

Towards the Genomization of Food? Potentials and Risks of Nutrigenomics as a Way of Personalized Care and Prevention

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Towards the Genomization of Food? Potentials and Risks of Nutrigenomics as a Way of Personalized Care and Prevention

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Abstract

The paper examines the increasingly pervasive genomization of food, understood as the redefinition of food consumption according to the needs for therapy, disease prevention, and enhanced wellness determined by the characteristics of an individual's genetic heritage. From this perspective, food is not only medicalized (reconceptualized in relation to its connections with health and diseases), not only pharmacologized (monitored in its physiological effects on the organism), but also genomized (consumed on the basis of correlations with the individual genome).

The medicine of care and prevention thus finds a further field in which it can overlap with the medicine of human enhancement, even it is one of the most ordinary and fundamental fields of everyday life. Although the genomization process is still ongoing, it appears advisable to focus on its potential and limitations, with a view to targeting control by the public authorities and welfare systems.

Keywords: food, nutrigenomics, medicalization, pharmaceuticalization, pharmacologization, genomization.

Introduction

Genetics is a branch of biology that studies the processes by which the traits of living organisms are transmitted through heredity. The discipline's origins date back to the distant past: its first bases were laid in the mid-1800s by G. Mendel, who developed the concept of 'decisive hereditary trait'. However, it was in the next century that genetics consolidated itself by

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shifting from a 'classical' to a 'molecular' framework. Put forward in 1910, in fact, was the hypothesis that the chromosome contained the genes, and in 1953 the structure of DNA was discovered. With the development of techniques enabling identification of the DNA sequence, genetics was replaced by genomics, a discipline that studies the overall system in which the individual genes are located and isolates their various functions. After 2003 – the year in which the mapping of the human genome was substantially completed – there ensued the rapid development of its applicative potential.

Pharmacogenomics and nutrigenomics consolidated themselves within this scenario as subdisciplines engaged in identifying the genes that supervise the metabolism and whereby every substance, whether a synthetic drug or a nutrient, is first decomposed and then re-synthesised into the new molecules on which the existence of the organism depends. Understanding the function of such genes means being able to devise a pharmaceutical treatment or a nutritional regimen of much greater efficacy.

After examining the epistemological and social changes that these scientific advances impose on diet (Section 1), the paper explores the process by which the consumption of food is conceptualized within an increasingly biological semantic mainly concerned with the interactions between nutrients and the individual's genomic structure. This is a process with enormous potential as regards therapy, disease prevention, or the enhancement of health (Section 2), but it is also accompanied by political-social risks which must be kept under control (Section 3) in order to create a system of health care and promotion that is fair and accessible to all sections of the population.

1. The genomization of food

As well known, individuals respond in different ways to drugs, just as they do to nutrients. In the case of drugs, physicians must optimize a dosage regimen for an individual patient by a trial-and-error method, even if mostly within the range of the patient information leaflet. This approach may cause adverse drug reactions in some patients, and this confronts medicine with huge problems: suffice it to consider the 2 million cases of adverse reactions recorded every year in the United States, over 100,000 of them leading to death (Lazarou et al. 1998; Daniel et al. 2006). Also in the field of nutrition, foods known to cause specific adverse reactions in some genotypes are also well documented (Ghosh et al. 2007): e.g. gluten in Celiac disease (Evans 2001) or lactose intolerance. Hence, the aim of both pharmacogenomics and nutrigenomics is to individualize or personalize medicines and food and

nutrition, and ultimately health, by tailoring the drug or the food to the individual genotype (Ghosh et al. 2007).

The factors that govern this variability indubitably reside in the ways in which a disease alters the organism's physiological processes (pathogenesis), the interaction between the pharmaceutical and nutritive principles, age, the individual's overall state of health, and the correlated renal and hepatic functions. In light of studies on the human genome, however, it becomes increasingly evident that it is the hereditary characteristics of the metabolism that largely determine the efficacy of the aforesaid substances, as well as their toxicity (Blum 2006).

The implications of what Blum calls – probably with excessive confidence – a “new era” are of importance for pharmacology and the nutritional sciences, on the one hand, and for the social-cultural meaning of food and diet on the other. However, whilst for the former the evolutionary advance is coherent with the epistemological approach that governs it, on the social level a more radical change has come about.

