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Understanding the Impact of Genetically Modified Organisms on Hormones and Their Effect on Mood: A Review Paper

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Abstract

The present research evaluated how consuming genetically modified organisms affects endocrine functioning that can potentially lead to mood changes or disorders. This is a systematic review paper that analysed 60 publications before selecting 30 which were obtained from Science Direct, Frontiers, Springer, Oxford Acadamic, CABI Digital Library, Wiley Online Library, Cambridge University Press, SCI Journals, MDPI, Metabolism Journal; while using Prisma Flow Diagram as the research tool; acknowledging that human hormonal health risks from consumption of genetically modified organism remain largely unknown due to evidence being primarily based on animal tests and brief trial periods with humans. Different reports issued by regulatory agencies combined with independent study findings increase the difficulty of properly identifying potential health risks. The present review properly analysed existing research to explain critical pathways between genetically modified organisms and hormonal functions and mood responses and established the necessity for extended human research methods. The development of safe regulatory measures and consumer protection requires thorough research at these identified knowledge gaps.

Keywords: Genetically modified organisms, hormones, mood disorders, endocrine disruption, glyphosate, gut–brain axis

INTRODUCTION

Genetically modified organism (GMO) has become a crucial component in contemporary agriculture because of their enhanced agricultural output and pest protection and strengthen food supply stability. Hence it is essential to discuss about GMO health implications especially their endocrine system alterations and changes in mood functions. Rising use of GMO in the food supply has prompted scientific investigations about its ability to disrupt hormonal functions that could cause anxiety and depression symptoms in those who consume GMOs. The body controls various essential physiological processes through the endocrine system including metabolic activities, which also control reproduction together with essential processes in which the nervous system contributes to emotional health. The present paper examined the links between ingestion of GMO and modifications in hormone levels and their impact on mood disorders by evaluating previous research and suggesting future investigation directions.

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The research examined consumption of GMO as its independent variable while studying direct food intake of genetically modified (GM) products

together with exposure to herbicides such as glyphosate-based herbicides (GBHs) that come with genetic modification. The research examined hormonal changes and investigated their influence on emotions that result after hormonal transformation. Science papers indicated that GMOs along with their production chemicals potentially obstruct endocrine system functioning. The most common herbicide in GMO agricultural operations called glyphosate functions as an endocrine disruptor that disrupts hormonal communications between cells. Scientific findings indicated that human contact with glyphosate and GBHs modifies hormones involved in reproductive functions thus impairing the hypothalamic–pituitary–gonadal axis responsible for regulating mood.

Scientific studies establish connections between changes in gut microbiota, which provoke both hormonal misalignments and mood-related conditions. Glyphosate exposure modifies the composition of gut bacteria based on research that may influence both the gut–brain axis and neurotransmitter production. The research showed that mice offspring developed depression and anxiety symptoms following their mothers' glyphosate exposure through their mothers. This effect correlated with alterations in gut microbiota and changes in serotonin-related gene expression patterns. Because serotonin functions as a primary neurological molecule for mood control disturbances in its production by GMO-related elements would produce considerable psychological effects. The estrogen receptor modulating effects of glyphosate create concern about its impact on female reproductive hormones that increases the risk of developing premenstrual dysphoric disorder [1–5].

The U.S. Environmental Protection Agency (EPA) together with the European Food Safety Authority (EFSA) support glyphosate's safety at permissible levels yet independent research findings that contradict each other demonstrate the necessity of additional studies. Little research has investigated the direct GMO-associated hormonal effects that lead to mood disorders among human subjects, which leaves important questions unanswered. The people who eliminated GM foods in their diet reported better mental states as well as greater cognitive performances thus supporting a GMO–mental well-being association. Better understanding of how GMOs influence humans require extensive further research because existing evidence gaps remain.

The purpose of the present review paper was to evaluate critically published research about how GMO consumption affects hormone regulation, which subsequently impacts moods. The research gathered data from multiple investigations to establish if GMOs and their agrochemicals create endocrine disruption and mood disorders. Both scientific progress and public health require immediate attention to GMO-related hormonal regulation since long-term consumption effects need to guide medical authorities and policy makers in decision making about GMO standards and consumer freedom [6, 7].

