



Are Genetically-Modified Foods Made for the Common Good? The Perspectives of the Victoria Islanders

Koleayo Omoyajowo^{1,3}, Kolawole Omoyajowo¹, Adeyemi Akinola², Amos Ogunyebi³, Rebecca Alao⁴, Oladapo Makinde⁴, Oluseye Orekoya⁴, Benjamin Mwadi Makengo⁵, Olusegun Akinola⁶, Sarah Samson Jatau⁷, Josephine Daniel Kakwi⁷, Sandra Nonyerem Bunmi Ukoh³, Morufu Olalekan Raimi^{8*}

¹Project Management in Global Health Program, University of Washington, Seattle, United States

² Services Librarian, Mountain Top University, Library, Ogun State, Nigeria

³ Department of Cell Biology and Genetics, University of Lagos, Akoka, Nigeria

⁴ National Centre for Technology Management, Victoria Island, Lagos, Nigeria

⁵ School of Politics, University of Kinshasa, Kinshasa, Democratic Republic of the Congo

⁶ Department of Biochemistry, Babcock University, Nigeria

⁷ Department of Public Health, Faculty of Health Sciences, Plateau State University, Boko, Nigeria

⁸ Department of Environmental Management and Toxicology, Faculty of Sciences, Federal University Otuoke, Bayelsa State, Nigeria

*Corresponding Author:

Email: raimimo@fuotuoke.edu.ng

Article Information

<https://doi.org/10.69798/53920008>

Copyright ©: 2024 The Author(s).

This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC-BY-4.0) License, which permits the user to copy, distribute, and transmit the work provided that the original authors and source are credited.

Published by: Koozakar LLC, Norcross GA 30071, United States.

Note: The views expressed in this article are exclusively those of the authors and do not necessarily reflect the positions of their affiliated organizations, the publisher, the editors, or the reviewers. Any products discussed or claims made by their manufacturers are not guaranteed or endorsed by the publisher.

Edited by: Oluseye Oludoye PhD

Abstract

This research investigated the depth of public knowledge on genetically modified food products, and further explored their understanding of the underlining socio-environmental and public health benefits of GM food products within the socio-demographic indices. To achieve this goal, 369 respondents were recruited through a convenience sampling method in Victoria Island, Lagos, Nigeria and data were gathered using a structured questionnaire. The target population for this study comprised "employed adults either residing or working" on Victoria Island, Lagos. The results showed that the majority of respondents (n=232, 62.9%) were knowledgeable about GM foods and their associated issues. However, many believed that people in their neighborhood or community were not well-informed on the topic. However, awareness on GM foods and associated concerns may be associated with sociodemographic factors such as marital status and education (P<0.01). The majority of respondents were well-informed and had an understanding of the environmental and health advantages of GM foods. In fact, about 61.8% believed that GM food production could sustainably decrease the reliance on chemical pesticides, fertilizers, and other energy inputs, along with their ecological impacts. Most respondents did not feel that purchasing or consuming GM foods conflicted with their beliefs or would affect their food choices. This study recommends that the government should actively educate the public on the ecological and health benefits of GM foods and address any safety concerns. Furthermore, the government should implement strict border controls and food labeling for GM products to safeguard consumer rights arising from the preference for the consumption of organic foods. Additionally, sufficient technical and financial assistance should be provided to farmers who subscribe to the organic seeds program for bolstering national food security.

Keywords:

Biotechnology; Public perception; Awareness; Perception; GM Foods; Consumers' Rights

INTRODUCTION

Biotechnology has transformed various aspects of humanities by providing a way out of what seems impossible, ensuring the possibility of getting desired outcomes at an unimaginable pace. It has shown tremendous capabilities in alleviating hunger and poverty, particularly in low-income climes. At its core, biotechnology encompasses any technique that employs or modifies biological systems - such as plants, animals, and microorganisms - or their components to create innovative products like food, dairy items, antibiotics, and hormones, ultimately benefiting humanity. This field is vast, with successful applications in agriculture, food science, medicine, and environmental science (Das *et al.*, 2023).

The origins of agricultural biotechnology date back millennia to when farmers selected crops with desirable traits, such as enhanced resistance to pests and diseases, and larger seeds and fruits, to bolster crop yields and agro-productivity (Wieczorek & Wright, 2012). Modern advancements in gene technology now enable the selection and incorporation of superior genes from other species for agricultural and industrial uses. (Zhu, 2022).

For clarity, any plant, animal, microorganism, or their derivatives that have undergone genetic modification are known as Genetically Modified Organisms (GMOs) (Onyeji, 2018). Researchers note that the food market is continuously inundated with GMOs, reflecting the widespread adoption and integration of biotechnological innovations in agriculture (Ademola *et al.*, 2007). This saturation has profound implications for food production, distribution, and consumption, necessitating a nuanced understanding of its technical and socio-economic aspects.

The dynamism and uniqueness of the Nigerian culture and politics can be expressed in the varying foods, implying that issues related to food are not only essential for nourishment but are also central to cultural identity, economic stability, and political discourse. Different regions and ethnic groups in Nigeria have their own unique cuisines that are a source of pride and cultural heritage, which are often recognised in social practices, and celebrations. However, many families face daily challenges in securing decent and enough meals, and numerous children endure malnutrition and food allergies. The country's porous territorial

boundaries facilitate the illegal entry of various foreign crop produce, including food commodities. This influx has significantly reduced the availability of traditional Nigerian foods, and thereby limiting people's food choices. Occasionally, affluent politicians and both domestic and international non-profit organizations offer food aid. In light of these issues, people's food purchasing, and consumption decisions may be shaped by their unique socio-economic circumstances and personal beliefs.

The essence of the African saying "Food is life" and Maslow's theory on the hierarchy of needs highlight the crucial importance of food stability for human existence and growth. Several researches have emphasized the advantages of GMOs, as it concerns the reduction of food insecurity as well as providing resistance to pests and prolonged lack of rainfall (Qaim, 2009). In the 1990s, genetically modified (GM) foods were introduced, and crop yields have since continued to grow exponentially. This has contributed to the cultivation of over 102 million hectares of farmlands worldwide with varieties of genetically modified crops (James, 2006). This situation has significantly increased the volumes of GM agricultural products grown and commercially used, most affecting developing countries that are the most vulnerable to food security (Iloh *et al.*, 2018).

