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Popular Article

Nutrigenomics in Aquaculture

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Introduction

"First, it was smart drugs, now it is smart food; eat right for your genotype and feed right for their genotype"

Scientific technologies are playing a pivotal role in growing aquaculture industries. Innovation and approach of advanced technology in aquaculture play a major role in getting optimum production from any type of aquaculture farming. Basic understanding of growth process is required for making any scientific strategy for enhancing aquaculture production**.** Nutrient is very relevant environmental factor. Nutritional science has long tradition for recommending specific diets to the farmed fishes for getting more production. Nutrigenomics is the application of high throughput genomics tool in nutritional research. Nutrigenomics is the study of "how foods affect genes and how individual differences in genetic makeup affect the ways in which animals respond to nutrients with regard to health". The concept that diet influences health is an ancient one. Nutrigenomics includes known interactions between food and inherited genes, called inborn errors of metabolism, that have long been treated by manipulating the diet. Nutrition is very relevant environmental factor that exerts its effect on the genetic background impairing or improving the likelihood to develop disease. Functional components (Immunostimulants, antioxidants, pre- & probiotics) are being considered in fish nutrition aiming to improve fish growth &/or feed efficiency, stress tolerance and disease resistance. One of the main challenges with the intensification of the farming operations is economic losses primarily due to infectious diseases. Preventive measures are deemed to be sustainable and Food and Agricultural Organization (FAO) has identified research areas viz:

(I) Role of good nutrition in improving aquatic animal health.

(II) Harnessing the host's specific and non-specific defense mechanisms in controlling aquatic animal health diseases.

(III) Use of immunostimulants and non-specific immune enhancers to reduce susceptibility to diseases.

(IV) Use of probiotics and bio-augmentation for the quality improvement of aquatic environment.

(V) To reduce the use of chemical and drugs in aquaculture.

It is now accepted widely that nutritional approaches are essential to alleviate diseases among farmed aquatic animals**.** The concept that better nutrition leads to improved health is very familiar in humans and is applicable to aquatic animals too. A lot of efforts had made to know the relation between nutrients; immune response and diseases. Nutrigenomics is a discipline of functional genomics, which deals with the effects of the diet, and its constituent ingredients, on the genome through the metabolism.

Nutri transcriptomics

Transcriptomics studies the complete set of activated RNA transcripts. The mRNAs are produced by a given moment and in a given tissue of a selected organism; therefore, gene expression varies according to the different circumstances and periods of time. Transcription factors, when activated, migrate to the nucleus and bind to a specific sequence of DNA in the promoter region of genes and, there, act by inhibiting or facilitating transcription. These transcription factors can be stimulated by (i) physiological signals, such as those triggered by nutrients/bioactive food compounds or the metabolites resulting from them. (ii) Hormones, pharmacological treatments, and diseases, among others. They act as sensors regulating/modulating transcription of the cells as needed. In nutrition research, transcriptomics can assist in providing information about the mechanisms or underlying effects of a particular nutrient or diet. It can also help identifying genes, proteins, or metabolites that change in the state of pre-diseases, as well as assisting on recognizing and characterizing the pathways regulated by nutrients or bioactive compounds in foods.

Proteomics

Proteomics is a primordial resource for Nutrigenomics, once that it is the gap between genome sequences and cell behavior, becoming the biological tool used to understand the process of genetic function determination, and of how genome is activated in response to certain diet. Proteomics is the science that studies the complete set of proteins involved in the biological processes of a certain species.

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Nutri metabolomics

The term metabolome was introduced in 1998 by Oliver and defined as a set of low molecular mass compounds present in the cell.It is the scientific approach that can analyse foods and human biospecimens to identify biomarkers of intake and their associations with health.

It is used to identify metabolites diseases that are influenced by nutrients, to develop personalized diet-based treatments, to predict individuals' metabolic dynamics and to apply precision nutrient to disease prevention and management. Example Salmon food specific compounds. Nutrimetabolomic studies employ the following methodologies:

a. Metabolite fingerprinting: identifies the overall nature of the samples. It is not merely restricted to the identifying of metabolites but it also involves the physiochemical characteristic of the samples. The output of the sensors in response to the sample is known as the fingerprinting.
b. Metabolite profiling: involves identification of the metabolites as the analysis is based spectrophotometric and chromate graphic methods.
c. Metabolome analysis: When time dependent resolution-based analysis of metabolite compounds is done, then it is called Metabolome analysis. It involves the study of the entire gamut of metabolites in a sample by synergistic application of various analytical tools.
d. Systems Biology: it carries out the partial or full integration of the transcriptomics, proteomic and metabolomics information specific compounds.