PARADIGM

Studying GM organisms and their possible hormonal and mood effects necessitates integrated investigation between endocrinology principles with those of neuroscience and toxicology and environment science. Genetic modification of food products impact endocrine function and mood regulation through multiple recognized concepts, principles, and theoretical perspectives. A Critical examination revealed which physiological pathways GMOs together with GBHs follow to interrupt hormonal equilibrium throughout the development of mood symptoms [7–13].

Endocrine Disruption Theory

The endocrine disruption theory serves as a primary theoretical basis in the present research because it demonstrates how certain chemicals affect endocrine operations causing developmental, reproductive, neurological and immune damage [7]. When used in GMO crop cultivation, Glyphosate functions as an endocrine disruptor and the scientific literature showed that it disrupts hormone signalling primarily affecting estrogen and thyroid hormones [14]. Any disruptions in the hormonal pathways result in damage to neurotransmitter function that may cause conditions such as anxiety and depression [12–22].

The Gut–Brain Axis and Microbiome Theory

The Gut–Brain Axis Theory representing a fundamental concept, was considered during the present study. The present paper investigated how gut microbiota communicates with the central nervous system (CNS) through bidirectional pathways to control mood together with cognitive performance. Different studies revealed that glyphosate exposure causes changes in gut microbiota leading to dysbiosis, which interferes with the production of serotonin and dopamine [4]. The synthesis of serotonin as a mood-stabilizing neurotransmitter depends on gut microbiota health since their alterations could cause impairment in mood regulation.

According to the Microbiome Theory of Disease, disruptions in microbial populations lead to different forms of chronic diseases including anxiety and depression. Pluebas from Glyphosate exposure decreased vital microorganisms including *Akkermansia* while allowing damaging *Alistipes* and *Blautia* bacteria to thrive and increase mental health abnormalities [15]. The study evinced that GMO consumption, which involved exposure to glyphosate, creates potential changes in mood because of microbiome-mediated systems [22–30].

Neuroendocrine Regulation of Mood

According to the Neuroendocrine Theory of Mood Regulation, the emotional wellness depends heavily on hormonal agents including cortisol and thyroid hormones as well as estrogen. Studies showed that abnormal functioning of hormonal regulation pathways directly causes depression with accompanying anxiety symptoms. Multiple studies have presented evidence that disorders found in GBH damage the hypothalamic–pituitary–adrenal (HPA) axis which leads patients to develop modified stress reactions while becoming more vulnerable to mental health conditions [27]. Studies have shown that neuroprotective effects of estrogen are disrupted when estrogen signaling becomes altered from glyphosate exposure, which may cause depressive symptoms especially in females [13].

Precautionary Principle in Public Health

The Precautionary Principle operates as a regulatory and ethical decision-making tool for public health purposes. According to this principle, absence of scientific agreement about substance safety requires preventive action for damage prevention purposes. Public health protection demands the implementation of the Precautionary Principle due to inconsistent research about endocrine-disrupting effects in GMOs and glyphosate [15]. Safety measures to address potential GMO risks must use independent research findings and rigorous regulatory standards for reduction of consumer dangers [30, 31].

METHODOLOGY

A literature review of 30 papers was done on the impact of GMO on hormones and their effect on mood.

- *Objective:* The present systematic review paper aimed to examine the impact of GMOs on hormonal regulation and their potential effects on mood.
- *Research Question:* How does the consumption of GM organisms influence hormonal balance and contribute to the development or exacerbation of mood disorders?

DISCUSSION

Impact of GMOs on Endocrine Disruption

Scientific evidence showed that GMOs use biochemical mechanisms to affect endocrine function in humans and other living creatures. Researched findings showed that GMO industry herbicide glyphosate functions as an endocrine disrupting chemical (affecting hormones) with results indicating hormonal imbalance. Research using animal models demonstrated how GBHs interact with hormone pathways from the estrogenic as well as androgenic family and thyroid hormones to cause hormonal imbalances affecting mood functions.

When an individual consumes food products from GMOs with modified genetic features it can lead to endocrine system changes in their body. Laboratory results suggested that intake of GM soy and corn

affect hormone production of estrogen and testosterone, which raises medical and psychological risks to reproductive function. Scientists have neither conducted nor published studies on GMO's long-term human impacts due to which the total scope of these effects remains unknown (Figure 1).

GMOs and their Influence on Mood Disorders

The endocrine system stands essential for mood control because hormones including cortisol and estrogen together with serotonin strongly affect emotional responses. Research indicated that GMO consumption leads to hormonal balance dysfunction, which produces anxiety and depression symptoms. The ingestion of glyphosate has shown evidence of disrupting gut microbial communities as well as altering the gut–brain communication pathways.