Numerous scholars have suggested allocating funds towards agricultural biotechnological exploration to create genetically modified (GM) foods. These food varieties hold the potential to tackle various global concerns regarding hunger and malnutrition, as well as contribute to environmental conservation efforts. By enhancing crop yields and minimizing dependency on artificial pesticides, GM foods offer promising solutions to these pressing issues (Pandey *et al.*, 2010). Moreover, agricultural biotechnology not only meets the escalating demands of an expanding global populace by bolstering yields but also drives down operational expenses and the prices of agricultural goods. This heightened efficiency in production translates into economic savings for consumers (Chen & Li, 2007).

Objectives of the Study

1. Within the community and workforce of Lagos Island, examining the extent of

understanding of GM sustenance and its benefits for nutrition and well-being.

2. Assessing the extent of societal knowledge about the agro-economic benefits of GM produce.
3. Measuring public opinions on the ecological and health impacts associated with GM nourishment.
4. Scrutinizing the sources from which people gain knowledge about genetically modified sustenance.
5. Exploring the elements that influence the manufacturing, intake, and spread of genetically modified sustenance.

Statement of the Problem

Nigeria, with its rapidly growing population, faces significant challenges in ensuring food security. Despite advances in agricultural technology, malnutrition and hunger remain prevalent issues. This is the reality that Nigeria and many developing climes faces, in the struggle for achieving the 2030 sustainable development goals. The rise of genetically engineered foods has become a widely proposed solution to improve crop yields and enhance food security. However, there is a lack of comprehensive data on the awareness, understanding, and patronage of GM foods among Nigerian consumers (Iloh *et al.*, 2018), particularly in urban areas like Lagos. Addressing this problem is crucial because understanding public perception and awareness can influence policy decisions, regulatory frameworks, and educational campaigns about GM foods. Without such data, efforts to promote GM foods may be met with resistance or fail to address public concerns effectively (Boldura & Popescu, 2016). Current literature on GM foods largely focuses on their agricultural and economic benefits, but there is a significant gap in research regarding consumer awareness and perception in the Nigerian context. Also, previous studies have shown that people perceive risk differently especially as it relates public health, ecological concerns, food safety, and exposure to toxins and allergens (Sateesh, 2008). This study aims to evaluate the depth of knowledge and perception of GM foods among residents of Lagos, Nigeria, explore factors influencing these perceptions, and identify strategies to improve public understanding and adoption of GM foods.

LITERATURE REVIEW

Hitherto, discourse on the emergence of transgenic organisms in agriculture and crop production has raised food safety concerns on different levels and has somewhat conflicted with consumers' rights in general. Fears and concerns about unidentified hazards to the human environment and public health are issues that still receive global attention, as people worry that GMOs could potentially transmit antimicrobial resistance genes or create unintended genetic material transfer by cross-breeding (Sateesh, 2008; Boldura & Popescu, 2016). Like other governments worldwide, the Nigerian government has received warnings from non-governmental organizations about the consequences of selling GM crops through the country's food system. These warnings stem from the lack of scientific evidence or integrity that can definitively prove organic produce are safe for both the environment and human health (Onyeji, 2018). Concerns include the potential for GM foods to trigger allergies, cause immune dysfunction, and lead to genetic disorders.

It is noteworthy that some countries have started advocating for the identification of GM products by labelling to facilitate efficient product surveillance and tracking, as well as to protect consumers' rights (European Commission, 2015). Regulatory agencies in many countries have risen to the challenge by conducting critical biosafety assessments of their nations' food supplies to detect unauthorized and potentially dangerous GM food products at retail outlets such as markets and shops (Okpara *et al.*, 2016). Despite these measures, public acceptance of scientific breakthroughs in certain food commodities remains low. For instance, the cultivation of GM versions of soybean, corn, cotton, and rapeseeds, which are herbicide-tolerant and pest-resistant, has met with skepticism (Sönmezoglu & Keskin, 2015).

There are concerns that foods are being imported into Nigeria illegally and without appropriate labeling through porous borders. A popular study attempted to identify GM food products sold in Nigerian markets across different geopolitical zones. Products examined encompassed maize powder, bean powder, cookies, beverages, culinary oil, complete dishes, corn cereal, biscuit snacks, maize crisps, maize gel, popped maize, sugary maize, infant nourishment, and bean pastries. The

study found that 26.7% of these products contained GMOs. According to Ilo *et al.* (2018), the detection of unlabeled GM food products in the market has heightened consumer fears and prompted food safety regulatory agencies to reinforce efficient detection methods, such as polymerase chain reaction (PCR), and ensure proper documentation.

Contrary to what is currently obtainable in developed climes in other continents of the world, consumer surveys are not often conducted or given due attention in Nigeria. Several studies suggest that opinions and viewpoints regarding genetically modified food products differ among individuals, countries, and across different periods (Chen & Li, 2007; Al-Khayri & Hassan, 2012). For example, an earlier survey in the US revealed that 58% of respondents had no idea about GM foods and could not distinguish them from traditional foods (Doering, 2005). Another study by the Pew Research Center (2016) found that despite the widely held opinion on the healthiness of genetically modified (GM) foods, many Americans remain sceptical, with a significant portion preferring non-GM options due to concerns about health risks, environmental impact, and the influence of industry on research findings. Similarly, research involving college students indicated that the majority either perceived genetically modified foods as dangerous or lacked knowledge about them and found it challenging to recognize these foods (Al-jebreen, 2010). Akinola (2017) asserted that the choices people make regarding agricultural information are socio-economic-linked. Another study reported that consumers and professionals had mostly negative opinions about gene technology, with 35% of the respondents having negative opinion about genetically modified foods.

In certain instances, the acceptance of genetically modified foods can be shaped by factors such as economic hardship or insufficient knowledge about genetically modified products (Ali *et al.*, 2016). Pachico and Wolf (2002) attributed the high propensity among consumers to try and buy GM products to the lack of quality food options at home. Matthews and Huffman (2001) argued that typical reasons for resistance to GM foods include moral, economic, and ecological issues, as well as concerns about health and international trade. Negative responses to GM foods have been linked

to perceived risks of negative impacts from their consumption. Onyango (2004) reported that well-informed consumers showed diminished willingness to try GM foods once they understood the risks. Baker and Burnham (2001) found that 30% of American buyers who showed interest in genetically modified cornflakes made purchasing choices based on a rational evaluation of their content. Gaskell *et al.* (2004) observed that European buyers generally emphasized the uncertain risks linked to GMO consumption, while American consumers did not scrutinize the risks or benefits as carefully. Furthermore, earlier research has shown that consumers often prefer to pay extra for non-GMO products (Lusk *et al.*, 2003).

