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The Security Issue of Genetically Modified Food Based on Bioethics

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Genetically modified food (GMF) provides human kind the great interests and potential risks as well. The principle of genetically modified technology was introduced. And security issues like feeding security, environmental security were discussed. To get more information and check the understanding to genetically modified food security of people, an investigation was carried out. The results show the risk of GMF from the perspective of the public, putting forward new security issue of genetically modified food.

1. Introduction

The 21st century is a century of biotechnology. The research and development of GMF (genetically modified food) has already become a hot topic in the academic circle and even in the public. The first GMC (genetically modified crop)-genetically modified tobacco was born on the earth in 1983, and the first GMC of commercial cultivation (delayed ripening tomato) emerged in the USA in 1994, and then GMC began to be planted in some countries such as Canada, Argentina, China. Is GMF safe? Should it be labelled? Should it be patented? How to ensure the just distribution of interests in the process of the commercialization of GMC? etc., these issues have been paid more attention to by professionals and the public.

Genetic engineering has been widely applied in the fields of agriculture, food, medicine, environmental protection and so on. Under the operation of market, genetically modified organisms including GM plants, GM animals and GM microorganisms have entered the market from laboratory and great economic interests have come out with them. Because there are many advantages for GMC, such as high yield, less cost, herbicide-resistant, insect-resistant and virus-resistant, quality and nutrition improving, convenient for transportation and storage, and keeping fresh as many advocates have claimed, some countries have given priority to the research of GMC and its commercial cultivation (Augoustinos et al., 2010). In 2002, there were thirteen countries (including five developing countries and eight developed countries) where GMC was commercially planted, and the planting area of GMC on the earth was 58.67 million hectares.

2. Genetically modified technology

Transgenic plants and animals transgenic plants and animals result from genetic engineering experiments in which genetic material is moved from one organism to another, so that the latter will exhibit a characteristic. Business corporations, scientists, and farmers hope that transgenic techniques will allow more cost-effective and precise plants and animals with desirable characteristics that are not available using up to date breeding technology. Transgenic techniques allow genetic material to be transferred between completely unrelated organisms (Azadi and Ho, 2010).

The laws on food safety in China consist of a set of laws, guided by Food Safety Law, Product Quality Law and Standardization Law, with special regulations on food safety including Food Hygiene Administrative Punishment Measures and Food Hygiene Supervision Procedures as the main body, and supplemented by relevant specifications in laws and rules such as Law on Protection of Consumers Rights and Interests, Contagious Law Prevention Law, Criminal Law, etc. These laws are not few, but characteristic of scattered articles due to section legislation, single law and regulation is adjustable in a narrow scope, with low level legal force, plus some legal specifications are theoretical and abstract, so they are difficult to operate. Therefore, in

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general, global legal regulation system of food life circle from food production to consumption to final treatment has not been established yet in China.

Inherent crossing and overlapping of laws and regulations lead to overlapping arrangement of regulatory agencies and plural and complex main body, affecting supervision effects. For instance, Product Quality Law specifies industrial and commercial and quality supervision departments are all law enforcement subjects, current Food Safety Law specifies administrative authorities for industry and commerce, hygiene, quality supervision, agriculture, etc. all undertake food hygiene supervision and management tasks, indefinite responsibilities are bound to cause repeated law enforcement or vacuum belt of law enforcement, coupled with inconsistency in recognition and understanding of law, driven by department interests, departments will frequently take what they need, compete against each other for rights and interests, evade from responsibly and fight with each other. Hence, strength of the departments cannot be combined, making it difficult for the whole regulatory agency to realize effective integration.

Social supervision mechanism of media (including network media and so on), experts, public figures and the public has drawbacks in the field of food safety. Food industry association has not played its due role effectively. Many specific regulations cannot be enforced in practice. Moreover, food industry association has a poor capacity of survival itself, weak independence, lack of fund and simple organizational structure, affiliated to the local government agency, thus it cannot undertake the supervision responsibilities of food industry. Meanwhile, due to lack of social participation mechanism of food safety volunteers, action channels are not available to the public in food safety.

