The use of zilpaterol and ractopamine in beef production

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We have a current global population of approximately 7.0 billion people which is predicted to expand to 9.5 billion by 2050. The food industry are implementing future plans in order to meet increased demands for food with the expanding global population. To remain competitive and meet industry demands there is more need for chemical additives in animals such as beef cattle.

The global forecast for beef production in 2013 was 67.5 million tonnes similar to what has been seen over the past five years. The three main producers of beef globally are USA, Brazil and EU respectively.

As it is very difficult to define the actual annual revenue the beef industry gained, it has been approximated using an average price of three main exports for 2012.

Australia, USA and Brazil charged $4176, $4913 and $4492 per tonne of beef respectively in 2012, with an average of $4527 per tonne of beef. This provides an approximate gross annual profit for the beef industry in 2012 at $305 billion.

Use of β-agonists

In both human and veterinary medicine Beta-Adrenergic Agonists (β-agonists) have been used for over 30 years. These substances are commonly used in the treatment of respiratory disorders such as asthma, chronic bronchitis, and Chronic Obstructive Pulmonary Disease (COPD).

The manner in which both natural and synthetic forms of β-agonists act, is through the binding to β-adrenergic receptors on the cell membrane of mammalian tissue cells inducing chemical reactions. As previously stated β-agonists are widely used in the treatment of respiratory ailments where stimulation leads to the relaxation of smooth muscle.

They are similarly used in veterinary medicine also as bronchodilators and tocolytics agents to minimise morbidity and mortality. The problem occurs when the dose administered to animals exceeds the prescribed concentration.

Once the concentration of β-agonists are increased above the therapeutic limit they then have growth promoting effects on the animal.

Taking into consideration the potential profit gain, there is little encouragement required for beef farmers to enhance their product in order to gain higher returns on their herd.

This is where the use of growth promoters such as β-agonists are now commonly used to gain a higher meat yield prior to slaughter. The β-agonists are orally administered to the cattle and will bind to the β-adrenergic receptors to promote protein synthesis and also decrease lipogenesis. This, in turn, will lead to a higher muscle to fat ratio in cattle prior to slaughter. This is an easy way for the farmers to ensure a higher return on their product in a shorter time, with the same food intake.

There are now certain β-agonists drugs commercially available in the USA and other countries for the purpose of increasing the meat yield of beef cattle prior to slaughter.

As stated there is a large market for meat globally and to meet these needs agencies such as the FDA have approved the use of these drugs.

Positive use of drugs

There are two main drugs that are commonly used in beef production due to their positive effects on the animal.

Ractopamine is one of the main growth promoting drugs on the market and widely used. The active ingredient in this feed supplement is Ractopamine Hydrochloride a β-agonist drug. This is fed to the cattle while in confinement over approximately a six week period direct before they are due for slaughter.

This is the expressed feeding period as trials have shown that when this time frame is exceeded the animal will become desensitised to the drug and will start to revert to its original muscle to fat ratio. There is no stated withdrawal time of the drug to animals, which can limit the amount of drug excreted from the system before human consumption.

The second β-agonist drug approved for use in the USA is zilpaterol, where the active ingredient is zilpaterol hydrochloride. Again this is a feed additive given to beef cattle in the same manner as described above including the exposure period and no required withdrawal instructions. This has been authorised for use to increase weight gain and promote leanness in the animal prior to slaughter.

Strict legislation

On a global scale many countries including the EU and Russia, have strict legislations in place banning the use of certain β-agonist drugs from animals for human consumption. There are reported cases of food poisoning and other side effects due to human consumption of beef products contaminated with a β-agonist drug Clenbuterol. Many of the reported food poisoning cases are due to this drug being present in beef muscle or liver.

There are reports of various side effects being observed in both the animal being dosed and humans who have consumed contaminated meat products.

The range of side effects that have been reported from contaminated food with this particular drug group usually affects the central nervous system and also the cardiovascular system. In this case, the group of people affected experienced tremors, dizziness, headaches and tachycardia. This is just one case, there are many which span across various countries such as Spain, China and Italy.

With the combination of this evidence and studies performed, this led to the banning of β-agonists in food producing animals many years ago in Europe.

Health problems

Chronic consumption of contaminated food products can lead to serious health problems such as the development of antibiotic resistance to these drugs. This is also another major global concern with more cases of resistance outbreaks occurring and less treatment options available.

Other issues with consumption of beef containing drug residues are to those who may develop hypersensitive reactions to small concentrations of such drugs. This can lead to severe health issues and in some instances result in death.

