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Review Article

Omics Driven Trends in Nutrition, Disease Prevention and Better Health

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Abstract

"Omics" based sciences have been recently acquiring significant attraction by the scientific community. Diet and dietary constituents have shown an impact on human health and in the areas such as the nutrition, nutrient-gene interaction, nutritional biomarkers and some nonessential nutrients and bioactive food components that can alter genetic and epigenetic events in the human body. The nutrients are able to interact and modulate the physiological system of the body. Evaluating and assessing the significance of the interrelationships among bioactive food components with the physiological system of the body in the context of Omics (transcriptomics, proteomics and metabolomics) will be of great help in understanding the disease pattern and its prevention. This review attempts at understanding the Omics driven changes happening in the field of nutrition with focus on disease prevention and better health for all.

INTRODUCTION

Nutrition plays a pivotal role in the physiological system. The interaction between the nutrients and the genetic components of the body is well known. Nutrition research has been regarded as a highly integrative science and contributes towards the fundamental role in the maintenance of health and in the treatment of diseases. The effect of nutrient deficiencies, imbalance of macro, micro nutrients and toxic concentrations of food components on health have been the main focus of nutrition research. In the area of food and nutrition, various technological applications have resulted in the discovery of some novel foods. Nutrigenomics has emerged as a novel and multidisciplinary research area based on the identification of Diet-gene interaction which offers an opportunity to develop dietary interventions. This has led to the discovery of "Omic" technologies (transcriptomics, proteomics and metabolomics) which focuses on new vistas and avenues in understanding the biological behavior of the human system in response to external stimuli and also more interestingly the interaction network between nutrients and molecules in the biological system [1].

Food components interact with the physiological system of the body both in the organ and cellular level [2]. There has been a renewed interest in the effect of food, food supplements and nutrition not only on the health but also in the disease prevention and treatment. The role of nutrition in medical management such as disease prevention, progression, prevention of communicable diseases, weight management, optimal bodily function, and

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energy balance is well known and there is a need to understand the nutritional factors that influence them. Proper nutrition offers one of the most effective and least costly ways to decrease the burden of many diseases and their associated risk factors.

Omics refers to the collective technologies used to explore the roles, relationships, and actions of the various types of molecules that make up the cells of an organism [3]. Omics (Genomics, proteomics, and metabolomics) enables one to determine how the specific nutrients interact with the human genes, proteins and metabolites in predicting the health of an individual. Whether it is communicable, non-communicable diseases or obesity related disorders. Omics encompasses all the parameters and provide vital information of the nutritional status. Nutrients can act directly or indirectly in the gene expression [4]. Dietary constituents are considered as cell signaling molecules and through appropriate signaling mechanisms they changes in the expression of gene, protein and metabolite [1,4].

In medical management of diseases and for better health, the top ten nutrition needs can be categorized as:

- 1. Disease progression and nutritional needs
- 2. Nutrition support for special groups and subgroups
- 3. Effective disease management
- 4. Ensuring optimal patient care
- 5. Government policies
- 6. Environmental cues

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- 7. Cultural differences
- 8. Communication tools, social networking and food marketing
- 9. Nutrition and brain functioning
- 10. Imprinting especially in obese children

The American Society of Nutrition (ASN) working group met in February, 2012 and came up with the challenges for nutrition research and science in 21st century.

- 1. Variability in individual responses to diet and foods
- 2. Healthy growth, development and reproduction
- 3. Health maintenance
- 4. Medical management and nutrition
- 5. Nutrition related behaviors
- 6. Food supply /environment (Grand challenges for Nutrition Research)

The Understanding of food supply environment is another concern that is current dietary guidance is effective way of communicating dietary change? The other components of disease prevention and better health includes food assistance programs, role of advertisements, Farm to fork how it affects the food habits, food consumption and novel food ingredient, public / private partnerships etc. Of lately there has been a Multidisciplinary approach to Omics Research. This Multi-disciplinary nature requires collaboration between different disciplines of science to develop knowledge and evidence based nutrition guidance and policies that will lead to better health for all and well-being of world populations.

The Institute of Medicine (IOM), USA recommended that Nutritional genomics holds promise to revolutionize both clinical and public health nutrition practice and suggested the following [2]:

- 1. Genome informed nutrient and food based dietary guidelines for disease prevention and healthful aging
- 2. Individualized medical nutrition therapy for disease management
- 3. Better targeted public health nutrition interventions including micronutrient fortification and supplementation that maximize benefit and minimize adverse outcomes within genetically diverse human populations.

Table	1: So	me	noness	ential	nutrient	s and	bioactive	e food	components
that ca	ın alte	r ge	netic an	nd epig	genetic ev	ents a	are listed	below	[14,17].