China's food safety risk management remains at the stage of post-analysis and summary, lack of prior risk analysis, placing food safety inspection and test in China at the passive status. It is still inadequate in risk assessment, risk management and risk pre-warning ability of food safety hazards. Moreover, regulators' safety risk is independent of themselves, which is due to lack of supervision of social public.

In order for a transgenic technique to work, the genetic engineer must first construct a transgene, which is the gene to be introduced plus a control sequence (Dannenberg, 2013). When making a transgene, scientists usually substitute the original promoter sequence with one that will be active in the correct tissues of the recipient plant or animal, shown in Figure 1.

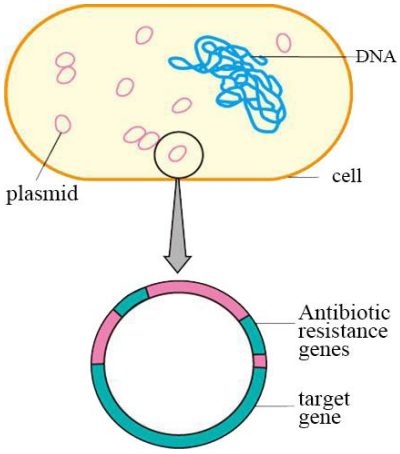

Figure 1: genetically modified principle

The creation of transgenic animals is one of the most dramatic advanced derived from recombinant DNA technology. A transgenic animal results from insertion of a foreign gene into an embryo. The foreign gene becomes a permanent part of the host animals' genetic material (Davos et al., 2009). As the embryo develops, the foreign gene may be present in many cells of the body. If the transgenic animal is fertile, the inserted foreign gene (transgene) will be inherited by future progeny. Transgenic animals are different from animals in which foreign cells or foreign organs have been engrafted. The progeny of engrafted animals do not inherit the experimental change (Dona et al, 2011). The techniques for creating a transgenic animal include the following: 1) picking a foreign gene, 2) placing the foreign gene in a suitable form called a "construct" which guides the insertion of the foreign gene into the animal genome and encourages its expression, and 3) injecting the construct into a single fertilized egg or at the very early embryo stage of the host animal. Much genetic engineering goes into the choice of a foreign gene and building a construct. The construct must have promoters to turn on foreign gene expression at its new site within the host animal genome. By choosing a

particular promoter and splicing it in front of the foreign gene, we can encourage expression of our transgene within a specific tissue.

3. Status of genetically modified foods

As we all know, modern biotechnology has brought human numerous benifits: Through the application of biotechnology, a broad and significant increase of food production can be happily seen at global agricultural production. Since 1983 when the first time human got transgenic tobacco, potato by using recombinant DNA technology, the plant genetic engineering technology in the world has achieved rapid development of transgenic plants for research and development, which has made a series of remarkable progress and has Successfully nurtured a number of crops with disease-resistance, insecticide resistance and even an incredible high-yield (Ejnavarzala, 2012). With the help of them, we can feed another more than millions of people, according to statistics, up to now; no less than 1.6 billion people have benefits from biotechnology.in the area, our mother country China has made tremendous contributions to the world's biotechnology. What must be mentioned is BT cotton and hybrid rice of Yuan Longing.

Commercialize genetically modified crops dates from the year of 1996, including Soybeans, cotton, cereals and oilseed rape. GM crops now occupy 10% of global arable land (LASKOS, 2013). In 2010, 81% of worldwide soybean, 64% cotton, 29% and 23% of the grain is genetically modified oilseed rape. Totally, 29 countries grow GM products all over the world. The top three countries with the largest area of cultivation are United States, Brazil and Argentina (Malatesta et al., 2013). The problem about the safety of GM products has been controversial. Genetically modified food will bring human and animal allergens and toxins of unknown.

