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BioCop – detecting chemical contaminants in food

Key external stakeholders:

Dairy, beef and sheep farmers; regulatory agencies e.g., DAFF, FSAI, IMB.

Practical implications for stakeholders:

- It is now possible to screen a large series of samples for the biological effects caused by the use of a growth promoting hormone using the BioCop, cost-efficient, protein based biomarker biosensor assay that has been developed.
- Rapid, improved diagnostic methods that are able to detect low concentrations of fluoroquinolone antibiotics have been developed and can be used in a range of animal products, including chicken muscle, eggs and fish.

BioCop addressed the issue of hormone growth promoters because they are banned for use in cattle fattening in the EU. Hormone abuse is a concern from food safety, animal welfare and law enforcement perspectives as residues in meat are a potential health threat, especially for vulnerable populations such as preadolescents. Current analytical methods are restricted, (i) to a limited number of known substances and, (ii) by the relative high cost. Therefore unexpected compounds will be overlooked and the number of samples analysed is limited by the cost.

BioCop addressed the issue of veterinary drug residues in food (fluoroquinolone antibiotics and hormone growth promoters) because overuse and/or illegal use of fluoroquinolone antibiotics in animal production is of particular concern to humans. Repeated exposure to fluoroquinolones, via the food chain, will limit the future effectiveness of these drugs by increasing the risk of antimicrobial resistance developing.

Main results:

- New biosensor assay developed to detect fluoroquinolone antibiotics in different foods.
- A new high throughput biosensor assay was developed to detect the hormone abuse in cattle.

Opportunity / Benefit:

This range of novel screening assays for chemical contaminants in food will provide the industry with a more cost effective, efficient food testing service allowing for an increase in safety and reduction in expenses.

Collaborating Institutions:

Queens University Belfast.

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1. Project background:

The objective of the BioCop project was to supply regulators, consumers and industry with long-term solutions to the complex problems associated with chemical contaminant monitoring.

Rapid and efficient transcriptomics, proteomics and biosensor-based technologies were developed in BioCop. These new systems allow the measurement of the effect of the contaminant(s) rather than single target compound concentrations. The 'biomarker and fingerprinting' concept was key to this strategy. Substantial advances in sample preparation were achieved using novel procedures such as aptamers, microwave-assisted extraction and pressurised liquid extraction. These technologies were validated to ensure that they meet the required standards.

Examples of new analytical systems developed on the project include the detection of pesticides, natural toxins produced by shellfish (paralytic shellfish poisons) and fungi (trichothecenes), therapeutic drugs (hormonal growth promoters, quinolone antimicrobials) and endocrine disrupters (phytoestrogens).

2. Questions addressed by the project:

- Can new effect based technologies be developed to detect contaminant residues in food?
- Is the technology suitable for application in reference laboratories?

3. The experimental studies:

Teagasc were active in Workpackage 8 (therapeutics) and their role was in the validation of analytical methods for detection of antibiotics and growth promoting agents.

A method was developed to detect very low levels of fluoroquinolone antibiotics, including the most frequently used substances such as flumequine, oxolinic acid, cipro/enrofloxacin and norfloxacin. The method has the advantage of automated high-throughput and cost-efficient analysis. The performance of the method was verified in accordance with current EC legislation for the validation of analytical methods. In addition to this, it was shown in direct comparison with established methods such as liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS) and microbiological inhibition tests that the new assay meets and in many cases exceeds the performance of the existing methods. The practical applicability, reproducibility, ruggedness and easy transferability of the biosensor method was impressively demonstrated by an international inter-laboratory method performance study (Nine laboratories from Europe and North America participated in this study). For a set of 42 naturally contaminated samples as well as residue-free chicken, trout and egg samples, all of the laboratories obtained almost identical findings with very low rates of false positive and false negatives (0% - 1%) results.

With view to a biomarker assay for the detection of the effects of illegal hormone growth promoter application, a set of candidate protein biomarkers was identified in Work Package 2. For the most suitable biomarkers, separate SPR biosensor methods were developed and optimised. These were then combined into a multi-analyte high-throughput assay for eight significant biomarkers in cattle blood. The developed testing procedure was subsequently validated, both via a single laboratory validation and a small-scale inter-laboratory method performance study. The protein biomarker biosensor approach was complemented by targeted and non-targeted mass spectrometric profiling in associated tissue, hair and urine samples. As a result of these activities a number of promising markers of hormone abuse were identified.

4. Main results:

- New biosensor assay developed to detect fluoroquinolone antibiotics in different foods.
- A novel biomarker based approach was developed to detect the hormone abuse in cattle. The technology was harnessed in the form of a high throughput biosensor assay. This approach is advantageous because it can exponentially increase the throughput of samples for growth promoter analysis.

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5. Opportunity/Benefit:

- Novel technologies for the cost-efficient and high throughput detection of residues of veterinary drugs will increase the frequency and volume of testing. As a result of this, food safety will increase, bringing benefits for the European consumer. In addition, lower expenses for food testing in the food industry may be reflected in food prices.
- The Food industry will directly benefit from the developed screening technologies for residues of antibiotics. Profit margins in this sector are considerably lower in comparison to other areas, e.g. pharmaceutical industry. The reduction of expenses for the quality control (in this case residue testing) of raw materials, e.g. eggs will have a direct impact on the production costs. The provision of easy to use high throughput screening technology to the European food industry will therefore contribute to increasing their competitiveness.

6. Dissemination:

Main publications:

Fodey, T., Leonard, P., O'Mahony, J., O'Kennedy, R., Danaher, M. Developments in the production of biological and synthetic binders for immunoassay and sensor-based detection of small molecules (2011) TrAC - Trends in Analytical Chemistry, 30 (2), pp. 254-269.

Duffy, E., Mooney, M.H., Elliott, C.T., O'Keeffe, M. Studies on the persistence of estradiol benzoate and nortestosterone decanoate in hair of cattle following treatment with growth promoters, determined by ultra-high-performance liquid chromatography-tandem mass spectrometry. (2009) Journal of Chromatography A, 1216 (46), pp. 8090-8095.

Duffy, E., Rambaud, L., Le Bizec, B., O'Keeffe, M. Determination of hormonal growth promoters in bovine hair: Comparison of liquid chromatography-mass spectrometry and gas chromatography-mass spectrometry methods for estradiol benzoate and nortestosterone decanoate (2009) Analytica Chimica Acta, 637 (1-2), pp. 165-172.

Cunningham, R.T., Mooney, M.H., Xia, X.-L., Crooks, S., Matthews, D., O'Keeffe, M., Li, K., Elliott, C.T. Feasibility of a clinical chemical analysis approach to predict misuse of growth promoting hormones in cattle (2009) Analytical Chemistry, 81 (3), pp. 977-983.

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