Labeling of genetically modified foods is a policy aimed at transparency, though regulations differ internationally. This policy allows consumers to make educated choices regarding the purchase of GMO products. For example, while labeling GMO items is optional in some US states, it is mandatory in Japan and Europe. Should GMO products be labeled upon consumer demand, it might lead to widespread rejection. In Taiwan, where GMO foods are labeled, Ganiere *et al.* (2004) identified significant consumer resistance.

Given the growth in the biotechnology industry that produces food and the development of a retail food distribution network, public opinion regarding GM products and awareness of the health risks of consuming GM food are important. This determined the purpose of the current study. Due to the lack of information on Nigerian consumers' attitudes towards GM foods, the study aims to examine their level of awareness, willingness to consume, and acceptability of prices for these products.

MATERIALS AND METHOD

A structured survey was conducted face-to-face among residents and workers in Victoria Island, Lagos, Nigeria, to gauge their awareness and opinions regarding the environmental and health benefits of producing and consuming genetically modified (GM) foods, using the convenience sampling approach. Convenience sampling is a non-probability method where participants are selected based on their availability and willingness to participate (Omoyajowo *et al.*, 2024a). Researchers often choose this method for its

simplicity and cost-effectiveness. It was deemed suitable for this initial research focused on advocating for consumer rights regarding GMOs. A total of 369 respondents completed the questionnaires. The survey included inquiries about their awareness and knowledge of GM foods, opinions on whether genetic modification of crops could reduce pesticide use, familiarity with GM foods, and perceptions of their potential harm to human health. Participants were also asked about their willingness to purchase, consume, and accept GM foods, as well as their past consumption or purchase experiences.

To ensure clarity, the questionnaire began with a brief introduction to GM foods and their characteristics, allowing those unfamiliar with them to participate fully. Respondents were presented with statements framed both positively and negatively to mitigate potential biases (Omoyajowo et al., 2021, 2023). All questions underwent validation by two scholars specializing in cell biology, genetics, and biotechnology. The questionnaire was developed in English and took approximately 10 minutes to complete. Data analysis employed descriptive statistics (means and percentages), correlation analysis, and contingency tables with P-values adjusted using the Bonferroni Method in IBM SPSS Statistics 28.0.

Study Area

Victoria Island, situated within the Eti-Osa Local Government Area (LGA) of Lagos State, Nigeria,

is a prosperous district encompassing Lagos Island, Ikoyi, and the Lekki Peninsula. It is surrounded by the Lagos Lagoon (see Figure 1) and serves as the primary hub for business and finance in Lagos State. Known for its affluent status, Victoria Island offers a range of recreational activities and job opportunities. It is considered a costly yet relatively secure residential area, and it notably accommodates numerous diplomatic missions, embassies, and consulates in Lagos. Furthermore, Victoria Island hosts the headquarters of several government agencies, religious institutions, major corporations, and multinational companies. The residents of Victoria Island are predominantly focused on community, professionals, entrepreneurial, adventurous, and open to new prospects.

We consider the study area appropriate as it represents a diverse civil community, encompassing affluent residents, middle-class professionals, and workers from various socio-economic backgrounds. This diversity makes Victoria Island an ideal location for assessing public awareness and perception of GM foods, as it encompasses a broad spectrum of opinions and experiences. The presence of educated professionals and expatriates in this area also suggests a higher likelihood of exposure to global discussions on biotechnology and GM foods, which is crucial for our study.

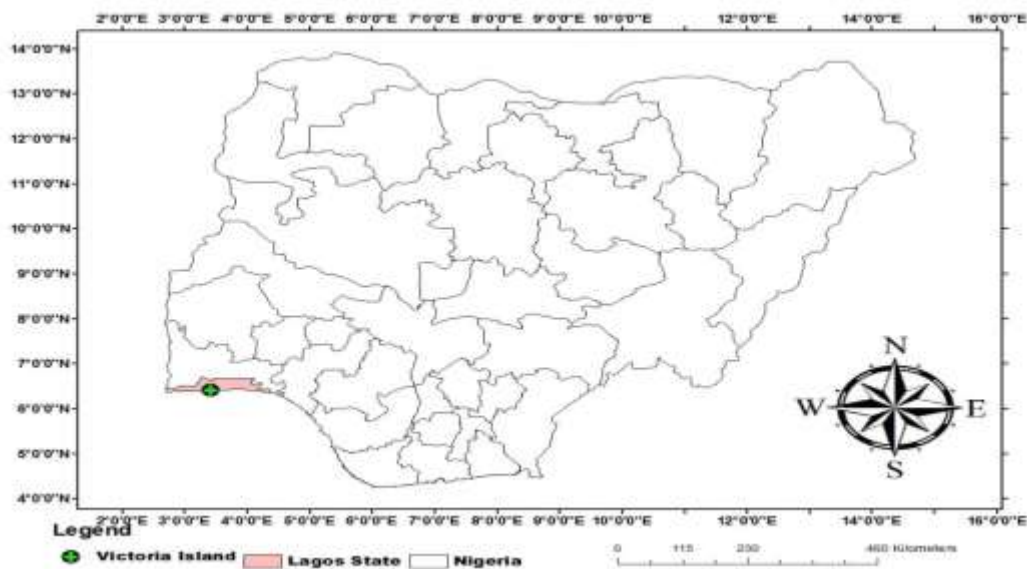


Figure 1: Map of Study Area

RESULTS AND DISCUSSIONS

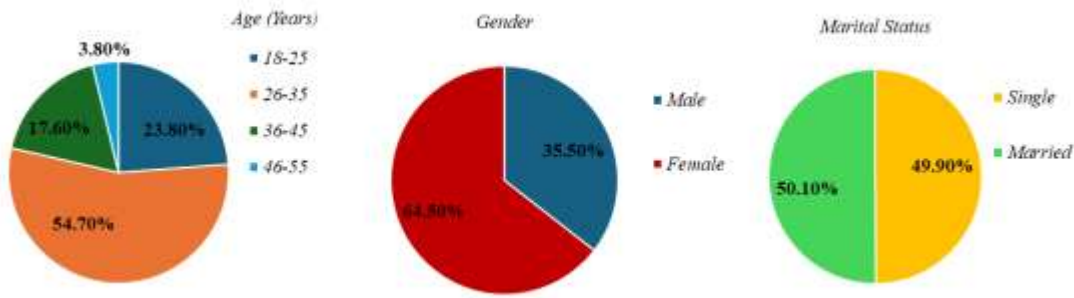


Figure 2: Respondents' Demographic data (Age, Gender, Marital Status)