There are also incidents with the cattle being dosed with these drugs experiencing serious problems causing heart conditions, foot lesions and, in serious cases, death.

Where situations like this arise investigations are necessary to eliminate larger concerns such as foot and mouth requiring prophylactic treatment of the whole herd to prevent the spread of disease. There are certain instances where the use of β-agonists drugs are allowed but these circumstances are tightly regulated and under strict veterinary supervision. This only encompasses therapeutic uses, such as when cattle are experiencing problems during labour.

There are specific regulations in place to control the use of banned substances in products for human consumption. The European Union (EU) have established Maximum Residue Limits (MRLs) for food products such as meat, fish, eggs and milk.

This specifies the maximum concentration of pharmacologically active substances which are allowed within foodstuffs for human consumption. There are MRLs in place for many veterinary drug used in animals to control the levels of active drug which will reach the consumer.

In instances where there is no set MRL in place this indicates that the drug is a banned substance, it is therefore not tolerated and should not be found in these food matrices or no MRL exists currently.

As countries can now easily import and export goods it is important to monitor the quality of food to protect consumers and identify illegal activity in the food industry. Within the EU there are set MRLs in place, which all countries within and those importing into must meet in order to be able to sell their products.

Screening guidelines

The European Commission have published a document to encompass the definitive guidelines under which validation of a screening method is assessed and evaluated.

To define a criteria which screening methods must conform the legislation 2002/657/EC was created as a universal guide for developers of screening technology. This states the requirements any assay that has claim to being a food screening platform must first meet before it has been passed as a validated technology.

The screening of samples depends on the drug in question and the route of excretion from the body. Commonly in slaughter houses they can either take sample pre-slaughter in the form of urine or post slaughter as a tissue sample, such as muscle, liver or kidney. The purpose of screening these samples is to ensure that they meet the MRL requirements for that country as stated by law.

As stated earlier the use of β-agonists drugs used in animals for human consumption is banned in the EU so there is no MRL in place. In this instance the screening technology that is used to detect the levels of drug residue in the animal samples must be very sensitive and accurate to detect minimal concentrations.

One of the leading screening technologies offered by Randox Food Diagnostics, which is used globally for the screening of veterinary drug residues, is Biochip Array Technology.

This technology is based on ELISA principles where an antibody coated platform is used to bind and detect the presence of specific analytes in beef, urine and various other matrices.

The Biochip is imaged using the Evidence Investigator, which is ideal for food producers, government laboratories and import/ export houses. This is a bench top instrument with various panels available to meet customer requirements.

Available arrays

Among the expansive list of arrays Randox Food Diagnostics offer is the Growth Promoter Multiple Matrix Screen (GPMMS), Ractopamine Only and the Beta-Agonist Array Zilpaterol Only (BAZIL).

Randox Food Diagnostics' GPMMS array can detect β-agonists, Boldenone, Corticosteroids, Nandrolone, Ractopamine, Stanozolol, Stilbenes, Trenbolone and Zeranol. This requires the use of the highly accurate Immuno-Affinity Columns to specifically bind the stated analytes and achieve exceptional recoveries.

The validated matrices available to run on this kit are urine, tissue (muscle, liver and kidney) and feed samples. Randox Food Diagnostics also provide a Growth Promoter Rapid Urine Screen (GPRUS) which has a simple centrifugation and dilution required for urine samples. It can detect the sample analytes outlined for the GPMMS array excluding Nandrolone and Stilbenes.

The GPMMS Ractopamine Only array has a faster sample preparation and specific for beef tissue where the LOD is 0.1ppb. This was developed due to high demands from Randox Food Diagnostics' Brazilian customers. The BAZIL array has a straight forward method for analysis of beef only with a LOD of 0.08ppb.

There have been extensive studies and reports of toxic effects of β-agonists contaminated tissue in humans which has led to bans on these substances in certain countries such as in the EU and Russia.

As there is such a large beef market globally with countries having varied opinions on the use of β-agonists drugs in cattle there is an increased risk of potentially contaminated meat reaching consumers. It is important that regulatory bodies implement the use of MRLs and enforce strict guidelines to reduce and eliminate the use of illegal drugs. To monitor the meat that is transported globally it is very important to establish screening methods of such samples.

With the growing public awareness of what contaminates may be in food and health risks associated it is even more important now to accurately screen samples.

Food safety agencies are much more effective at identifying the source of food poisoning and recording these instances to minimise this type of activity. The importance of a highly sensitive, precise and accurate screening technology with a wide range of test parameters is highly sought after. ■

References are available from the author on request