Serial Number	Nutrients	Examples
1	Phytochemicals	Isothiocyanates, allyl sulfur Carotenoids, flavonoids, indoles,
2	Zoochemicals	Conjugated linoleic acid, n-3 fatty acids
3	Fungochemicals	β-glucans, lentinan, schizophylan, and other compounds in mushrooms
4	Bacteriochemicals	Equol, butyrate, and other compounds formed from gastrointestinal flora fermentation

OMICS AND ITS RELATION TO NUTRITION

To define the healthy phenotype a major methodological challenge and first prerequisite of Nutrigenomics is to be known in the light of:

- 1. Integrating genomics (gene analysis)
- 2. Transcriptomics (gene expression analysis)
- 3. Proteomics: (protein expression analysis) and
- 4. Metabonomics: (metabolite profiling)

Genomics, refers to "the study of genes and their function". The effects of nutrients at the genomic level are referred to as the Nutrigenomics. It encompasses the effect of genetic variation the interaction between diet and disease. Genetic predisposition is believed to play a major role in determining an individual risk of developing a certain disease [1,4]. There are examples of complex interections between genetics, diet and disease. Nutritional genomics cover the response to bioactive food components, the changes induced by the nutrients on the DNA methylation, chromatin alterations, and the gene expression (nutritional transcriptomics) induced by the various nutrients. Nutregenomics and nutrigenetics are emerging as new area of research as it is becoming increasingly evident that certain diseases such as degenenarative diseases increases with DNA damage which is dependent on nutritional status. Moreover studies have shown that the presence of micronutrients is essential for the prevention of genome damage which is also dependent on genetic polymorphisms that alter genetic functions. Nutrigenetics deals with our genetic predisposition and susceptibility toward diet [3,5]. It aims to understand how the genetic makeup of an individual co-ordinate its response to diet and it considers the underlying genetic polymorphisms. Epigenetics represent DNA sequence- unrelated biochemical modifications of DNA itself and DNA-binding proteins.

Nutrigenomics provides a genetic understanding for how common dietary components affect the balance between the health and disease. Understanding the gene-nutrient interaction, diet, diagnosis and nutritional treatment of genome instability, there is every possibility of preventing and controlling the conversion of healthy phenotypes to disease.

Proteomic is a central platform in nutrigenomics that describes how our genome expresses itself as a response to diet [3]. Proteomics in nutrition can identify and quantify bioactive proteins and peptides and addresses questions of nutritional bioefficacy [2,3].

Proteomics helps in identifying the work in biological system and also in mapping the networks of their physical interactions among with each other nutrients, drugs and othersmall molecules [4]. Metabolomics is a diagnostic tool for metabolic classification of individuals in order to go for metabolic profiling. The investigation is on the quantitative, non-invasive analysisof easily accessible body fluids like urine, bloodand saliva. This also holds true to proteomics with the constraint that this is more complex in terms of chemical properties and dynamic range of compounds present.

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NUTRITIONAL BIOMARKERS

There is a need to understand the relationship between the health and nutrition. Modern nutritional research is aiming at health promotion and disease prevention. Omics addresses how diet influences gene transcription, protein expression and metabolism [4]. Nutritional Biomarkerswill dealt starting from one individual nutritional intake and their responses in terms of genetic make up, environment gut flora, lifestyle etc. to the characterization of responses [3]. The biomarkers such as the single gene, protein and metabolites allows the individual response to thenutrition intake.Metabonomics is a rather diagnostic tool for metabolic classification of individuals. The important asset of this platform is the quantitative, non-invasive analysis of easily assessible human body fluids like urine, blood and saliva [3]. The development of the specific biomarkers would help in identifying the metabolic dysregulation and susceptibility that are influenced by nutritional component of the dietary mixture [3]. It is also presumed that Omics would have the potential of delivering biomarkers for health and comfort, reveal early indicators for disease disposition, helping in finding out responders and non-responders, bioactive and beneficial food components [3].

NUTRITION, IMMUNOLOGY AND GENETICS

As already discussed the nutrigenomics helps in estimating the nutrition-responsive genome activity. The junction between the health, diet and genomicsis defined as nutrigenomics. Studies have reveal that bioactive dietary components have diverse tissue and organ specific effects. These includes gene expression pattern(transcriptome), chromatin organization (epigenome), protein expression patterns including post translational modificatioons and metabolic profiling. Nutrigenomics eventually can lead to dietary intervention aspects and can help in preventing diseases related to diet [5]. The immune system is also regulated by nutrients. Studies have revealed the immunological deficiencies resulting from nutrition deficiencies resulting in compromising an individual's ability to resist infectious pathogens and cancerous growth [6]. Nutrition have direct effect on the immune system and there by influence the normal physiological processes of the body. The release of cytokines, for example due to a nutritional insult compromise the inimmune system and triggers neurological responses. Epidemiogical studies have suggested that nutritional imbalances tend to have a greater risk factor for chronic and degenerative diseases [7]. Genomicsunravel the functions of the different genes and the ways in whichthey interact with food and food supplements. The study of nutregenomics will aid in understanding the increasing genome-diet influences on various diseases. Moreover the effect of nutrition and its influence on the metabolic pathways and the ways and means it is disturbed in the early phase of a diet related disease can be known [8].

