The effect of Science Literacy on the Outlook of Genetically Modified Crops

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Introduction

A recent shift in consumer values shows the rising craze for natural foods. According to recent global health reports, 80% of North Americans would spend more to purchase natural foods (Nielsen, 2015). A call for archetypical wholesome farmers and their natural crops has created a wave of health awareness that has swept developed countries and engulfed reliable food options. Genetically modified (GM) crops, defined as organisms with recombinant DNA technology (Bawa & Anilakumar, 2013), have succumbed to this mindset. Groceries have nourished and thrived off of these beliefs sporting “non-GMO and organic” products at higher prices (Kalaitzandonakes, Lusk, & Magnier, 2018). This abhorrence of GM crops is due to a lack of science literacy regarding the safety and efficacy of GM crops. A lack of understanding of genetics and genetic modification, inequitable GM health risks grounded in pseudoscience and false contraindications of GM applications have served to erroneously educate the public on the dangers of GM crops.

Misunderstanding genetic modification

Pseudoscientific sources view genetic changes as unnatural and therefore dangerous (“GMOs – Unnatural Foods, Unhealthy”, 2013). Using organic isn’t a “return” to natural products as suggested by media (Siddique, Hamid, Tariq, & Kazi, 2014), as agriculturalists have been selecting crops for their genetic changes for years. Reproduction of many plants involves the formation of gametes with independent assortment and random segregation causing many random genetic changes. In the past, plants were selected based on these random genetic changes causing phenotypic changes that were observable by sight or taste (Thrall, Bever, & Burdon, 2010). However, these random genetic changes are likely to have been accompanied by numerous other non-phenotypic genetic changes to the crops. In contrast, GM crops are subject to controlled and monitored genetic change (Key, Ma, & Drake, 2008). Therefore, rather than harmful “frankenfruit” (Ludekens, 2013), genetic modification in GM crops can be viewed as accelerating natural processes with greater restraint, to produce idyllic foods.

A fear of consuming genetically modified foods stemming from repercussions of the genetic changes is based in pseudoscience. Some sources spread fear by stating that these genetic changes are transferable and consuming the genes will infect the consumer as well (Walia, 2014). These sources fail to mention the DNA contained in every living organism that we consume. The body possesses mechanisms to break down the genetic modifications of GM crops and native genomes alike. For example, the pancreas releases nucleases into the intestines that indiscriminately break DNA molecules down into nucleotides (Hendrickson, 2017). Therefore, the process of consuming a GM food is identical to the process of consuming a non-GM food (MacDonald, 2015), and a fear of consuming altered genomes is illogical.

Fabricated GM health risks

The health risks associated with GM foods have been supported by pseudoscientific claims, not reliable primary research. Many online sites claim that GM foods have been causing diseases such as liver cancer and renal cancer (Sarich, 2014). The support for these claims rely on the correlation of the increase in the incidence of these diseases, and the increase in GM foods since their widespread inception (Smith, 2010). Although this may seem convincing, these claims are based in correlation, not causation, and therefore there are many potential confounding variables that must be accounted for.

Furthermore, when primary research is cited, it is often cited incorrectly. The most consistently cited evidence of the harms of GM foods states that a GM foods cause cancer

(Smith, 2017). The study fed rat models a GM food diet consisting of GM maize and compared their health outcome to control rats after two years. To many individuals, this is more than enough proof to condemn the use of GM foods. However, this study was flawed as there were a low number of replicates and the strain of rats that were used (Sprague-Dawley) are susceptible to developing tumors. These factors are so debilitating, that the authors of the research have since retracted their article (Séralini et al., 2012). Additionally, several more recent articles have not found any significant differences between rats that were fed a GM food diet and control rats. Comprehensive 90-day animal feeding trials with GM maize, many replicates and a different breed of rats have found no significant difference between treatment groups (GMO 90plus, 2015). Additional 90-day animal feeding studies with other strains of GM maize yielded no significant differences (Zeljenková et al., 2014). Additionally, longer trials of 1 year did not yield any adverse effects (Zeljenková et al., 2014).

Deceitfully dismissed applications of GM crops

While the unjustified health risks are repeated, the significant applications of GM crops are overlooked. GM crops have already contributed to feeding starving nations. *Bacillus thuringiensis* (BT) cotton is a genetically modified variant of a cotton producing plant that produces its own insecticide (Kathage & Qaim, 2012). This crop has decreased the need for insecticides and increased crop yields (Qaim, 2010). These factors have resulted in increased income from farming and therefore increased quality of life for the farmers that adopt these crops. GM crops have also contributed to solving malnutrition, particularly in developing countries. Vitamin A deficiency is known to have various clinical implications, including vision impairment (Sommer, 2008). GM rice, titled golden rice for its color, has been engineered to produce β-carotene, a precursor to vitamin A. Furthermore, the ability of the β-carotene from golden rice to produce vitamin A in children was equivalent to pure β-carotene, demonstrating its effectiveness (Haskell, 2012). Additionally, the crop could provide nutrition to remote populations that would otherwise not have access to vitamin A supplementation (Moghissi, Pei, & Liu, 2016). These examples provide a just basis for the monumental applications of GM crops.

In addition to overlooking the applications of GM crops, they are often falsely contraindicated. Given that there are herbicide tolerant GM crops, some sources claim that GM crops will promote herbicide use, and therefore lead to environmental harm, among other health effects like "sterility, hormone disruption, birth defects, and cancer" (Smith, 2010). Although the claim that herbicide resistant GM crops will encourage herbicide use is a logical progression of thought, it is not based in primary research. For example, a recent exhaustive meta-analysis has revealed GM crops have reduced the need for pesticides, indicated by a 37% decrease in pesticide use (Klümper & Qaim, 2014). In addition to the pesticide use claims, anti-GM sites often claim that GM crops definitively harm the environment (Glass, 2018). Although further research is required to evaluate the invasiveness and pervasiveness of GM crops and its effect on biodiversity (Tsatsakis et al., 2017), GM crops have had measurable positive impacts on the environment. For example, the increased crop yield and decreased pesticide use have resulted in decreased fuel use and tillage changes (Brookes & Barfoot, 2016). These reductions have resulted in a yearly decline in greenhouse gas production equivalent to that of 10 million cars (Brookes & Barfoot, 2016). Therefore, the positive impacts of GM crops are severely undermined by baseless claims rooted in pseudoscience.

Conclusion

As with any emerging innovation, fear can manifest and impede its institution. This is especially true for GM crops. A lack of science literacy has resulted in several erroneous implications of GM crops: a lack of understanding of genetics resulting in an unnatural outlook on GM crops and a fear of consuming altered DNA, incorrect interpretations of correlations of diseases and pseudoscientific health effects of GM crops, and overlooked applications that are surmounted by unsubstantiated claims. With an increase in science literacy, the unsubstantiated claims surrounding GM crops could be eradicated. Critical thinking paired with a search for reliable primary research could ail the growing pseudoscientific anti-GMO community. Thankfully, initiatives are already being developed to educate the public on pseudoscientific claims like those concerning GM crops to combat science illiteracy (Sherman, 2015). Hopefully the implementation of this program and future programs will help refute baseless claims to the general public and support innovative technologies like GM crops.

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