Programmed nutrition – the game changer for meat production

by Karl A. Dawson, Director of Worldwide Research, Alltech Inc.

The results of nutritional research and product development at Alltech have led us to rethink the fundamentals of nutrition.

Our latest advances in R&D have been propelled by the new tools available to today's scientists that show how nutrition can be used to sustainably control animal health and performance and improve the quality of human life. Indeed, game-changing visions for the future of nutrition have emerged based on our new realisations:

- Genomes do not determine destiny; nutrition determines destiny.
- Nutrition is a process; we have the tools to program this process.
- Programmed nutrition will necessitate new standards for animal products and human health in the future.

The basics

The story begins with the science of genetics – understanding the genome and the way that traits are passed from generation to generation. This blueprint for all life hinges on a four-letter code and is the platform for our modern understanding of biology.

In 2003, we entered the post-genomic era, with completion of the identification and mapping of the human genome (three billion letters or bases on 23 chromosome pairs). We now know that biological development is not determined by genes, but rather by gene expression, which is controlled by biochemical signals, the environment, and nutrition (nutrigenomics). New terms have emerged: transcriptomics is the use of the microarray to measure gene expression; epigenetics are the changes in gene expression caused by mechanisms other than changes in the underlying DNA sequence.

One example of how external forces alter gene expression is foetal conditioning in response to maternal nutrition. Children of women who are nutrient depleted during pregnancy (for example during times of famine) have been shown more likely to be obese in early adulthood and more likely to develop late-onset diabetes.

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On average, daughters of women who were pregnant during the Dutch famine of 1944-45 were significantly more obese at age 50.

This phenomenon confirms it is possible to condition (or program) nutritional and health responses. This truth has been demonstrated in the laboratory using Agouti mice, whereby genetically identical mice have been conditioned to have dramatically different phenotypes depending on which genes were expressed.

The developmental changes resulting from foetal conditioning are not a consequence of mutational changes to DNA, but rather reflect changes in gene expression independent of nucleic acid sequences.

Programmed nutrition

Now there are the tools to program nutritional processes. By comparing gene expression patterns associated with antioxidant status, Alltech designed the first feed product (EconomasE) to beneficially control gene expression patterns, resulting in improved chicken meat quality.

Likewise, Alltech, have conditioned chicks by altering mineral requirements throughout life by controlling the composition of starter diet. Conditioning based on adjusted dietary mineral content in a low-nutrient diet clearly resulted in greater body weights, greater weight gains, increased feed efficiency, increased calcium adsorption, increased phosphorus adsorption and greater mineral retention.

Conditioning improved intestinal calcium and phosphorus absorption at 32 days of age and increased the expression of the gene for the mineral transporter protein in the small intestine resulting in better absorption throughout the entire life of the bird. Conditioning in the first 90 hours of chick life was shown to determine its ability to use specific nutrients. So, it is not just what we feed, but when we feed that matters.

Nutritional programming of gene expression entails the strategic use of specific ingredients to manage growth and product quality.

Nutritional programming differs from simply changing a feed formulation and suggests a new way to view animal feeding strategies:

- **Pigs.** Programmed nutrition in finisher pig diets has been shown to improve meat colour and quality, dressing percentage, and feed efficiency.

- **Broilers.** Programmed nutrition in broilers has been shown to improve meat quality and lower feed costs. A programmed diet with a lower nutrient content, 25% less energy content, 20% less vitamin E, lower trace mineral content (~25% of standard), and decreased phosphorus and calcium contents is capable of producing meat with higher antioxidant capacity, improved colour, and reduced drip loss, without adversely affecting growth. Thus a lower cost diet can provide similar performance, while reducing environmental impact and improving meat quality.

- **Beef.** Programmed beef nutrition results in meat with lower meat pH; lower MDA (by 50%); improved meat colour, flavour, tenderness, moisture content and mineral status; and lower fat and cholesterol contents. Consumers now have access to a beef product, Alltech Angus, with improved tenderness, lower fat content, improved flavour, and greater consistency. Survey results indicate that 93% of customers will re-purchase Alltech Angus. Producers benefit in that average daily gain is improved by 20% and time-to-market weight is decreased by 30 days.

Future implications

Programmed nutrition will transform the future of nutrition by improving performance, weight gain, efficiency, and product consistency, while reducing the use of antibiotics in feeds, limiting hormone use, and using alternative feedstocks. By programming nutrition, we can ensure that animals will reach their genetic potential.

The ability to control animal health and performance will necessitate new standards for food animal products. We will be called to redefine our expectations for meat based on colour, juiciness, tenderness, and caloric content. Current-day grading standards for meat, initiated in the 1920s, were based on marbling (fat levels). As the quality of our meat improves through the power of nutritional programming, these systems will be limited in their ability to differentiate between the attributes of the products of the future.

Likewise, programmed nutrition has implications up the food chain for human health. We now have the tools to completely change our views on human health.

Imagine maternal diets that will prevent obesity throughout their offspring's lifetime. Imagine a diet for children that will condition metabolism and prevent the onset of diabetes. Imagine a conditioning diet for children that will boost disease resistance and add 30 years to life expectancy. All this is possible through the power we now have through knowledge of the human genome, coupled with the tools of the microarray and bioinformatics.

Together these enable us to understand the interaction between our genetics and our environment.

The stage is set for the greatest advances in nutrition in the history of nutritional science. ■