THE DIAGNOSIS AND NUTRITIONAL TREATMENT OF GENOME DAMAGE ON AN INDIVIDUAL BASIS

Until recently, nutrition research has been directed towards deficiencies in food and nutrition, but the present era of Omics is in improving health through personalization of diet. Development of dietary patterns, foods and supplements that can improve genome health maintenance with specific genetic backgrounds will help to create new optimum health strategy. Nutrigenetics will help clinicians identify the food component that affect the physiological functions and ultimately can provide an optimal diet for a given individual. This may lead to Genome health Nutritional clinics [9]. There has been a paradigm shift in the biomedical approach of treating disease. Disorders such as obesity, type2 diabetis, CVD, osteoporosis and many inflammatory syndromes has genetic predisposition and shows genetic based differences in susceptibility [10]. Knowledge of the genotype will allow selection of health promoting foods for indviduals. Similarly with the outcome of the Human Genome sequence and understanding the human genetic variations, the investigator in the field of nutrigenetics can now identify the specific DNA polymorphism linked to altered risk of disease or sensitivity to diet [10]. Disease such as cancer are affected with certain nutrients [11]. In exerting the carcinogenetic effects almost all dietary or environmental carcinogens undergo enzymatic biotransformation [12]. The drug metabolizing enzymes are important mediators in regulating the effects of the carcinogens. The deficiency of dietary components have found to disrupt DNA repair pathways and many dietary components such as flavonoids, vitamin E and C that scavange ROS have shown to stimulate and repair DNA damage [11,12]. These dietary constituents affect the post translational events that are important in the prevention of many diseases including cancer [13]. Various nutrients have shown to affect gene expression and to induce changes in the DNA and protein molecule [14]. Studies revealed the nutrient induced changes in DNA methylation, histone post translational modifications and other chromatin alterations. Moreover nutritional transcriptomics studies suggested the nutrient induced gene expression [15]. The study of the Omics would eventually lead to evidence based dietary interventions, genetic variations, epigenetics events and regulation of gene expression to various nutrientswhich would pave a way in preventing or delaying the symptoms of various diseases.

Some basic nutrients and chemicals involved in DNA methylation which may effect on response to bioactive foods causing variable response at cellular levels [15] :

Alcohol	Genistein
Arsenic	Methionine
Betaine	Nickel
Cadmium	Polyphenol
Choline	Selenium
Coumestrol	Vitamin A
Equol	Vitamin B6
Fiber	VitaminB12
Folate	Zinc

OMICS DRIVEN BIOMARKER DISCOVERY IN NUTRITION AND HEALTH

The omics disciplines applied in the context of nutrition and health have the potential to develop and deliver biomarkers for health and comfort, there by revealing early indicators for disease disposition and assisting in differentiating dietary responders and discover bioactive beneficial food components [16]. This may help in the intervention and prevention of disorders such

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as allergy, diabetes, and obesity with appropriate nutritional intervention and nutrient bioavailability.

MOLECULAR TARGETS FOR BIOACTIVE FOOD COMPONENTS FOR CANCER PREVENTION

Dietary habits are important determinant for cancer risk and tumor behavior [17,18]. A Host of food components influence phosphorylation and other post translational events. Bioactivefood components can influence key molecular events leading to changes in DNA methylation and other chromatin alterations [14,17]. A wealth of evidence points to the diet as one of the most important modifiable determinants of the risk of developing cancer [15]. Assessment of biological effect of a specific food or bioactive component that is linked to cancer and prediction of individual susceptibility as a function of nutrientnutrients interaction and genetics is an essential element to evaluate the beneficial effects of dietary interventions. Nutrigenomics studies will provide ample opportunities in identifying the potential targets on how gene expression can be altered or regulated by nutrients intake [19]. Omics focuses on the understanding of interactions and responses by the individual genes with diet and their molecular targets for bioactive food components for cancer prevention.

OMICS FOR BETTER HEALTH AND PREVENTION OF DISEASES

The use of new and innovative technologies, such as nanotechnologies, microarrays, RNA interference will provide newer insights into molecular targets for specific bioactive food components and to influence individual Phenotypes [3,20]. As the era of molecular nutrition unfolds, a greater understanding of how these food and components influence diseases will surely arise. Undeniably to understand the interaction of food components and gene products, there is a need for additional research in the" Omics" of Nutrition. There are many opportunities and many challenges ahead. In the coming years, the Omic technologies (transcriptomics, proteomics and metabolomics) will open up new vistas and avenues in understanding the biological behavior of the human system in response to external stimuli and also more interestingly the interaction network between nutrients and molecules in the biological system. Undoubtedly, the omics will pave a way in providing the dietary recommendations, and shall be of great help in alleviating various diseases of the mankind and in providing better healthcare.

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