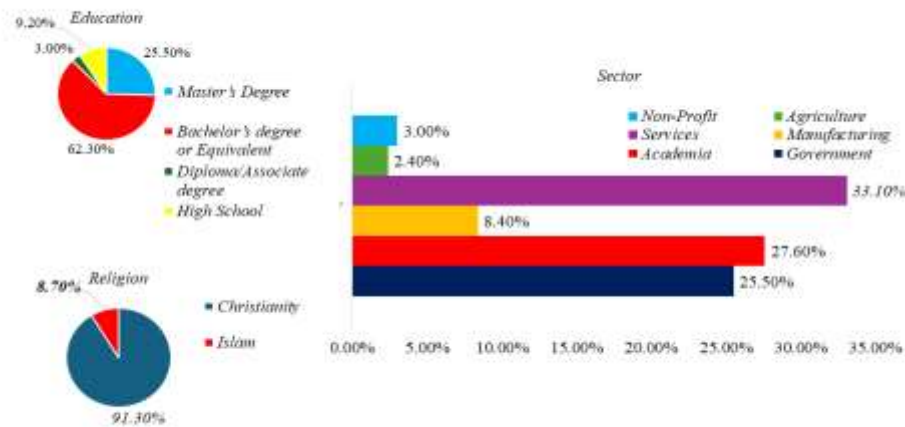


Figure 3: Respondents' Demographic data (Education, Religion and Job Sector)

The examination of sociodemographic data offers perspectives on the connection between social identity and additional variables (Abdelal *et al.*, 2009; Omoyajowo *et al.*, 2024b). Participants in this research were employed in diverse sectors of the Nigerian economy (see Figure 3). Specifically, 33.1% were affiliated with the service sector, 27.6% with academia and research institutions, 25.5% with government, 8.4% with manufacturing, 3.0% with non-profit organizations, and 2.4% with agriculture.

Most respondents (54%) were between the ages of 26-35, while 23.8% were between 16-25, indicating that most participants were young and socially active. Females constituted 64.5% of the sample, while males made up 35.5% (see Figure 2). A nearly equal distribution was observed regarding marital status, with 50.1% married and 49.9%

single. The religious affiliation was predominantly Christianity (91.3%), with a minority (8.7%) identifying with Islam. Regarding their educational attainment, 62.3% of participants held a bachelor's degree or equivalent, 25.5% had completed a master's degree, 9.2% possessed a high school diploma, and 3.0% had obtained a national diploma. This demographic indicates that the respondents were generally well-educated, young, and socially active, suggesting they would be attentive to public and food-related issues, potentially holding diverse views on food-health matters, including GM foods. These demographics are consistent with findings from previous public awareness surveys (Omoyajowo *et al.*, 2021, 2023, 2024a, 2024b). Akinola (2017) proposed that socio-economic factors may impact public awareness, especially in terms of how people acquire information and make decisions.

Level of Awareness on GM foods

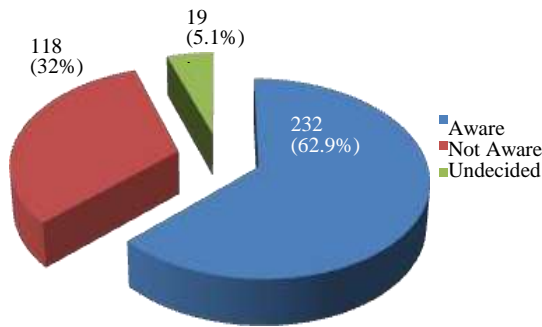


Figure 4: Level of Awareness on GM foods (n=369)

Increasing public knowledge on any aspect of public health is crucial for facilitating well-informed governmental decisions, gaining community support, and mobilizing local resources towards positive health outcomes (Omoyajowo et al., 2021). Specifically, understanding about genetically modified (GM) foods can profoundly influence consumer behaviors and acceptance. As depicted in Figure 4, the level of familiarity with GM foods among the participants in this study was relatively high at 62.9%, indicating that a majority of respondents were informed about GM foods and recognized their nutritional and health benefits.

Meanwhile, 32% of participants lacked awareness, and 5.1% were unsure.

Previous research has shown varied levels of awareness regarding GM foods. For instance, Huang et al. (2006) revealed that two-thirds of urban consumers had heard about GM foods, although their understanding of biotechnology was limited. The Hartman Group (2018) reported near-universal consumer awareness of GM foods at 97%, with an increasing number of consumers seeking to avoid them. In contrast, Patron (2005) found that many consumers in Trinidad (90%) had little knowledge about GM foods, and most suppliers (67%) were unaware that they sold genetically modified foods. Similarly, a 2016 report by the Pew Research Center indicated that 29% of Americans were well-informed about GM foods, while 19% had not heard anything about them. Ali and Rahut (2018) observed disparities in awareness among Pakistani farmers: over 90% were knowledgeable about GM cash crops, but few were aware of GM food crops and vegetables.

These findings underscore the necessity for comprehensive public education on the advantages of GM foods, encompassing their nutritional and environmental benefits. Utilizing diverse communication channels to educate the public can empower individuals to make informed decisions about their food choices, promoting both legal and public acceptance of GM foods

Table 1: Perception on the level of public acceptance of GM foods

	Strongly Disagree (SD)	Disagree (D)	Somewhat Disagree (SWD)	Undecided (U)	Somewhat Agree (SWA)	Agree (A)	Strongly Agree (SA)
I think my community lacks awareness of the nutritional and health benefits of consuming GM food products.	18(4.9)	19(5.1)	62(16.8)	100(27.1)	60(16.3)	39(10.6)	71(19.2)
I think GM seeds are not available to farmers to use	20(5.4)	6(1.6)	59(16.0)	130(35.2)	19(5.1)	59(16.0)	76(20.6)
I think GM seeds are not user-friendly or easily reproducible	48(13.0)	47(12.7)	60(16.3)	143(38.8)	26(7.0)	24(6.5)	21(5.7)
Producing GM foods requires some sort of special education and training.	33(8.9)	17(4.6)	47(12.7)	108(29.3)	31(8.4)	18(4.9)	155(31.2)
GM production can lead to the loss of local food sources or cultivars	37(10.0)	53(14.4)	48(13.0)	108(29.3)	55(14.9)	26(7.0)	42(11.4)
I doubt if the government supports GM foods	50(13.6)	57(15.4)	36(9.8)	104(28.2)	70(19.0)	24(6.5)	28(7.6)
No existing policies to sustain the adoption and patronage of GM foods	18(4.9)	23(6.2)	38(10.3)	151(40.9)	74(20.1)	24(6.5)	41(11.1)
GM foods are very expensive and can only be purchased by wealthy people	40(10.8)	37(10.0)	40(10.8)	153(41.5)	32(8.7)	31(8.4)	36(9.8)
I have a reserved taste for organic foods compared to GM foods	61(16.5)	42(11.4)	41(11.1)	126(34.1)	12(3.3)	19(5.1)	68(18.4)
The production and consumption of GM foods is against my belief	151(40.9)	38(10.3)	27(7.3)	86(23.3)	53(14.4)	9(2.4)	5(1.4)
GM foods are not real "They are not what they claimed to be"	106(28.7)	45(12.2)	33(8.9)	132(35.8)	15(4.1)	13(3.5)	25(6.8)
I am afraid of the potential health havoc that the consumption of GM foods may cause in the future	49(13.3)	73(19.8)	56(15.2)	82(22.2)	15(4.1)	30(8.1)	64(17.3)
Consuming GM foods may reduce my life expectancy	107(29.0)	12(3.3)	47(12.7)	121(32.8)	20(5.4)	27(7.3)	35(9.5)

