to occur as a residue. An A compound is the one that is the most likely to occur as a residue and has the highest health risk. It's just the different degrees of risk to human health.

M. B. Rasmussen: I'm from South Dakota State University, and my question deals with the sulfa issue that you brought up. I was wondering if companies such as Monfort would consider offering incentives for producers to reduce residues. I know that the Pork Councils in South Dakota and also on the national level are instituting what they call a pork quality assurance program to get away from the residues. Would you offer some type of price incentive or something like that for producers enrolled in the program?

Aaronson: I can't speak for Monfort Corporation. Perhaps Kirk Jones might want to answer that. Kirk is director of product integrity and food safety for the pork division. He might have more insight into that than I do.

K. Jones: That is a good question because it is asked very often in conjunction with our program. Monfort's response is that residue safety at the producer level is the cost of doing business. In other words, every consumer out there has the right to receive product that is free of residues, and we're not going to pay extra to have somebody do something they should be doing already.

B. Kelly: I wonder if you are also doing this residue monitoring because you might be going into a global situation where you could export to other countries and this testing would be required to meet some of those other countries' requirements?

Aaronson: I'm sure that's probably an ulterior motive, but it's really secondary to the commitment to food safety. I don't want to stand up here and sound like a commercial for Monfort, but food safety is not a marketing tool at Monfort. We don't go around telling this story to people. Food safety is considered a basic consumer right at Monfort. That is the primary issue, but I'm sure that secondary to that is that we will have to have a data base. And by the way, it's very important that other people in the meat industry, other producers and manufacturers, get their own residue programs up and going so that we can create a data base of chemical residue or the lack of chemical residue data. We need this so that we can take on issues that come at us from abroad or even from the media within. We do not need what happened to the apple industry. If "60 Minutes" wants to come after Monfort, we have 9 years worth of bacteria safety data and 3 years worth of chemical residue data. They better be ready if they want to come after us.

R. Field: There are a few people who go to pristine environments and hunt wild animals. How much data do you have on wild animals?

Aaronson: None. But I would expect to find residue levels there.

Field: I would expect so, too, and I was wondering if you had any data. I know a few of your executives hunt once in a while. Another question is related to some of your data on organic beef. Do you feel like you have a pretty good data base on organic beef and would you care to comment on the pesticide or herbicide levels in that product?

Aaronson: Well, you saw the levels that were up on the slide. They're in the part-per-billion range. There's nothing that comes anywhere near a violation or anything like that. In response to your question, yes, we have a considerable data base presently. There was considerable participation by so-called organic or naturally-represented beef in the study. Once again, the levels aren't anywhere near violation levels, but the one thing that you have to consider is that farmers do a lot of aerial application. Pesticides do not just fall on the field that is being targeted. Wind comes along and takes it or it gets into irrigation water that finds its way downstream. If you analyze certain plants, you will find levels of toxic substances naturally occurring in plants. What the studies showed was that organic beef has the same low levels of residues that feed beef has. In both cases, neither one of them has a residue problem, but they do show residues.

D. Burson: You used a slide that compared implanted and non-implanted estrogen levels to plant sources such as peas and soybeans. I've seen that data used several times and one comment that was passed to me was that maybe that's a unfair comparison because there may be different biological activities of those compounds. Would you care to comment on that?

Aaronson: The only comment I can really make about it
is an example. For instance, Monfort uses an implant with a synthetic form of naturally-occurring estrogen, it's estradiolbenzoate. Once that estradiolbenzoate hits the bloodstream in the animal, it is metabolized into the naturally-occurring estrogen. There is no way for us to differentiate between the naturally-occurring and the synthetically-occurring estrogen. We've tried and you just cannot tell the difference between the two. I don't know if that answers your question.

Burson: I think the concern was that we were trying to compare meat sources of estrogens to plant sources, and we may not be comparing apples to apples.

Aaronson: We might not. But I think that we should look at what's naturally occurring in a male child. You're talking about 1.9 nanograms of estrogen in a 3-oz serving of beef from an implanted animal versus about 41,000 nanograms produced per day in a male child before puberty. If you consider the FDA's 1% rule, you would have to consume 40 lb. of meat a day to reach a level of estrogen which might have a harmful effect. I mean, I like meat, but 40 lbs. a day? I think this relationship is more the point than comparing it to vegetables. It's really not a hormonal issue.