Research indicated that GMO exposure damages thyroid function and produces depressive symptoms since thyroid hormones are essential for both neurological processes and brain performance. Medical records showed that endocrine disorder patients who consume GMOs develop more frequent mood swings. Research on connection between GMO consumption and mood disorders remains sparse even though several links have been observed. Scientists should conduct well-controlled human-based longitudinal research to establish causal relationships.

Role of the Gut–Brain Axis in Hormonal and Mood Regulation

The present study indicated that the gut–brain axis acts as the main connection point between GMOs, hormones, and mood disorders. The gut microbiota that receives dietary influence controls neurotransmitter synthesis for mood and emotional balance through serotonin and dopamine production. Research showed that GMO eating habits together with glyphosate byproducts impair stomach microbial structures while reducing useful bacteria such as *Lactobacillus sp.* and *Bifidobacterium sp.* that serve as the foundations for serotonin production.

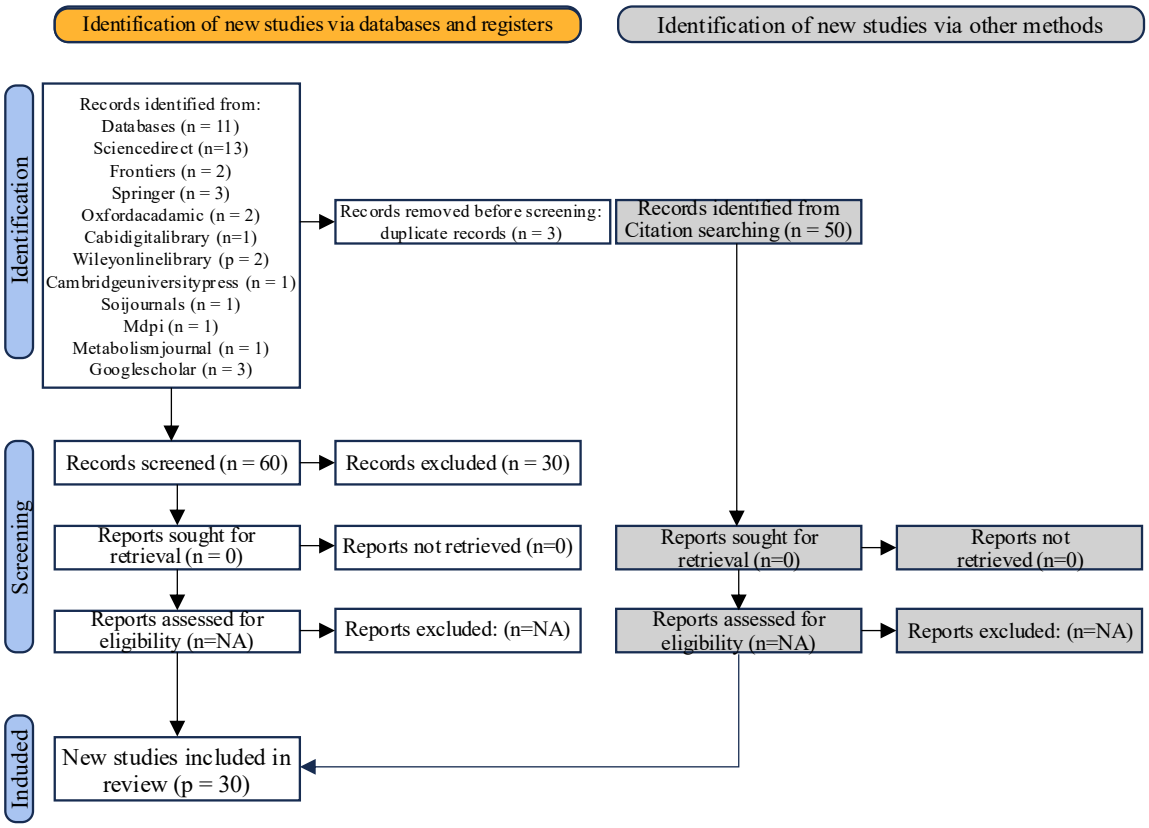

Figure 1. Prisma flow diagram.