(Calculated Agreement % = %SWA+%A+%SA, Disagreement% = %SD+%D+%SWD) **Source:** Field Survey 2019

Table 1 depicts public perceptions regarding the acceptance of genetically modified (GM) foods. A majority of respondents (46.1%) expressed varying degrees of agreement (16.3% somewhat agree; 10.6% agree; 19.2% strongly agree) that individuals in their community lack awareness of the nutritional and health benefits associated with consuming GM foods/products. This perceived lack of awareness echoes findings from previous studies (Patron, 2005; Huang *et al.*, 2006). Insufficient awareness about public health, safety, and socio-economic significance can hinder national development. Continuous public education on the benefits and potential risks of GM foods is therefore essential.

Additionally, over 40% of participants (5.1% somewhat agree, 16.0% agree, 20.6% strongly agree) believed that GM seeds are not accessible to farmers, while 35.2% were unsure and the remainder disagreed (Table 1). Adequate provision of GM seeds by relevant agricultural agencies could incentivize farmers to cultivate more drought- and pest-resistant crops, thereby enhancing national food security. Previous reports indicate that farmers opt for GM seeds due to increased yields and cost savings (AFS, 2018). GM crops have contributed to reducing hunger by boosting incomes for 18 million smallholder farming families, benefiting over 65 million people in developing countries (AFS, 2018).

Regarding the usability of GM seeds, more than 40% disagreed with the statement that GM seeds are not user-friendly (13% strongly disagreed, 12.7% disagreed, 16.7% somewhat disagreed), while 38.8% were undecided and the remainder agreed. This finding may not fully represent farmers' perspectives, as only 2.4% of respondents were from the agricultural sector. Farmers often save and replant GM seeds unless restricted by intellectual property rights (AFS, 2018). Nevertheless, in various public sector projects such as the Hawaiian papaya and insect-resistant eggplant in Bangladesh, farmers are permitted to save and share GM seeds without royalty obligations (AFS, 2018).

Regarding the educational and technical expertise required for GM food production, over 40% of respondents believed that this influences public acceptance, while 29.3% were undecided and

approximately 26% disagreed. About 37% disagreed that GM crops could lead to the loss of local food sources or cultivars, with 29.3% undecided and about 33% agreeing. Therefore, concerns about losing local cultivars may not significantly affect public acceptance of GM foods.

Approximately 38% disagreed with the assertion that the government does not support GM foods, while 28.2% were undecided and 33% agreed. This indicates that most respondents perceive government support for GM food production and distribution, consistent with previous findings among the American population (PRC, 2016). Around 37% believed that there are weak or nonexistent policies to sustain GM food adoption, while 40% were undecided. Previous studies have noted limited trust in scientists associated with GM foods (PRC, 2016). This study advocates for inclusive policymaking involving scientists, small-scale farmers, and the public.

Regarding the cost of GM foods, 41.5% were undecided, approximately 30% disagreed, and only 26.9% agreed that GM foods are expensive and accessible only to the wealthy. Moreover, 39% disagreed that a preference for organic foods influences acceptance of GM foods, with 34% undecided and 26% agreeing. Thus, a preference for organic foods does not significantly influence acceptance of GM foods.

Recent studies have shown that some individuals often engage in anthropogenic activities driven by deep spirituality or religious beliefs (Omoyajowo *et al.*, 2023). In this study, the majority of respondents (58.5%) disagreed with the statement "GM food production and consumption conflict with their spiritual or religious beliefs," while 23.3% were undecided and the rest agreed. This suggests that religious beliefs do not majorly influence acceptance of GM foods. This finding aligns with previous research indicating that media, environmental activists, scientists, and the food industry have a greater impact on consumer perceptions than religious beliefs (Omobowale *et al.*, 2009).

Approximately 50% of respondents believed that GM foods are authentic, 35.8% were undecided, and a minority doubted their authenticity. Regarding potential health risks, 48.3% expressed no concerns, 22.2% were undecided, and 29%

expressed fears. Previous studies have reported similar mixed perceptions, with some perceiving no difference between GM and conventional foods, while others view GM foods as risky for health (PRC, 2016). Younger adults and those concerned about health risks are more likely to view GM foods skeptically (PRC, 2016). Additionally, 45% did not believe that GM foods could shorten life expectancy, 32.8% were undecided, and 22.2% agreed.

Approximately 40.9% were uncertain about existing policies supporting GM food adoption, while 36.9% were unsure if policies were supportive. Effective policies are crucial to promote GM food adoption. Finally, 31.2% strongly agreed that GM food production requires education and technical expertise. Concerns about food and environmental safety due to genetic modification techniques underscore the need for companies to engage qualified experts (Boldura and Popescu, 2016).

Table 2: Source of Information on GM foods Awareness

Source(s)	Frequency (%)
Internet/social media	194 (52.57)
Family & Friends/Word of Mouth	117 (30.71)
Government Agencies	58 (15.72)

Source: Field Survey 2019

Table 2 shows that the primary sources of information about GM foods for respondents were the internet and social media (52.5%), followed by family and friends/word of mouth (30.7%), and government agencies (15.7%). This finding is consistent with previous public awareness surveys on information sources (Mittal and Mehar, 2013; Omoyajowo *et al.*, 2024a, 2024b). This study underscores the significant role that internet and social media platforms play in promoting awareness and knowledge about public health topics, including GM foods.

According to Table 3, a majority of the participants (50.41%) seldom purchase or consume genetically modified foods, then 28.83% of the participant occasionally consume modified foods.

