Original Article

Effects of Parental Dietary Exposure to GM Rice TT51 on the Male Reproductive System of Rat Offspring*

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Abstract

Objective To evaluate the health effects of parental dietary exposure to GM rice TT51 on the male reproductive system of rat offspring.

Methods Rice-based diets, containing 60% ordinary grocery rice, MingHui63, or TT51 by weight, were given to parental rats (15 males/30 females each group) for 70 days prior mating and throughout pregnancy and lactation. After weaning, eight male offspring rats were randomly selected at each group and fed with diets correspondent to their parents' for 70 days. The effects of exposure to TT51 on male reproductive system of offspring rats were assessed through sperm parameters, testicular function enzyme activities, serum hormones (FSH, LH, and testosterone levels), testis histopathological examination, and the relative expression levels of selected genes along the hypothalamic-pituitary-testicular (HPT) axis.

Results No significant differences were observed in body weight, food intake, organ/body weights, serum hormone, sperm parameters, testis function enzyme ACP, LDH, and SDH activities, testis histopathological changes, and relative mRNA expression levels of GnRH-R, FSH-R, LH-R, and AR along the HPT axis.

Conclusion The results of this study demonstrate that parental dietary exposure to TT51 reveals no significant differences on the reproductive system of male offspring rats compared with MingHui63 and control.

Key words: Genetically modified rice; Sperm parameter; Hypothalamic-pituitary-testicular axis; Reproductive toxicity

Biomed Environ Sci, 2016; 29(4): 267-274 doi: 10.3967/bes2016.034 ISSN: 0895-3988

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INTRODUCTION

Genetically modified (GM) crops are now under rapid development and commercial use worldwide. Knowing if GM food affects human and animal health before putting it on the market is a question of great importance. However, we are still uncertain whether GM food can exert potential reproductive toxicology on humans or animals[1]. Until now, only a small number of studies have reported the health effects of GM crops on animal reproductive system[2-6]. Thus, the current scientific data are considered by many scientists as inadequate to prove whether GM food affects reproductive health; some studies even have reported apparently harmful effects. In the study performed by Vecchio[2], the authors fed pregnant Swiss mice and male litters on a standard laboratory

*This study was supported by the National GMO Cultivation Major Project of New Varieties (2012ZX08011001-002).
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chow containing 14% GM soybean. By means of immunoelectron microscopy, they focused their attention on Sertoli cells, spermatogonia, and spermatocytes at 2, 5, or 8 months of age. The results of their study indicated that the immunolabelling for Sm antigen, hnRNPs, SC35, and RNA Polymerase II decreased in 2 and 5 month-old GM-fed mice and was restored to normal at 8 months. Moreover, in GM-fed mice of all considered ages, the number of perichromatin granules was higher and the nuclear pore density was lower. The author further found enlargements in the smooth endoplasmic reticulum of Sertoli cells in GM-fed mice. A three-generation study reported minimal histopathological changes in the liver and kidney of F3 female offspring rats fed on *Bt* maize diet[6]. The appearance of these apparently harmful effects inevitably aroused suspicion and public anxiety for the safety of GM food and caused extensive debate among scientists.

Rice is one of the most important world widely consumed crops, which is severely damaged by insects. The development of pest-resistant GM crops provides to farmers an effective method for the prevention of pest. TT51 was recently created by inserting a synthetic gene *CryAb/Ac* into parental rice MingHui63. Field tests indicated that TT51 could reduce pesticide application and increase the efficiency of rice production. For its excellent performance, TT51 was granted with the biosafety certificate by China’s Ministry of Agriculture in 2009. It means that China is on the threshold of becoming the first country to allow the commercialization of GM rice. However, considering that rice is the most widely consumed staple food, if the product was toxic; the outcome would be quite serious. Therefore, it is not difficult to understand why an acute debate on the safety of this GM rice never stopped since the release of its biosafety certificate in China.

The function of the male reproductive system depends upon various complex biological processes that can be disrupted by many extraneous factors. This system is at risk during fetal development, postnatal period during puberty, and even over the entire life span; the targets include testes and accessory organs. In addition, the high rate of cellular proliferation and the unique cellular differentiation within the mammalian testis make it a very sensitive organ that is able to detect cellular and molecular changes when exposed to a toxicant[1].

In our previous 90-day feeding study, we found no harmful effects on the male reproductive system in rats after dietary exposure to TT51[5]. Considering that rice is a widely consumed staple food and serious debate continues on the safety evaluation of GM crops to protect a large number of people from the risk of potential adverse effects of the GM rice, it would be better to finish the debate by conducting extensive toxicological evaluations. One can consider that if GM food/feed exerts reproductive toxicology on humans or animals after long time-consumption, it is most likely that it would not appear in the parental generation but in the offspring generation. Gene expression index is considered more highly sensitive compared with general toxicological parameters. Until now, the influence of dietary exposure to GM food on the expression levels of male reproductive regulation-related genes has rarely been investigated. Due to this unclear situation, the relative expression levels of reproductive-related genes GnRH-R, FSH-R, LH-R, and AR along the HPT axis of male offspring rats were firstly investigated in this study.

MATERIALS AND METHODS

Materials

Genetically modified rice TT51 and its none-transgenic counterpart MingHui63 were cultivated in the experimental field of Central China Agricultural University in adjoining plots, under identical environmental conditions. After harvest, the paddies were dried under sunshine and then stored in a dry warehouse. Additional common rice purchased at the supermarket was selected as the negative control. Detailed description of the process of compositional analysis and results of the test materials, as well as preparation of the experimental diets, were presented in our previous article[5]. Testosterone (T), folliclestimulating hormone (FSH), and luteinizing hormone (LH) radioimmunoassay (RIA) assay kits were purchased from Beijing North Institute of Biological Technology. Total protein (TP), acid phosphatases (ACP), lactic dehydrogenase (LDH), and succinate dehydrogenase (SDH), were bought from Nanjing Jiancheng Bioengineering Institute (China). Genomic RNA purification kits, cDNA synthesis kit, and SYBR Green PCR Master Mix were bought from BIO-LAB, China.

Animals and Treatment

Four-week-old Wistar rats, purchased from Vital

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