Multiple research studies demonstrated that GM crops containing *Bacillus thuringiensis* (Bt) toxins create detrimental effects on gut health structure that induce systemic inflammation that causes depressive conditions. The evidence showed that dietary choices such as GMO consumption modify gut microbiota, which sustains the argument regarding dietary impact on psychological health.

Regulatory Conflicts and Scientific Discrepancies

Evaluating the effects of GMO on hormonal and mood-linked health presents additional difficulty because of opposing findings between regulatory organizations and independent scientific research. Independent research revealed the possibility of endocrine-endangering characteristics that need further scientific evaluation in GMO foods although regulatory authorities such as U.S. Food & Drug Administration (FDA) and European Food Safety Authority (EFSA) continue to state GMO foods are safe to consume. The analysis of contrast between studies funded by industry as compared to independent investigations conducted by various authors showed that industry funding tends to downplay adverse effects but independent investigations showed prominent concerns [28]. New clinical investigations that combine independence and extended follow-up times will shed light on the genuine hormonal and psychological effects of GMOs on human beings.

Need for Rigorous Longitudinal Studies

The current body of evidence showed that GMOs produce hormonal disruption and mood disorders yet problems in research methodology with insufficient number of participants and study times cannot definitively solve these effects. The outcomes from existing research depend heavily on short-term examinations of animal subjects since human exposure to GMOs extends beyond the timeframes examined by these studies.

However, the effects of GMO should be investigated of extended-time cohort studies that monitor endocrine changes in parallel with the mental health outcomes. The study of potential health risks from GMOs would become more thorough through research that includes people from different backgrounds who consume GMOs to different extents.

LIMITATIONS

The present review contains specific constraints that researchers must recognize. Most animal-based research examples featured in these studies [27] present barriers towards the broad application of their results to people. Different research designs across studies introduced significant variability when it comes to GM organisms being tested as well as hormonal marker measurement and behavioral assessment approaches. Study of the prolonged exposure to GMOs among people for determining their impact on hormonal regulation and mood retention remains insufficient. Multiple research studies lacked proper control methods that could account for external psychosocial stressors and dietary habits because these variables appeared to impact endocrine and psychological results.

RECOMMENDATIONS

Scientists need to conduct thoroughly designed human experimental trials that follow up on animal study results to establish definite links between GMO exposure and hormone regulation and mood disorders. The standardization of experimental procedures that details tested GMO varieties together with measured hormonal factors would lead to better research comparison results. Researchers need to control environmental factors along with lifestyle factors as a means to establish distinct relationships between GMOs and hormonal health and mood stability. Studies should employ collective research methods involving experts from fields of nutrition and endocrinology together with psychology and toxicology.

FUTURE IMPLICATIONS

The review data brings significant consequences for public health management and clinical practices together with food policy decisions. Regulatory institutions should use recently discovered data points

to strengthen their GMO safety evaluation systems while medical staff can develop dietary screening practices for mood disorder treatment. Research conducted in the future will enable better guidelines for diet and improved consumer choices regarding GMOs thereby better understanding of GMO influence on human hormonal and mental health.

CONCLUSION

The present review demonstrated GMO consumption along with endocrine disruption as the cause of mood disorder while emphasizing the requirement for extended human research studies. Multiple lines of current evidence showed three key factors working together to produce psychological distress—glyphosate exposure, changes in gut microbiota populations, and hormonal dysfunctions. The HPA axis and sex hormones within the endocrine system along with the gut microbiota suffer disruption, which creates potential mechanisms for these observed effects. Additional research is needed to prove these claims because current regulations and research limits require improvement. Future research needs standardized longitudinal research design to properly understand the connection between GMO consumption and hormone regulation on mood stability. However, understanding these mechanisms is crucial for formulating evidence-based policies that can prioritize consumer safety and overall well-being.