The tools used are chromatography, gas chromatography and capillary electrophoresis for separation of metabolites. Mass spectroscopy and nuclear magnetic resonance are tools used for detection of metabolites.

Some examples of nutrigenomics studies in fish include:

a. Examining how replacing fish oil with vegetable alternatives affects gene expression.
b. Identifying genes involved in lipid metabolism and digestion. Study the effect of environmental factors like temperature and contaminants on fish physiology.

Epigenomics: Epigenomics is the study of complete set of epigenetic modifications of genetic material of a cell known as epigenome.

How it works-

Nutrients and DNA: Nutrients can directly interact with DNA to change gene expression.

Epigenetic interactions: Nutrients can also interact with DNA epigenetically, modifying its structure through methylation and chromatin remodeling.

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Transcription factors: Nutrients can alter gene expression by binding to transcription factors, which control the binding of RNA polymerase.

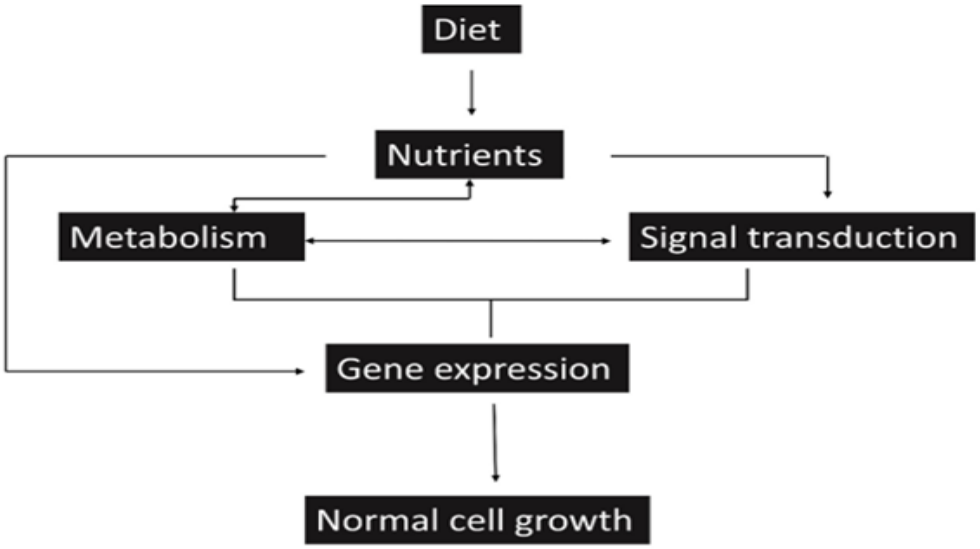
Signal transduction: Nutrients can directly affect signal transduction pathways.

Cellular receptors: Cellular receptors receive and transmit information from nutrients to the cell nucleus or cytoplasm.

Gene expression: The cell nucleus or cytoplasm can then reprogram the cell to adapt to new environmental conditions. This reprogramming can involve changes in gene expression, protein stability, or protein activity.

Benefits of Aquaculture from nutrigenomics research:

a. For evaluation of the response of an organism towards nutrients.
b. Facilitate thorough understanding about a nutrient response in cell nutrients.
c. Diet development by optimizing the dietary nutrient utilization by a particular species.
d. Identify the factors responsible for metabolism. Facilitate to know the organs and tissue specificity for different nutrient utilization.
e. Nutrigenomic studies in Nutrient Transport



Conclusion

The new omics technologies, especially transcriptomics coupled with full genome sequences, offer enormous potential to investigate the complex relationship between fish nutrition and immunity, both in health and disease .The future perspective is to develop the relationship between the nutritional content of aquaculture feeds, fish intestinal microbiota and the resultant metabolites, and how these

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metabolites modified differently by different diets impact fish heath and their resistance to pathogens. These noble technologies need to improved genome annotation, the knowledge of immune cell type-specific responses and mathematical computational expertise, which can then be combined and used to dissect the molecular mechanisms underlying the diet-immunity interactions. By developing these technologies scientists can develop feed with positive effects and produce designed modified fish to fulfil the specific market demands.

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