4. Issue of genetically modified foods

4.1 Feeding Security

Is GMF natural or unnatural? According to the naturalist tradition of Taoism, GMF is unnatural and it violates the natural law. For Confucianism, GMF is unnatural, but it is not bounded to violates the natural order, because it seems to Confucianism that “Human can carry forward the Dao, but the Dao cannot carry forward human” (Confucius). There are two kinds of arguments about GMF for the present scholars: some scholars think that GMF is natural, and the other scholars think that GMF is unnatural. In fact, GMF is a unity of natural and unnatural, and GMF being unnatural is not a sufficient reason for rejecting GMF, but we can get some good enlightenment from this argument. We not only should respect natural orders but also should respect humanness in the process of developing GMF.

The safety of GMF is a crucial ethical issue. It includes four dimensions such as food safety, ecological safety, effects on biodiversity and possible cross-species infection. After analysing and evaluating the arguments for and against the related issues, the author draws the following conclusion: the short and direct influences of GMF on human health are relatively small, but the long and indirect influences of GMF on human health are uncertain; the probability about the influences of GMC/GMF on eco-environment and biodiversity may be relatively high, and GMC/GMF may give rise to disastrous outcome if we cannot control it well; and we should pay more attention to the issue of possible cross-species infection because of its mega-risk although the probability of cross-species infection is very low. The author argues that we should carry out the strategy of “guilty until proven innocent” towards the safety issue of GMF for its possible mega-risk.

Human experiment with GMF is directly related to the safety of GMF. In order to know the effects of GMF on human health, we should make human experiment with GMF before it enters the market for protecting possible harm to human health. On the basis of analysing and evaluating the two kinds of arguments on this issue, human experiment with GMF can be justified ethically. The author also provides some recommendations about how to carry out human experiment with GMF.

4.2 The Principles Regarding Evaluation of the Food Safety of Genetically Modified Plants

International consensus has been reached on the principles regarding evaluation of the food safety of genetically modified plants. The concept of substantial equivalence has been developed as part of a safety evaluation framework, based on the idea that existing foods can serve as a basis for comparing the properties of genetically modified foods with the appropriate counterpart. Experiences with the safety testing of newly inserted proteins and of whole genetically modified foods are reviewed, and limitations of current test methodologies are discussed. The development and validation of new profiling methods such as DNA microarray technology, proteomics, and metabolomics for the identification and characterization of unintended effects, which may occur as a result of the genetic modification, is recommended. The assessment of the allergen city of newly inserted proteins and of marker genes is discussed. An issue that will gain importance in the near future is that of post-marketing surveillance of the foods derived from genetically modified crops. It is

concluded, among others that, that application of the principle of substantial equivalence has proven adequate, and that no alternative adequate safety assessment strategies are available.

The concept of substantial equivalence is part of a safety evaluation framework based on the idea that existing foods can serve as a basis for comparing the properties of a genetically modified food with the appropriate counterpart. Application of the concept is not a safety assessment per se, but helps to identify similarities and potential differences between the existing food and the new product, which is then subject to further toxicological investigation. Three scenarios are envisioned in which the genetically modified plant or food would be (i) substantially equivalent; (ii) substantially equivalent except for the inserted trait; or (iii) not equivalent at all. A compositional analysis of key components, including key nutrients and natural toxicants, is the basis of assessment of substantial equivalence, in addition to phenotypic and agronomic characteristics of the genetically modified plant.

The issue of the potential occurrence of unintended effects due to the genetic modification process, such as the loss of existing traits or the acquisition of new ones, was examined. The occurrence of unintended effects is not unique for the application of rec DNA techniques, but also occurs frequently in conventional breeding. Present approaches to detecting such effects focus on chemical analysis of known nutrients and toxicants (targeted approach). Animal studies are deemed necessary to obtain information on the characteristics of newly expressed proteins, analogous to the conventional toxicity testing of food additives. Testing of whole foods may be considered if relevant changes in composition may have taken place in addition to the expected ones; however, such studies should be considered on a case-by-case basis, taking the limitations of this type of study into account. The minimum requirement to demonstrate the safety of long-term consumption of a food is a sub chronic 90-day study. Longer-term studies may be needed if the results of a 90-day study indicate adverse effects such as proliferative changes in tissues.