As regards pharmacogenomics, Ghosh and colleagues clarify that it “can be described as an approach to pharmacology that (...) uses genomic techniques to study drug functionality and discover new drug targets, genetically high based throughput screens to discover new drugs and large-scale genotyping to characterize and analyze the research and treatment populations. Thus, pharmacogenomics uses genotyping to screen populations in order to determine which drugs would work best in human subpopulations in curing or preventing a disease, as well as using various genomic technologies (e.g. gene expression) to understand how the drug is interacting with the genotype. The older term pharmacogenetics differs from pharmacogenomics only in the technologies used and in the breadth of scope of the genes studied” (2007: 567). Because pharmacogenomics studies the entire genome system, it is characterized by the adoption of mathematical-statistic methods able to incorporate the complex information emerging from analysis of the various genes and their mutual conditionings into a logically consistent model.

As regards nutrigenomics, this discipline seeks to elucidate the interactions between genome and diet. Given its functional approach, nutrigenomics is interested in the molecular processes of life, rather than the molecular structure of life. In other words, “it is not the gene per se that is critical, but the interaction between the gene and the wider cellular environment” (Harvey 2009: 122). In fact, “there are very few phenotypic traits for which a gene is the sole causal factor, and very few diseases where a genetic element is necessary and sufficient” (ivi). The challenge is

understanding how the complex interaction between the broader genome and its nutritional environment determines the risk of pathogenesis.

It is evident from the above definitions that both disciplines adopt, and indeed develop further, an epistemological approach of bio-medical type which studies disease and its treatment in light of the bio-physiological dimensions. Their development, however, has caused radical changes in another symbolic sphere, which concerns the socio-cultural meaning of diet.

With the recent development of ‘nutraceuticals’, a portmanteau word formed by merging ‘nutrition’ and ‘pharmaceuticals’, and which denotes the study of foods with beneficial effects on health, the concept of food has changed its traditional meaning. In fact, food is no longer understood as consisting solely of substances that the organism can assimilate for generic nutritional purposes. The neologism ‘nutraceutical’ instead refers to foods performing a specifically therapeutic or preventive function (Kim 2013; Koteyko 2010; Niva 2007; Viviani 2012). Thus, food becomes medicine as well, and this gives rise to further semantic shifts.

With reference to the debate opened by Illich (1991) and developed by Conrad (2007) and Zola (1972), we can interpret this change as indicative of the progressive medicalization of diet, so that the consumption of food departs from everyday routine and assumes meanings akin to treatment, prevention, or the enhancement of health.

Nevertheless, according to Abraham, the phenomenon also assumes the more specific features of pharmacologization (or “pharmaceuticalization”), which can be defined “as the process by which social, behavioral, or bodily conditions are treated, or deemed to be in need of treatment/intervention, with pharmaceuticals by doctors, patients, or both” (2010: 290). Through nutraceuticals, in fact, a normal condition is not only redefined as susceptible to therapeutic treatment, prevention, or enhancement (for instance, the presence of calcium in the bones to be kept at suitably high levels, or cholesterol in the blood to be instead kept at the lowest possible levels, the intestinal bacterial flora to be cultivated, and so on), but such treatment also involves foods with specific natural or synthetic additives whose efficacy has been ‘verified by’ bio-pharmaceutical research. The inverted commas are mandatory because – as Abraham points out – the consumption of such foods is often advocated, not by medical science, but by industry stakeholders, practitioners, and patients themselves (Llavinés 2013).

Moving from nutraceuticals to nutrigenomics is presumably to move from the pharmacologization of food to its genomization, in that control of its biochemical effects on the organism becomes radically more pervasive.

First to be emphasised is that these effects are measured at genomic level: that is, they are measured in correspondence to the factors decisive for the evolution of life, wellness, and disease.

These effects are observed as they operate in two directions: the first is when the assumption of food is modified by the genomic system and the processes whereby it regulates the metabolism; the second, opposite, direction is when food actively modifies the genomic system and its functions (Corthesy-Theulaz 2005, Evans 2001, Ghosh et al. 2007).