REFERENCES

1. Aitbali Y, Ba-M'hamed S, Elhidar N, Nafis A, Soraa N, Bennis M. Glyphosate based-herbicide exposure affects gut microbiota, anxiety and depression-like behaviors in mice. Neurotoxicology and Teratology. 2018; 67: 44–49p. Available from: https://doi.org/10.1016/j.ntt.2018.04.002.
2. Barnett JA, Bandy ML, Gibson DL. Is the use of glyphosate in modern agriculture resulting in increased neuropsychiatric conditions through modulation of the gut-brainmicrobiome axis?. Frontiers in Nutrition. 2022; 9: 827384p. Available from: https://doi.org/10.3389/fnut.2022.827384.
3. Bicca DF, Spiazzi CC, Ramalho JB, Soares MB, Cibin FWS. A subchronic low-dose exposure of a glyphosate-based herbicide induces depressive and anxious-like behavior in mice: Quercetin therapeutic approach. Environmental Science and Pollution Research. 2021; 28: 67394–67403p. Available from: https://doi.org/10.1007/s11356-021-15402-3.
4. Buchenauer L, Haange SB, Bauer M, Rolle-Kampczyk UE, Wagner M, Stucke J, et al. Maternal exposure of mice to glyphosate induces depression-and anxiety-like behavior in the offspring via alterations of the gut-brain axis. Science of the Total Environment. 2023; 905: 167034p. Available from: https://doi.org/10.1016/j.scitotenv.2023.167034.
5. Das S, Chatterjee A, Pal TK. Organic farming in India: a vision towards a healthy nation. Food Quality and Safety. 2020; 4(2): 69–76p. Available from: https://doi.org/10.1093/fqsafe/fyaa018.
6. Dawkar VV, Chougale AD, Barvkar V, Tanpure RS, Giri AP. Genetically engineered crops: opportunities, constraints, and food security at a glance of human health, environmental impact, and food quality. In: Genetically Engineered Foods. USA: Academic Press; 2018. 311–334p. Available from: https://doi.org/10.1016/B978-0-12-811519-0.00012-1.
7. de Araújo-Ramos AT, Passoni MT, Romano MA, Romano RM, Martino-Andrade AJ. Controversies on endocrine and reproductive effects of glyphosate and glyphosate-based herbicides: a mini-review. Frontiers in Endocrinology. 2021; 12: 627210p. Available from: https://doi.org/10.3389/fendo.2021.627210.
8. Gao M, Li B, Yuan W, Zhao L, Zhang X. Hypothetical link between infertility and genetically modified food. Recent Patents on Food, Nutrition & Agriculture. 2014; 6(1): 16–22p. Available from: https://www.cabidigitallibrary.org/doi/full/10.5555/20153010432.
9. Gardier AM, Guiard BP, Guilloux JP, Repérant C, Coudoré F, David DJ. Interest of using genetically manipulated mice as models of depression to evaluate antidepressant drugs activity: a review. Fundamental & Clinical Pharmacology. 2009; 23(1): 23–42p. Available from: https://doi.org/10.1111/j.1472–8206.2008.00640.x.
10. Hooper L, Ryder JJ, Kurzer MS, Lampe JW, Messina MJ, Phipps WR, et al. Effects of soy protein and isoflavones on circulating hormone concentrations in pre-and post-menopausal women: a systematic review and meta-analysis. Human Reproduction Update. 2009; 15(4): 423–440p. Available from: https://doi.org/10.1093/humupd/dmp010.

