Nutrigenomics and nutrigenetics

There has been a long-standing debate whether the fate or characteristics of a particular organism orhuman beingis dependent on theenvironmentor its genetic makeup although scientific data collected in recent years point to the interaction between these two. According to experts in the field, the physical, chemical and behavioral properties of a person can be attributed to the interaction between the blueprint which is genetics and the test site which is the environment. Genetic makeup can be considered a blueprint wherein properties regarding growth and development of an organism is stored and copied while environment can be regarded as the actual dynamism of living and nonliving factors that surround and affect the organism.

Currently, there are two controversial areas of interest related to nutrition, healthand well being, the nutrigenomics and nutrigenetics. These two fields involve the study of implications between nutrition, metabolism and genetic mechanisms. Proponents of nutrigenomics and nutrigenetics believe that nutrition plays a vital role in the metabolic processes inside the body and that there are specificfoodand fluids that are appropriate for a particular genetic makeup.

This paper aims to differentiate between nutrigenomics and nutrigenetics and their role in the current nutrition research. Thegoals, applications and implications will be likewise enumerated. In addition current researches that delve into this area will be included to better understand the future and impact of this controversialscience.

Goals and Implications of Nutrigenomics and Nutrigenetics

According to Mariman (2007) one of the primary goals of nutrigenomics and nutrigenetics is to pinpoint nutrient-dependent health characteristics and nutrition-dependent diseases. This revolves on the fact that certain genetic disorders are triggered by particular food or be relieved by certain supplements. These areas on important nutrient-dependent genetic conditions are the ones gaining foremost attention but there are other research fields that are equally important and can be considered part of nutrigenomics and nutrigenetics.

An example is the search for nutritional strategies to prevent or manage overweight orobesity. The purpose is to find food types that can easily induce satiety to affected persons while providing the needed nutrients at the same time. Another example is studying mechanisms involving food fermentation by primitive organisms in the digestive tract and in an artificial condition.

Such information will be enlightening regarding better and efficient digestion. The other area connected to nutrigenomics and nutrigenetics concerns food composition and performance of quality assessment by studying the interconnectivity of the proteomic and metabolic pathways that will be explained next (Burton & Stewart, 2004; Mariman, 2007).

Undoubtedly, there will be a large impact on the food industry, genetics and disease research all around the world when the direct and exact mechanisms and applications of nutrigenomics and nutrigenetics are laid down through scientific and intensive research (Burton & Stewart, 2004).

Effects of Nutrient on the Genome, Proteome and Metabolome

Nutrition is believed to be influencing the genetic and metabolic makeup of an organism in three basic levels. These are on the level of the genome, proteome and metabolome. Genome is the overall genetic blueprint of an organism. It includes all the genes and other regions of the nucleotide sequences in all the chromosomes that are transferred from the parent to the offspring. According to studies concerning nutrient and genomics, certain genes are either turned on or off by the presence, abundance or absence of a particular nutrient. Severe imbalance in nutrition adversely affects an individual due to the expression of genes that makes that individual susceptible to chronic diseases (Paturel, 2006).

According to Paturel (2006), antioxidants are an example of molecular food components that can extensively affect the genome and gene expression of an individual. Certain diseases such as cancer and health conditions such as aging are believed to be associated to the lack of antioxidants in the diet of affected persons.

Another very important nutrient that can severely affect the genome is folate. Folate and folic acid, which are forms of vitamin B9, play a very important role in the deoxynucleotide acid (DNA) synthesis, replication and repair. This means that absence of this said nutrient can lead to depletion of genetic material, errors in DNA replication and damage to the genome. This lack of folate in the diet can result to severe healthcare problems such as birth defects and cardiovascular disease among important genetic disorders (Meshkin & Blum, 2007).

On the proteome and metabolome level, nutrition also has large impact. An example is the inability to process or digest milk proteins. This condition is attributed to lactose intolerance in persons with disruptions in intestinal enzyme needed to digest dairy products. This condition induces the body to synthesize morphine-like compounds which triggers autism and schizophrenia when absorbed by specific regions of the brain. The goal, therefore, is to design food supplements that would prevent lactose intolerance and consequently prevent autism and schizophrenia (Paturel, 2006).