Control of these effects is also exercised on individual bases. Nutrigenomics provides a framework for the development of genotype-dependent novel foods that will promote health and prevent and help manage chronic diseases (Ghosh et al. 2007), bearing in mind the specific functionalities which characterize the genetic heritage of every person.

2. Between prevention and enhancement

The advent of nutrigenomics has produced important changes, especially as regards disease prevention. It was emphasised above that the systemic approach of nutrigenomics does not simply focus on the relationship between a gene and the dietary compounds; rather, it looks at the complex interactions between many genes in the genome, in the context of their nutritional milieu (ivi). This focus on the global genotype allows a holistic approach to be taken to disease prevention, identifying not just the risk of one particular disease but ensuring overall good health (ivi). “Analyses must be able to predict the likelihood of future diseases within the context of an individual’s overall health (...). It is not sufficient to reduce the risk of one disease if in so doing the risks of another are increased. (...) Health is comprehensive; therefore, assessment must also be comprehensive, using techniques that allow integration with whole-body metabolism to predict phenotypic outputs of metabolic pathways” (2009: 123). The understanding here – Harvey concludes – is of the body as a functional whole rather than a collection of individual components.

This holistic approach has applicative possibilities at both macro and micro level. As regards the former, “the existence of linkages between gene variation at the level of the population sub-group, diet and health underpins the notion that it might be possible to design dietary recommendations, or indeed functional (i.e. health promoting) food products, for specific sub-groups” (ibidem: 125). As regards the latter, “the sequencing of the human genome laid the foundation for (...) an evidence-based understanding that while human individuals are genetically similar, each retains a unique genetic

identity underlying the wide array of biochemical, physiological, and morphological phenotypes in human populations” (Kaput et al. 2005: 624). In other words, “while genes may link you to your family, race or indeed the human species, the particular combination of genes that makes up your genome is unique to you. As such, each individual is uniquely at risk of developing diet-related disease (...). Once such correlations are established, functional genomics can be applied to unpicking the mechanisms of gene function and gene regulation by which phenotype is produced through interaction of genome with environment, so understanding not just how we are (through the unique weakness of our genomes) uniquely at risk of disease, but also what we can do to prevent that risk being realized. Nutrigenomics, then, as functional genomics, takes up from molecular biology a concern with understanding how the gene and its environment operate together in the cellular processes of life» (Harvey 2009: 126). On these bases it becomes possible to suggest what actions an individual can take to ameliorate this risk by altering the nutritional environment in which one’s genome operates (*ivi*).

Although the findings of genomics grow increasingly accurate, every diagnosis is still inevitably uncertain (Rose 2006), and it is generally not possible to establish either when or with what severity a pathology will develop. This requires translation of the risk of pathogenesis from the level of the population to that of the individual, on the basis of such factors as family history, lifestyle, age, and gender. “The aim is to produce a probabilistic risk estimate for the individual, in numerical form, such a desire for quantification coming both from the scientific rationality that sees such quantification as a guarantee of objectivity and from patients who seek certainty in numbers” (Harvey 2009: 127).

There thus takes shape a risk to wellness which is temporally indeterminate, and in regard to which unprecedented responsibilities arise for its control (Rose 2006). This is a liminal, pre-symptomatic, situation of potential, though not certain, illness, and with respect to which, as several authors stress, the individual must adopt an increasingly active role (Novas, Rose 2000: 490; Harvey 2009, 2010).

As Harvey emphasises, nutrigenomics deals not with probability but with uncertainty. In fact, the risk does not concern one single gene, as it does in the genetic sciences. In genomics, “the gene is one factor among many others specific to the individual that together suggest a possible future – one that can be free of disease, if we attend to the task of ensuring our genomes are provided with a proper environment in which to function” (Harvey 2009: 128). Hence, the uncertain future cannot be predicted by using the risk techniques of statistical calculation and probability estimation.