11. Hsiao CC, Yang AM, Wang C, Lin CY. Association between glyphosate exposure and cognitive function, depression, and neurological diseases in a representative sample of US adults: NHANES 2013–2014 analysis. Environmental Research. 2023; 237: 116860p. Available from: https://doi.org/10.1016/j.envres.2023.116860.
12. Haddaway NR, Page MJ, Pritchard CC, McGuinness LA. PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency. Open Synthesis Campbell Systematic Reviews. 2022; 18: e1230. Available from: https://doi.org/10.1002/cl2.1230 Download citation (.ris).
13. Ingaramo P, Alarcón R, Munoz-de-Toro M, Luque EH. Are glyphosate and glyphosate-based herbicides endocrine disruptors that alter female fertility? Molecular and Cellular Endocrinology. 2020; 518: 110934p. Available from: https://doi.org/10.1016/j.mce.2020.110934.
14. Hulsken S, Märtin A, Mohajeri MH, Homberg JR. Food-derived serotonergic modulators: effects on mood and cognition. Nutrition Research Reviews. 2013; 26(2): 223–234p. Available from: https://doi.org/10.1017/S0954422413000164.
15. Kalofiri P, Balias G, Tekos F. The EU endocrine disruptors' regulation and the glyphosate controversy. Toxicology Reports. 2021; 8: 1193–1199p. Available from: https://doi.org/10.1016/j.toxrep.2021.05.013.
16. Khan SJ. Genetically modified organisms (GMOs): Food security or threat to food safety. Pakistan Journal of Science. 2012; 64(2): 85–91p. Available from: https://doi.org/10.57041/vol64iss2pp%25p.
17. Levine SL, Webb EG, Saltmiras DA. Review and analysis of the potential for glyphosate to interact with the estrogen, androgen and thyroid pathways. Pest Management Science. 2020; 76(9): 2886–2906p. Available from: https://doi.org/10.1002/ps.5983.
18. Li S, Liu C, Song Y, Ma N, Lu J. Association of Soyfoods or Soybean Products Consumption with Psychological Symptoms: Evidence from a Cross-Sectional Study of Chinese University Students during the COVID-19 Pandemic. International Journal of Environmental Research and Public Health. 2023; 20(1): 819p. Available from: https://doi.org/10.3390/ijerph20010819.
19. Lund TD, Lephart ED. Dietary soy phytoestrogens produce anxiolytic effects in the elevated plus-maze. Brain Research. 2001; 913(2): 180–184p. Available from: https://doi.org/10.1016/S00068993(01)02793–7.
20. Madani NA, Carpenter DO. Effects of glyphosate and glyphosate-based herbicides like Roundup™ on the mammalian nervous system: A review. Environmental Research. 2022; 214: 113933p. Available from: https://doi.org/10.1016/j.envres.2022.113933.
21. Maddalon A, Galbiati V, Colosio C, Mandić-Rajčević S, Corsini E. Glyphosatebased herbicides: Evidence of immune-endocrine alteration. Toxicology. 2021; 459: 152851p. Available from: https://doi.org/10.1016/j.tox.2021.152851.
22. Muñoz JP, Bleak TC, Calaf GM. Glyphosate and the key characteristics of an endocrine disruptor: A review. Chemosphere. 2021; 270: 128619p. Available from: https://doi.org/10.1016/j.chemosphere.2020.128619.
23. Miyake Y, Tanaka K, Okubo H, Sasaki S, Furukawa S, Arakawa M. Soy isoflavone intake and prevalence of depressive symptoms during pregnancy in Japan: baseline data from the Kyushu Okinawa Maternal and Child Health Study. European Journal of Nutrition. 2018; 57: 441–450p. Available from: https://doi.org/10.1007/s00394-016-1327-5.
24. Nagata C, Shimizu H, Takami R, Hayashi M, Takeda N, Yasuda K. Serum concentrations of estradiol and dehydroepiandrosterone sulfate and soy product intake in relation to psychologic well-being in peri-and postmenopausal Japanese women. Metabolism-Clinical and Experimental. 2000; 49(12): 1561–156p. Available from: https://doi.org/10.1053/meta.2000.18522.
25. Ozkok GA. Genetically modified foods and the probable risks on human health. International Journal of Nutrition and Food Sciences. 2015; 4(3): 356–363p. doi: 10.11648/j.ijnfs.20150403.23.
26. Prakash D, Verma S, Bhatia R, Tiwary BN. Risks and precautions of genetically modified organisms. International Scholarly Research Notices. 2011; 2011(1): 369573p. Available from: https://doi.org/10.5402/2011/369573.

27. Mampuys R, Brom FW. Ethics of dissent: a plea for restraint in the scientific debate about the safety of GM crops. J Agric Environ Ethics. 2015 Oct;28(5):903–24.
28. Then C, Bauer-Panskus A. Possible health impacts of Bt toxins and residues from spraying with complementary herbicides in genetically engineered soybeans and risk assessment as performed by the European Food Safety Authority EFSA. Environmental Sciences Europe. 2017; 29: 1–11p. Available from: https://doi.org/10.1186/s12302-016-0099-0.
29. Trivedi M, Singh R, Shukla M, Tiwari RK. GMO and food security. In: Omkar (Ed.). Ecofriendly pest management for food security. Cambridge: Academic Press; 2016. 703–726p. Available from: https://doi.org/10.1016/B9780–12-803265-7.00023-3.
30. Tsatsakis AM, Nawaz MA, Tutelyan VA, Golokhvast KS, Kalantzi OI, Chung DH. Impact on environment, ecosystem, diversity and health from culturing and using GMOs as feed and food. Food and Chemical Toxicology. 2017; 107: 108–121p. Available from: https://doi.org/10.1016/j.fct.2017.06.033.
31. Uzogara SG. The impact of genetic modification of human foods in the 21st century: A review. Biotechnology Advances. 2000; 18(3): 179–206p. Available from: https://doi.org/10.1016/S0734–9750(00)000331.