Differences between Nutrigenomics and Nutrigenetics

Nutrigenomics is defined as a set of technological research and applications involving the elucidation of the mechanisms wherein the genetic program functioning in cells and tissues of an organism is supposedly influenced by the organism’s diet. Muller and Kersten (2003) defines nutrigenomics as the application in nutrition research of high throughput genomics tools by analyzing dietary signals in cells and tissues towards clarification of the impact of nutrition on homeostasis. Simply put, nutrigenomics is the merging of nutritional environment and cellular or genetic functions (Kaput & Rodriguez, 2004).

Nutrigenetics, on the other hand, is the use of genetic variation data correlated with dietary health risks. Nutrigenetics is based on the assumption that there is genetic variation in human populations and that an individual’s response to nutrition is governed by various genes. Thus, nutrigeneticists claim that individuals may react differently on different diets which imply that nutrition-related disorders can be treated and prevent by

modifying diet. This includes identifying those genes that are involved, the differences of these genes in every individual and the applications for health and disease in the population setting.

The above definitions give a clear view of the differences between nutrigenomics and nutrigenetics. Nutrigenomics looks at the whole response of the genome on particular diet or nutrition. Studies conducted under nutrigenomics use a set of individuals who are largely dissimilar in metabolic responses to particular diet. For example, research related to obesity uses those that are not susceptible to the said condition versus individuals that have obesity or chronic obesity.

Using different types of nutritional setup or specific food groups, scientists aim to provide the metabolic pathways that are specific to developing obesity or resistance to such tendency. Another example isdiabetesor cardiovascular disease wherein individuals who are found to have high risks on such diseases are examined on their reaction to particular diet or nutrition. Other examples of single gene traits that have large healthcare impacts are those involved in phenylketonuria and galactosemia (Kaput & Rodriquez, 2004).

Nutrigenetics, on the other hand, looks on the population response to diet or nutrition. Sequence variations are detection through molecular studies. An example of such molecular tool is the study of single nucleotide polymorphisms (SNPs). These changes in the nucleotide sequence of subjects can lend an explanation on the reaction of particular individuals in relation to the reaction of other individuals.

Persons with this changes or SNPs may have crucial substation leading to a health care condition. For example, a cytosine-to-thymidine substitution may cause an increase in the levels of homocysteine in the plasma which increases a person’s risk of acquiring venous thromboembolic disease and neural tube defects (Subbiah, 2006).

Since the two areas of research differ on the part and extent of patient characteristics, therefore the tools and applications largely vary. Nutrigenomics involve various technological implements to ascertain the expression of target genes. Nutrigenomics uses mRNA profiling, protein profiling, metabolite profiling, gene expression tests and other molecular tools. The goal is to determine the presence of a particular enzyme, protein, by-product or metabolite in the cells, tissues or system in the subjects subjected to nutrients being tested (Mariman, 2007).

On the other hand, nutrigenetics requires the use of genetic polymorphism tests such as isozyme or nucleotide sequencing. The aim is to detect changes or polymorphisms in a person that is divergent from that of the population. Of important interest is placed in cases of known conditions arising from nucleotide changes such as the one mentioned above involving cytosine-to-thymidine substation which resulted to neural tube defects (Kaput & Rodriguez, 2004; Subbiah, 2006)

Obviously, since the target areas of nutrigenomics and nutrigenetics are very different from each other, the intervention strategies or treatments should also be divergent. Whereas personally-tailored nutrition and supplements should be given to patients in nutrigenomics the nutrients or supplements to

be given to nutrigenetics subjects may be less specific. For example, for those suffering from galactosemia and phenylketonuria, appropriate foods are to be given to avoid or prevent the negative effects of these health conditions (Wallace, 2006; Kaput & Rodriguez, 2007).

Nutrigenetics, on the other hand, covers a large portion of the population wherein functional foods and supplements may be made available to the market for people who have the risk, as tested by polymorphism detection, of a disease or health condition such as cardiovascular disease or obesity. Supplements that lower cholesterol that adversely affects certain groups may be taken as prescribed by physicians (Meshkin & Blum, 2007; Subbiah 2006).