“Although such uncertainty can be viewed as offering nothing but a relentless descent into chaos, as in the ‘risk society’ thesis developed by Beck (1992)”, nutrigenomics – again according to Harvey – “makes room for individuals to create their own future – not simply to take an active role in managing a future revealed through genetic testing, but to produce a new future for themselves through their own entrepreneurial activity, as health-creating not simply health-seeking individuals” (Harvey 2009: 128). From this perspective, individuals can be considered “genetic entrepreneurs [who] will employ susceptibility testing and personalized dietary advice to create a future that maximizes their ‘vital capital’ by ensuring the optimal functioning of their unique genome” (ibidem: 130). Through a diet and a lifestyle personalized according to the individual’s identity, nutrigenomics aspires to being a discipline that, besides identifying the risk of pathogenesis, also suggests how to become “optimally healthy” (Harvey 2010). In the above-mentioned genomization of diet, therefore, preventive medicine is increasingly bound up with the medicine of enhancement, because “wellness becomes an enhancement of our corporeality at the molecular level, our genetic functioning. Knowledge of the specific weaknesses in one’s genome (provided by a nutrigenomic test) allows one to be proactive in taking steps to counter that weakness, providing one’s genome with the best possible environment to maximize its functioning (by following a personalized diet), so attaining a new state of health specific to one’s genomic individuality” (ibidem: 129).

2. Emerging uncertainties

Analysis of the interrelation between the human genome and food certainly gives the medical sciences unprecedented therapeutic and preventive potential. However, this potential is overshadowed by the enormous complexities surrounding the genome and the possible applications of nutrigenomics. The mapping of human DNA has in fact shown how difficult it is to clarify the reciprocal conditionings among more than 22,000 genes, and then between these and the nutrients with they come into contact in ecological and social settings. An even more complex task is determining how such interactions can have specific effects on the health of human groups and individuals. “The literature on the influence of nutrients on health is therefore replete with contradicting evidences” (Korthals, Komduur 2009: 436).

To be emphasised is that the results of diagnostic tests indicating a ‘pre-disease’ are often highly uncertain, to the point that their identification is premature: “there is quite a lot of chance that a ‘predisease’ won’t develop into a disease due to the normal reactions of the body [and that] the companies

that currently offer these tests on the market (internet or elsewhere) are mostly not very reliable” (ibidem: 440). Various analyses conducted by public authorities such as the Food and Drug Administration confirm this need to give greater guarantees to citizens (Frood 2010; Ng et al. 2009).

A second uncertainty concerns dietary advice and preventive measures based on risk analysis. With what probability can the adoption of specific healthy lifestyles or consumption habits reduce susceptibility to particular diseases? It is important for the individual to know the real validity and experimental reliability of such suggestions.

Thus far in the discussion, uncertainties of a cognitive nature have been stressed. But the psycho-social implications should also be borne in mind. As Korthals and Komduur emphasise, “it is uncertain to what extent risk indications about obesity and diabetes and other vulnerabilities really influence people to live healthier and therefore help to prevent these conditions” (2010: 441). In fact, the broader debate on the factors decisive for good health and the relative lifestyles has demonstrated how the “health behavior of people is uncertain to what extent risk indications (...) really influence people to live healthier and help to prevent these conditions” (ivi). The switch to a healthier lifestyle depends, besides structural variables such as economic and cultural resources, also on the extent to which awareness of the risk is shared in everyday life networks, from formal ones (relations with healthcare practitioners) to, especially, informal ones (family, friends, etc.), in that the latter exert a stronger psycho-emotional impact (Katz 1957, Mauro 2007, Rogers 1983).

At a more general level, also to be considered is how diverse institutions and professionals (e.g. governments, insurance companies, dieticians and general practitioners, food companies, retailers) regulate the production of information about the risks of a genome based nutrition. On examining with a qualitative approach the webpages of companies that sell direct-to-consumer genetic tests, Saukko *et al.* point out that a new “surge of products with an ambiguous status vis a vis medical and consumer goods” is emerging (2010: 752).

A first problematic aspect to consider concerns the costs that an individual must sustain in obtaining a genomic profile which identifies his or her hereditary health risks. At present, the genome test kits offered by private companies (e.g., deCODEme, 23andMe) are becoming cheaper, at least in connection with a basic and standard offer; but when the request is related to specific tests, they can be very expensive. Consequently, without intervention by the welfare system, there may arise disparities in access (van Trijp, Ronteltap 2008). Some authors speak of ‘genomic divide’ in this regard (Ghosh et al. 2007).