Table 3: How often do Respondents buy or eat GM Foods

How Often Do You Buy or Eat GM Foods	Frequency (%)
Always	55 (14.91)
Very Frequently	30 (8.13)
Occasionally	99 (28.83)
Rarely	185 (50.14)

Source: Field Survey 2019

Additionally, 14.91% and 8.13% of respondents indicated that they purchase or consume GM foods "very frequently" and "always," respectively. Another study found that despite limited knowledge of biotechnology, Consumers in Beijing generally exhibited positive disposition towards genetically modified (GM) foods, especially those with enhanced product qualities, with willingness to pay influenced by positive opinions and self-reported knowledge (Li *et al.*, 2002). In contrast, a study highlighted that Americans' food preferences are strongly influenced by their emphasis on healthy and nutritious eating habits (PRC, 2016).

Table 4: Public Perception and Knowledge on the Environmental Benefits of GM Food Production System

Variables/Statements	Yes	NO	Undecided
Production of biotech plants (GM plants) could help save space, water, energy inputs and other resources	210(56.9)	118(32.0)	41(11.2)
Willingness to be involved in the production of GM foods	221(59.9)	114(30.9)	34(9.2)
I think farmers and other stakeholders involved the national food production system will benefit from the economic gains of GM foods	279(75.6)	55(14.9)	35(9.5)
Biotech (GM) food production could sustainably help reduce the use of chemical pesticides, fertilisers, and other energy inputs as well as their impacts	228(61.8)	117(31.7)	24(6.50)

Source: Field Survey 2019

Based on results of our findings presented in Table 4, most respondents acknowledged the potential benefits of GM food production. Specifically, 75.6% of participants believed that farmers and other stakeholders in the national food production system would reap economic benefits from genetically modified (GM) foods, while 61.8%

agreed that GM food production could lower the use of chemical pesticides, fertilizers, and energy resources. Additionally, 59.6% were willing to engage in GM food production initiatives.

Although this study did not thoroughly investigate the factors affecting public willingness to participate in such programs, findings from Ali and Rahut (2018) indicated that households with higher incomes and more extensive landholdings were more inclined to take part. Moreover, 56.9% of respondents agreed that GM plant production could conserve resources like space, water, and energy, indicating a positive perception of GM technology's environmental benefits.

These findings align with Sönmezoğlu and Keskin's (2015) assertion that GM crops, such as herbicide-tolerant and insect-resistant soybeans, maize, cotton, and rapeseeds (*Brassica napus*), are increasingly cultivated globally, contributing to debates on their health and safety implications. However, public opinion on GM foods varies. A report cited by PRC (2016) indicated that while some express concerns about the environmental and health effects of GMOs, others remain optimistic. This suggests that perceptions of GM food production's environmental and health benefits may differ across regions and cultures.

Table 5: Correlation Matrix between Socio-demographic information, Awareness, and Perception

	Age (1)	Gender (2)	Marital Status (3)	Religion (4)	Education (5)	Awareness on GM foods (6)	Perception (7)
1	1	.149**	.594**	-.044	-.463**	.054	.238**
		.004	.000	.400	.000	.298	.000
2		1	.393**	-.194**	-.313**	.081	.137**
			.000	.000	.000	.122	.009
3			1	.076	-.308**	.164**	.320**
				.144	.000	.002	.000
4				1	-.044	.057	.147**
					.403	.277	.005
5					1	.216**	-.275**
						.000	.000
6						1	-.007
							.898
7							1

***. Correlation is significant at the 0.01 level (2-tailed)*

The correlation matrix below highlights the varying degrees of relationships between sociodemographic factors (age, gender, marital status, education) and the awareness and perceptions of genetically modified (GM) foods (Table 5). Notably, age exhibits a positive but weak correlation with perception ($p < 0.01$), indicating that older respondents may have more favorable views of GM foods. This finding contrasts with a prior study of the US population, which found that younger individuals are more likely to recognize health benefits in organic produce and perceive health risks in GM foods (PRC, 2016).

Similarly, gender and religious affiliation (Christianity or Islam) show weak but positive correlations with perception ($p < 0.01$). This suggests that gender and membership in either Christian or Muslim religious groups may influence

perceptions of GM foods in Nigeria. Previous research has shown that men are more likely to have positive views of GM foods compared to women (PRC, 2016). However, there is limited evidence to establish a significant correlation between religious affiliations and perceptions of GM foods. Interestingly, awareness of GM foods and their benefits demonstrates weak but positive correlations with both marital status and education. This indicates that marital status and educational background may affect individuals' perceptions of GM foods. Higher levels of education and scientific knowledge may lead to more favorable views of GM foods. Overall, these findings underscore the influence of socio-demographic factors on public perceptions of GM foods in Nigeria, highlighting the importance of considering these variables in future research and policymaking endeavors.

Table 6: Cross Tabulation between Respondents’ level of awareness and Socio-Demographic information

Variables	Respondents' Level of Awareness on GM Foods				Total
	Categories	Yes	No	Not Sure	
Age	18-25	47 _a	41 _b	0 _a	88
	26-35	140 _a	57 _{a, b}	5 _b	202
	36-45	35 _a	16 _a	14 _b	65
	46-55	10 _a	4 _a	0 _a	14
	Total	232	118	19	369
Gender	Male	84 _a	47 _a	0 _b	131
	Female	148 _a	71 _a	19 _b	238
	Total	232	118	19	369
Religion	Christianity	217 _a	101 _b	19 _{a, b}	337
	Islam	15 _a	17 _b	0 _{a, b}	32
	Total	232	118	19	369
Education	Master’s Degree	82 _a	7 _b	5 _a	94
	Bachelors or Eq.	134 _a	82 _a	14 _a	230
	OND/NCE	0 _a	11 _b	0 _{a, b}	11
	High School	16 _a	18 _b	0 _{a, b}	34
	Total	232	118	19	369
	Marital Status	Single	124 _a	60 _a	0 _b
Married		108 _a	58 _a	19 _b	185
Total		232	118	19	369

OND/NCE=National Diploma/Certificate, Eq. =Equivalent, each subscript letter denotes a subset of Respondents' Awareness on GM Foods categories whose column proportions do not differ significantly from each other at the 0.05 level. Results of Z-test, column proportions were compared, and P-values were adjusted (by Bonferroni Method). Yes – awareness, No– Lack of Awareness, Not Sure–Indecision. (Source: Field Survey 2019)

The comparative analysis offered profound understanding into the connections between sociodemographic factors and awareness of genetically modified (GM) foods (see Table 6). Among all age groups, except for those aged 18-25 years, there were no significant differences ($p>0.05$) in levels of awareness. Notably, respondents within the 18-25 age group exhibited a significantly higher level of awareness. Gender did not significantly influence awareness levels ($p>0.05$), although studies suggest that women tend to be more informed and concerned about GM foods compared to men (PRC, 2016). Regarding religion, while most respondents identified as Christians, there was a significantly higher awareness level ($p<0.05$), but a significantly lower level among Muslim respondents. Educational attainment was associated with awareness, with individuals holding a master's degree demonstrating significantly higher awareness ($p<0.05$), whereas those with an associate degree equivalent (OND/NCE) or a high school diploma showed significantly lower awareness. Marital

status did not significantly affect awareness levels ($p>0.05$).