The contrast experiment is done in this paper. The major decisions on food safety action were categorized in 3 kinds: negative action, ordinary action and positive action. The choice of the 3 decisions depended on 2 factors. One factor was enterprises' anticipation on the economic benefit of food safety. The other factor was the compare between the costs of obeying regulation and the costs of defying regulation. If enterprises considered that food safety activity helped improve economic benefit, then no matter there were food safety regulations, enterprises would take positive food safety activity. Whereas, if enterprises anticipated that food safety action could not bring any benefits, then enterprises' action depended on the compare between the obeying costs and defying costs. If the obey costs were more than the defying costs, they might take negative food safety; or else, they might take ordinary action. The paper provided a method, based on which food safety activity modes can be effectively discussed. And based on the method, 2 kinds of activity modes of implementing HACCP in China's food enterprises were differentiated for the first time. The results of empirical study showed that more food enterprises (making up 66.7%) in China took HACCP as a kind of tool, and hoped that HACCP could help enterprises control microbe, improve quality, acquire admittance of domestic market and improve benefits; the other enterprises (33.3%) took the implementation of HACCP as a part of enterprise strategy, hoping HACCP could help improve enterprise's fame and gain competition predominance. Costs and benefits associated with the implementation and operation of HACCP in the China's food enterprise were analysed. Based on first source materials, the paper analysed enterprises' characters operating HACCP, such as enterprises' structure, product type and target market. Results showed that the enterprises implementing HACCP mainly were big and middle-sized enterprises; and acquiring admittance in foreign market was one of the major incentives. Based on this, 12 meat produce enterprises were investigated to analyse the costs and benefits of implementing and operating HACCP. Results showed that: 1) Costs and benefits were quite different among enterprises; 2) Major costs of applying HACCP in meat product industry was staff training and investment in new equipment; 3) Major costs of operating HACCP were product testing and staff time in documenting system; 4) Difficulties during implementing and operating HACCP were related with people, such as how to train staffs and incentive managers; 5) The most important benefit was the enhanced ability to retain existing customers; 6) The benefits gained by enterprise were not consistent with their anticipation, which showed that most enterprises might misunderstand the function of HACCP. Based on all the above research results, we should improving the statue with the proposed 9 pieces of advice, such as allocating regulation resource efficiently, establish a food safety committee guided by prime minister, paying more attention to evaluated regulation policies to assure their feasibility, guiding and training small sized food enterprises, strengthening information regulation, perfecting food supply system in countryside, expanding HACCP implementation in China and speeding cooperation in more fields between regulation organizations and food enterprises.

4.3 Public' Risk Perception

Based on the risk social theory, cultural theory and governance theory, this paper want to understand the basic situation of Wuhan citizen and their cognition, attitude, involvement level and risk perception of GMF, etc.

through the questionnaire, to describe the cognitive status of the public about the risk of GMF systematically, and adopts Factor Analysis Method to extract the dimension of public risk perception in GMF, then explores the factors that influence public risk perception of GMF with the use of Structural Equation Model.
In analysis, p value is needed.

$$t = \frac{\left(\overline{x_T} - \overline{x_C}\right) - \Delta}{S_{\left(\overline{x_T} - \overline{x_C}\right)}} \quad (1)$$

$$S_{\left(\overline{x_T} - \overline{x_C}\right)} = \sqrt{S_C^2\left(\frac{1}{n_T} + \frac{1}{n_C}\right)} \quad (2)$$

$$S^2_C = \frac{\sum\left(x_T - \overline{x_T}\right)^2 + \sum\left(x_C - \overline{x_C}\right)^2}{n_T + n_c - 2} \quad (3)$$

$$u = \frac{\left(P_T - P_C\right) - \Delta}{S_{\left(P_T - P_C\right)}} \quad (4)$$

$$S_{\left(P_T - P_C\right)} = \sqrt{pq\left(\frac{1}{n_T} + \frac{1}{n_C}\right)} \quad (5)$$

Public awareness degree of specific varities of GMF is shown in Figure 2. And the public risk perception of GMF on each dimension is investigated, shown in Figure 3.Figure 4 shows the public recognition status of GMC and GMF.