From this perspective, the bioethic debate helps to distinguish the problems, but also to focus on new questions. When nutrigenomics is used to treat or prevent diseases (e.g. diabetes, cancer, etc.), new responsibilities should arise for the welfare system (Daniels, in Maturo 2012: 109) in order to ensure that all segments of the population have the right to access these services, even with financial support if needed. But when nutrigenomics has applications more similar to human enhancement (e.g. cognitive, physical or aesthetic characteristics and connected performance), what approach should the welfare system take? Some authors, such as Segall (ivi), argue that it should commit to these as well, at least if there are unfavorable situations which it is reasonable to expect that individuals wish to avoid (luck egalitarianism). Other authors (Maturo 2012: 110), however, argue that the optimization of individual productivity is not a social right as strong as the right to care or prevention. Therefore, it should not be guaranteed by the welfare system.

We agree with this second position. But with respect to the specific topic of nutrigenomics, the problem is still not solved, for two main reasons. On the one hand, it is not always easy to determine what functions are to be classified as pathological (to treat or prevent) or normal (to be optimized). On the other hand, pathology and normality are flexible and often overlapping concepts: what is considered normal today, tomorrow may be redefined by society as pathological. Hence, the debate on nutrigenomics and the right to health remains open.

Further issues arise when tests for susceptibility to a disease and the relative nutritional profiles are furnished by private companies – even if these are contracted to the public health system – they may attempt to persuade potential customers to purchase their services by furnishing misleading information. In this case, “nutrigenomics-producers acting according to Corporate Social Responsibility codes can give consumers some assistance in deciphering marketing slogans and claims” (Korthals, Komduur 2010: 451; Ozdemir, Godard 2007).

Also necessary is careful supervision of the procedures with which health information is handled. In order to obtain professional support, the results of genomic tests must necessarily be divulged to third parties: while “the genetic information is stable over time, (...) consumers may be uncertain where information about their DNA will be stored and whether it may be used against them. As a result, risks of loss of privacy, loss of employment or insurance will be likely consumer concerns. They may also experience personalisation as an undesirable interference with personal preferences, and as an attempt by marketers to persuade them” (Rontentalp 2007: 13).

Further issues concern the functions that health professionals perform in consultation with persons who have been subject to genetic tests. As Harvey

underlines, it is often “envisaged as providing some ‘hard figures’, a concrete estimation of risk. Such a vision contrasts with the existing format of genetic testing, where the presence or absence of a genetic marker does not itself confer a specific degree of risk, but is a factor that is considered by the clinician alongside other relevant risk information (...) in making his/her judgment as to whether the person is ‘at risk’” (2011: 323). In the case of monocausal diseases due to the existence of a limited and defined number of genes, consultation with a specialized geneticist is essential. In this regard, as Harvey points out in her qualitative research, already present among practitioners is widespread awareness of how to furnish support that helps the person understand the implications of the test. When instead the test is performed to determine potential association with multicausal diseases, as in the case of nutrigenomics, another field of medicine is entered, one very similar to primary prevention and in which mainly general practitioners (GPs) are involved. A greater ‘knowledge deficit’ is apparent in this sector, given that “it has been reported that GPs recognize that they are likely to have to deal with genetics, but are concerned that they lack the knowledge and skills, the conclusion being that education of expensive primary providers in genetics is necessary” (ibidem: 321). In fact, primary care must be considered the proper place for generic susceptibility testing which allows identification of a person's specific risk of disease. The role of GPs is therefore to care for the individual and their skills at dealing with this risk (ivi). The objective is to empower citizens in making appropriate dietary choices based on the results of their genetic analysis (Harvey 2010). This is not easy because it stands at the point of intersection between conflicting demands: on the one hand, those of the welfare system, which seeks to ration resources by paying for treatment only where there is adequate clinical evidence to justify it; on the other, those of citizens prompted by a growing culture of medicalization and health enhancement to request closer controls on all forms, even potential ones, of disease, as well as to strengthen their own psycho-physical functionalities for increasingly effective performance.