CONCLUSION

Based on the findings of the study, it is evident that Victoria Islanders, like many others globally, are cognizant of the importance of genetically modified (GM) foods in addressing food security challenges. Despite initial concerns about potential health risks, respondents showed a nuanced understanding of the benefits offered by GM crops, including increased crop yields, resistance to diseases and pests, and the provision of nutritious food options that still resonate with various cultural identities. The study underscored the crucial role of GM foods in promoting sustainability within the food production system and creating socio-economic opportunities for farmers and food producers. Victoria Islanders recognize that GM technology has the potential to address pressing agricultural challenges, such as limited arable land, water scarcity, and the need for environmentally friendly farming practices.

One notable finding of the study was the prevalence of awareness about GM foods among respondents, with many accessing information through internet and social media platforms. This indicates a growing interest and engagement with discussions surrounding GM technology, reflecting a desire for informed decision-making regarding food choices. Moreover, the study revealed that Victoria Islanders generally possess a solid understanding of the environmental and health benefits associated with GM food production systems. This suggests a high level of literacy and awareness regarding the potential implications of GM technology on both human health and the environment.

However, it is important to prioritize consumers' right as well as understand that perceptions regarding GM foods may vary across different demographic groups, influenced by factors such as gender, education, and religion. Therefore, efforts to promote awareness and understanding of GM technology should consider these diverse perspectives and tailor communication strategies accordingly.

Based on these findings, we offer the following recommendations for informed policy decisions:

1. Government and relevant stakeholders should prioritize efforts to educate the public about the comprehensive environmental and health benefits of GM foods, while also addressing safety concerns. This education should utilize various media channels to reach diverse audiences effectively.
2. Governments should take proactive measures to strengthen border controls and enforce food labeling regulations for GM products in the Nigerian market. This will empower consumers to make informed choices and protect their rights, particularly those who prefer organic foods.
3. Adequate training and financial support should be provided to farmers and interested citizens to facilitate the cultivation of GM crops. This will contribute to addressing food insecurity challenges in the country and promote sustainable agricultural practices.
4. Government agencies must collaborate to establish and implement a cohesive risk-management system for monitoring the safety of both existing and new biotechnology products. This system should prioritize environmental, human, and animal health

considerations to ensure the overall safety of GM foods and their production processes.

Future research should investigate the efficacy of current regulatory frameworks governing GM foods in Nigeria and beyond, aiming to pinpoint areas for enhancement concerning safety assessment, labelling standards, and enforcement protocols. Furthermore, studies should delve into the health and environmental consequences of consuming and producing GM foods. Understanding how demographic variables such as gender, education, religion, and socio-economic status shape consumer perceptions and attitudes towards GM foods is essential. Additionally, examining the determinants of farmers' choices regarding the adoption or rejection of GM crops is crucial for informed policymaking and sustainable agricultural practices.

Author Contributions: KOO conceived the idea, wrote the first draft, and performed the data analysis. KAO co-wrote the second draft and participated in the literature review. AAA contributed to the literature review and the interpretation of the results. ALO participated in the literature review and provided technical guidance. RBO, OM, and OO participated in the literature review and data collection. BMM, OA, SSJ, JDK, SNB, and MOR each contributed to the literature review. All authors contributed to the final draft and approved the manuscript.

Data Availability Statement: The data used in this study can be provided by the corresponding author upon reasonable request.

Funding Statement: No funding was received for this study.

Conflict of Interest: The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Ethical Statement: Although formal ethical approval was not obtained for this study, it adhered to the ethical principles outlined in the Helsinki Declaration.

Supplementary Data: Not applicable.