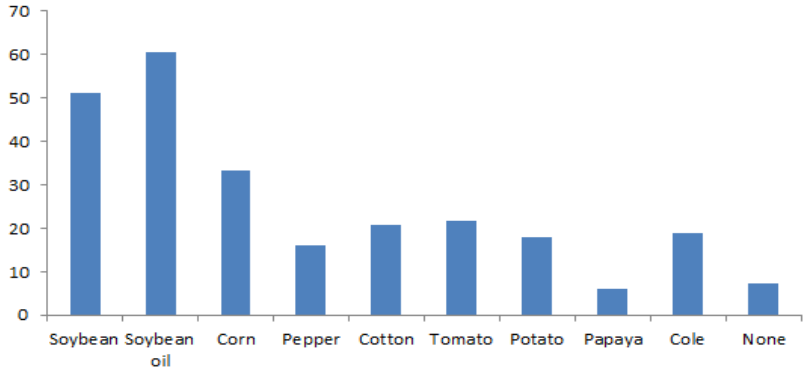

Figure 2: Public awareness degree of specific verities of GMF (%)

The results show: (1) Overall, the public do not have a severe concern about GMF safety problems in Wuhan city; (2) The public risk perception of GMF can be divided into four dimensions, namely health risk, environmental risk, social economic risk and product performance risk, among which, human health and environmental risk perception is relatively high; (3) GMF knowledge has impact on public risk perception; the person who has richer information and knowledge always has higher risk awareness.

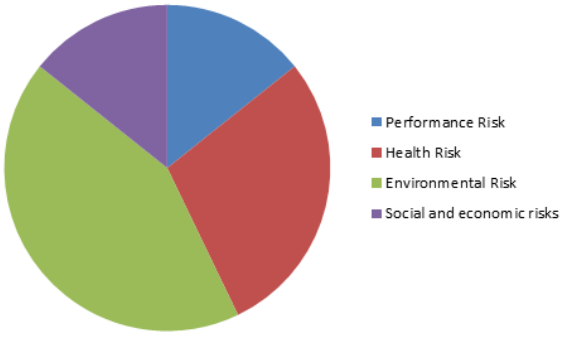

Figure 3: The public risk perception of GMF on each dimension

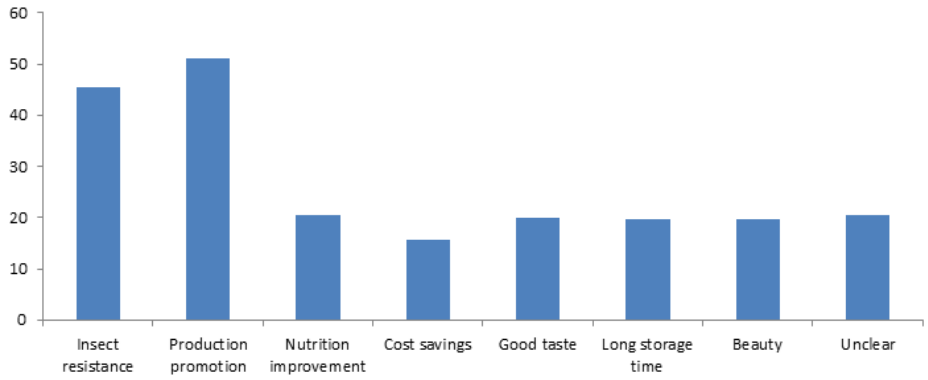

Figure 4: The public recognition status of GMC And GMF (%)

5. Conclusion

Genetically modified food (GMF) provides human kind the great interests and potential risks as well. The principle of genetically modified technology was introduced. And security issues like feeding security, environmental security were discussed. We should unite the technological dimension with humane dimension of human existence, and carry out the paradigm shift from non-sustainable development to sustainable development, from reductionism to organic holism and from monist linear thinking to pluralistic and non- linear thinking in order that GMF can serve the harmonious development between human and nature.

GMF is the same as other high technology in that its development and application are full of scientific and ethical/philosophical disputes. The scientific and ethical/philosophical workers need to lead people to keep rational attitude towards GMF.

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