Conclusions

We are heading towards a society that, as Maturo (2012), claims, can be defined as increasingly ‘bionic’. In fact, firstly, one witnesses an increase in both the possibilities and the demands for the use of technology to transform human biology. Secondly, “not only do we act on the biological, we also ‘think’ in biological terms” (ibidem: 17). Medicalization, or the transformation of individual and social conditions once considered ‘normal’ into medical

problems, is increasingly common, and it permeates all the dimensions on which sickness can be studied. It is apparent in the case of sickness understood in organic terms (disease), where not only the diagnoses of pathologies but also the relative professional assessments are anchored to a bio-physical semantic. It is apparent at psychological level (illness), where the individual perception of pain (experienced illness) as the experiential re-elaboration of the sickness (semantic illness) again draws on bio-physical language to reconstruct its sense (Barker 2012). And it is apparent at social level, where both the institutional recognition of sickness (sick role), and its social representation (sickscape) found their legitimacy upon bio-physical bases (Maturo 2007: 122, Sontag 1977).

In this scenario, the study of nascent nutrigenomics allows the aforesaid bio-medicalization to be further specified as the genomization of everyday life. As “science that investigates interactions between genetic and nutritional variables and how those interactions produces ill health” (Harvey 2009: 120), nutrigenomics allows practices of disease prevention as well as of wellness enhancement to be guided by a specific biological template: the system of hereditary traits inscribed in the chromosome.

This system has two main features: first, it forms the basis of life and therefore performs a crucial conditioning function; second, it is a system that, notwithstanding the similarities among the humans in the membership group, remains irreducibly personal.

This makes it possible to devise nutritional strategies for therapy, prevention or enhancement of much greater efficacy because they are no longer based on evidence drawn from broader social groups, but instead on the specific characteristics of the individual – with the further benefit of averting the negative effects of the trial-and-error procedures that the pre-genomic sciences necessarily had to follow.

Again according to Maturo, the bionic society has a third feature: in it, action is taken not only to treat what has been discovered/constructed as pathological but also to enhance what is normal (2012). The advent of nutrigenomics allows further specification of this scenario: food is not only ‘pharmacologized’. The attribution of a therapeutic function to foods on the basis of specific technological treatments has, in fact, already been made by the much-debated ‘nutraceuticals’. After being ‘medicalized’ and ‘pharmacologized’, food is also, so to speak, ‘genomized’ in the sense that any nutrient of everyday life can be reclassified according to its effects producible on the basis of the specific characteristics of the hereditary system. Contemporary individuals – definable according to Harvey (2009, 2010) as a ‘genetic entrepreneur’ – can therefore regard food as medicine able not only to cure disease but also to prevent it and to improve wellness, this last being no

longer understood solely as the absence of disease but also as the optimization of health. Hence, contrary to what Harvey contends, the advent of nutrigenomics not only helps to strengthen the capacity of citizens to control the weaker aspects of their genes; it also paves the way for the modification of the self according to purposes that extend beyond care or the prevention of disease. The medicine of care and prevention thus finds another field in which it can overlap with the medicine of human enhancement, even in one of the most ordinary and fundamental fields of everyday life.

After the first enthusiasm, therefore, critical examination of the literature requires a scaling-down of expectations placed in the genomic sciences, especially in the short term. In a scenario where biology seemingly assumes a leading role even in an apparently elective domain like diet, sociology is called upon to perform an essential function of observation and criticism. In fact, as soon as the social implications of genomization are considered, manifold problems arise in terms of unequal access to therapeutic/preventive measures, stigmatization, mystification of information for commercial purposes, adequacy of professional support, and so on. But upstream of these phenomena one discerns a more general risk already highlighted by critical thought (Ussher 2011): that of the 'de-politicization' of health, or the growing tendency to claim that the causes of illness, as well as its possible remedies, lie mainly at biological level, indeed in the genome itself, with the consequent neglect of the array of psycho-relational, organizational, and cultural factors for which the community and the institutions continue to bear fundamental political-social responsibility.

From this perspective, it should be borne in mind that the genomization of everyday life is still a highly ambivalent phenomenon caught between the discovery of increasingly pervasive biological conditionings and the assertion of perhaps equally influential ideological constructs. Both these aspects should be monitored with a connectionist and multidisciplinary approach, because only thus will it be possible to guarantee the effectively integrated protection of the right to health.

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