Current Research in Nutrigenomics and Nutrigenetics

Novel research on folate nutrigenomics research highlighted the importance of this vitamin in the development of humans such that absence can invariably lead to birth defects. Research by Meshkin & Blum (2007) found high association between folate and cardiovascular disease and birth defects reduction. They were also to able to find the genetic influence on folate. Studies such as this led to the review of current policies regarding one-size-fits-all government approach of folate and folic acid supplementation.

Chen et al. (2007) found chromium picolinate to have anti-obesity nutrient traits since it affects body composition and reduces weight in humans. They achieved this by genotyping the dopamine D2 receptor gene using standard polymerase chain reaction techniques. Using placebo and different treatment of chromium picolinate, the authors found the significant therapeutic effect

of the said nutritional compound in influencing weight loss and reduction in body fat. Their results established the need for DNA testing for this application.

Heuvel (2007) conducted a research regarding the effects of pistachios on cardiovascular disease risk factors. His research included effects of pistachios on lipoproteins and lipids, apolipoproteins, insulin, blood pressure and genetic expression of various genes among other related factors. Results showed that cholesterol reduction diet with pistachios greatly improved the efficiency. In addition, increasing pistachio dose also increased the benefits in decreasing the cardiovascular disease risk on subjects. The said research was achieved by considering the different risk factors in a nutrition genomics experiment. Aside from this study, the author has other proposed experiments including the effects of walnuts on hypercholesterolemia and peanuts on cardiovascular health.

Holick (2006) reiterated available and extensive evidence on the importance of vitamin D related to prevention and treatment of rickets, osteoporosis, type 1 diabetes mellitus, many common cancers and hypertension. His paper put importance on sun exposure and vitamin D supplements to avoid vitamin D deficiency and avert succumbing to various diseases which apart from the above, includes also psoriasis, multiple sclerosis and cardiovascular disease among others.

Researchers from the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) are currently in search for answers regarding celiac disease, a disorder wherein a person cannot tolerate a protein in wheat, rye,

barley and oats called gluten. Aside from designing diet that would be beneficial for patients suffering from celiac disease, these researchers are also in the hunt for the responsible chemicals in the destruction of the function of the immune system. They are engineering enzymes that can neutralize or destroy immunotoxic peptides produced in affected persons by establishing the environmental and genetic aspects of the disease (NIDDK, 2007).

Above advances in the nutrigenetics and nutrigenomics research are indeed fast paced and covers multiple fronts due to the large impact of their results to the food, genetics and healthcare industry. What is very noticeable is the specific focus of each research team on particular areas in individual disease or disorder. Their studies are more focused because the causes already been identified by the involved pathways or gened. This is due to the fact that causes have been pinpointed to the key genes or pathways involved. For example, folate, chromium picolinate and vitamin D in the enumerated researches above have been isolated by workers in these fields.

One noticeable pattern, however, is the prominence of nutrigenomics over nutrigenetics. There are more research activities being conducted tackling the effect of nutrition on the genome reaction. More gene expression, metabolic pathways and proteomic analyses are being performed than genetic diversity tests in relation to nutrition. In other words, the approach of nutrition genomics is currently more adapted to personalized diet design since this can be considered a quick fix.

However, the trend is not towards the dominant use of nutrigenomics. Instead, there is a need for nutrigenomics and nutrigenetics to be used in combination. This is because nutrigenomics can put solutions on the gene, protein and metabolic level of the disease but those that are suffering from various disorders are not isolated or few.

There are large proportions in the population who are affected by diseases like cancer, cardiovascular disease, chronic obesity, diabetes or celiac disease and each patient is unique and groups in every population are also deemed to be unique in their own genetic makeup. Since nutrigenomics can be used to develop quick-fix diet but not in a population level. This is where nutrigenetics should come in.

In summary, nutrigenomics and nutrigenetics are two differing fields of modern nutrition and health science with a very large impact on the food and healthcare industry. Nutrigenomics aims to help individuals overcome disorders or disease by identifying key genes, proteins and metabolic pathways and providing appropriate diet or supplements while nutrigenetics tackles the variations in populations related to diet and nutrition dependent disease or disorders.

Current researches delve into the specific effects of food and nutrition to the risks and development of known disorders such as cancer, diabetes, cardiovascular disease, obesity, birth defects and many others. Although there have been more work being conducted in nutrigenomics, combination with nutrigenetics is seen to have more beneficial results for patients and other people that are at risk to the said healthcare problems.

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