REFERENCE

- Abdelal, R., Herrera, Y. M., Johnston, A. I., & McDermott, R. (2009). *Measuring identity: A guide for social scientists* (pp. 1–16). New York, NY: Cambridge University Press.
- Ademola, S. A., Bakare, A. A., & Morenikeji, O. A. (2007). Genetically Modified Foods in Nigeria: a long-lasting solution to hunger? *Estud. Biol.* 29(67), 191-202.
- Akinola, A. A. (2017). Influence of socio-economic factors on farmers' use of mobile phones for agricultural information in Nigeria. Retrieved from <https://digitalcommons.unl.edu/libphilprac/>
- Ali, A., & Rahut, D. B. (2018). Farmer's willingness to grow GM food and cash crops: empirical evidence from Pakistan. *GM crops & food*, 9(4), 199–210.
- Ali, A., Rahut, D. B., & Imtiaz, M. (2016). Acceptability of GM foods among Pakistani consumers. *GM Crops & Food*, 7(2), 117-124
- Al-jebreen, D. H. (2010). Perception and attitude of Riyadh University Students towards products derived from Genetically modified Crops in Saudi Arabia. *Pakistan Journal of Biological Sciences*, 13(1), 28-33.
- Al-Khayri, J. M., & Hassan, M. I. (2012). Socio-demographic Factors influencing Public Perception of GM foods in Saudi Arabia. *American Journal of Food Technology*, 7(3), 101-112.
- Alliance For Science. (AFS) (2018). *10 Myths about GMOs*. Retrieved from <https://allianceforscience.cornell.edu/wp-content/uploads/2018/03/mythsFINAL.pdf>
- Baker, G. A., & Burnham, T. A. (2001). Consumer response to genetically modified foods: Market segment analysis and implications for producers and policy makers. *Journal of Agricultural and Resource Economics*, 26(2), 1-17
- Boldura, O. M., & Popescu, S. (2016). PCR: A Powerful Method in Food Safety Field. In A. Samadikuchaksaraei (Ed.), *Biochemistry, Genetics and Molecular Biology "Polymerase Chain Reaction for Biomedical Applications"* (pp. 135-158). Intech Publishers, USA.
- Chen, M. F., & Li, H. L. (2007). The consumers' attitude toward genetically modified foods in Taiwan. *Food Quality and Preference*, 18, 662-674.
- Doering, C. (2005). Americans split overbuying cloned meats. Poll (Reuters). Retrieved from <http://forums.seochat.com/Science-news-71/Americans-split-overbuying-cloned-meats/57478.html>
- Das S, Ray MK, Panday D, Mishra PK (2023) Role of biotechnology in creating sustainable agriculture. *PLOS Sustain Transform* 2(7): e0000069. <https://doi.org/10.1371/journal.pstr.0000069>
- EC (European Commission). (2015). Fact sheet: Questions and answers on EU's policies on GMOs. Available at http://europa.eu/rapid/press-release_MEMO-15-4778_en.htm.
- Ganiere, P. W., Chen, D. H., & Chiang, F. (2004). Consumers attitudes towards genetically modified foods in emerging markets: The impact of labeling in Taiwan. *International Food and Agribusiness Management Review*, 7, 1-3.
- Gaskell, G., Allum, N., Bauer, M. W., Durant, J., Allansdottir, A., Bonfadelli, H., & de Cheveigné, S. (2004). GM foods and the misperception of risk perception. *Risk Analysis*, 24(1), 185-194.
- Hartman Group. (2018). *Organic & Natural 2018*. Retrieved from <https://www.hartman-group.com/reports/45201607/organic-natural-2018-02/11/2022>
- Huang, J., Qiu, H., Bai, J., & Pray, C. (2006). Awareness, acceptance of and willingness to buy genetically modified foods in Urban China. *Appetite*, 46(2), 144-151.
- Iloh, A. C., Onyenekwe, P. C., & Ojo, O. O. (2018). Detection of genetically modified DNA in processed maize and soybean products in Nigeria. *African Journal of Biotechnology*, 17(35), 1090-1098.
- James, C. (2006). Global Status of commercialized Biotech/GM Crops ISAAA Brief 35-2006. Retrieved from <https://www.isaaa.org/resources/publications>
- Li, Q., Curtis, K. R., McCluskey, J. J., & Wahl, T. I. (2002). Consumer attitudes toward genetically modified foods in Beijing, China. *AgBioForum*, 5(4), 145-152
- Lusk, J. L., Roosen, J., & Fox, J. A. (2003). Demand for beef from contaminated growth hormones or fed genetically modified corn: A comparison of consumers in France, Germany, the United Kingdom and the United States. *American Journal of Agriculture*, 81, 16-21.
- Matthew, R., & Huffman, W. E. (2001). GM Food and its trading partners. Staff Paper No.344, Iowa State University, Department of Economics. Retrieved from <http://ageconsearch.umn.edu/bitstream/18245/1/isu344.pdf>
- Mittal, S., & Mehar, M. (2013). Socio-Economic Impact of the Mobile Phone based Agricultural Extension. *Mobile Phones for Agricultural Extension*.
- Okpara, C. N., Elijah, A. I., Adamu, L. O. G., & Uzochukwu, S. V. A. (2016). Screening for genetically modified maize in raw and processed foods sold commercially in Southern Nigeria Border States. *Applied Food Biotechnology*, 3, 50-158.
- Omobowale, E. B., Singer, P. A., & Daar, A. S. (2009). The three main monotheistic religions and GM food technology: an overview of perspectives. *BMC international health and human rights*, 9, 18. <https://doi.org/10.1186/1472-698X-9-18>
- Omoyajowo, K. O., Adewunmi, M. A., Omoyajowo, K. A., Ogunyebi, A. L., Njoku, K. L., Makengo, B. M., ... Ojo-Emmanuel, G. (2024a). Transitioning to a Climate-Resilient Society: Empirical Evidence on What Drives the Adoption of Green Computing Policies in Nigerian Organizations. *Trends in Ecological and Indoor Environmental Engineering*, 2(1), 28-34. <https://doi.org/10.62622/TEIEE.024.2.1.28-34>
- Omoyajowo, K., Agbaogun, B., Ogunyebi, A., Kanaan, M., Omoyajowo, B., Makengo, B. M., Alayemi, A., Omoyajowo, K., & Alao, R. (2024b). Is bisphenol A (BPA) a public health concern? A cross-sectional study of public knowledge, attitude and risk perception in southwestern part of Nigeria. *FUDMA Journal of Sciences*, 8(2), 364-372.
- Omoyajowo, K., Danjin, M., Omoyajowo, K., Odipe, O., Mwadi, B., May, A., Alao, R. (2023). Exploring the interplay of environmental conservation within spirituality and multicultural perspective: insights from a

- cross-sectional study. *Environ Dev Sustain*, (2(24)), 35–46. doi: 10.1007/s10668-023-03319-5.
- Omoyajowo, K., Raimi, M., Waleola, T., Odipe, O., & Ogunyebi, A. (2021). Public Awareness, Knowledge, Attitude, and Perception on Microplastics pollution around Lagos Lagoon. *Ecology Safety and Balanced Use of Resources*, 2(24), 35-46
- Onyango, B. (2004). Consumer acceptance of Genetically modified foods: Role of product benefits and perceived risk. *Journal of Food Distribution Resources*, 35, 154-161.
- Onyeji, E. (2018). Don't Introduce GMO crops- Group warn Nigerian government. Retrieved from www.premiumtimesng.com/healthnews
- Pachico, D., & Wolf, M. (2002, July). Attitudes toward genetically modified food in Colombia. Paper presented at the 6th International ICABR Conference, Ravello, Italy.
- Pandey, A., Kamle, M., Yadava, L. P., Muthukuma, M., & Kumar, P. (2010). Genetically modified food: its uses, future prospects ad safety assessment. *Biotechnology*, 9, 444-458.
- Patron, D. (2005). A survey of GM foods consumed health implications and recommendations for public health food safety in Trinidad. *International Journal of food safety*, 7, 4-14.
- Pew Research Center. (2016). *The New Food Fights: U.S. Public Divides Over Food Science*, 100pp.
- Qaim, M. (2009). The economics of genetically modified crops. *Ann. Rev. Resource Economics*, 1, 665-694.
- Sateesh, M. K. (2008). Use of genetically modified organisms and their release in the environment. In S. M. K. Sateesh (Ed.), *Bioethics and Biosafety*. (pp. 217-242). New Delhi: I.K. International Pvt. Ltd.
- Sönmezoğlu, O. A., & Keskin, H. (2015). Determination of genetically modified corn and soy in processed food products. *Journal of Applied Biology and Biotechnology*, 3, 32-37.
- Wieczorek, A. M., & Wright, M. G. (2012). History of Agricultural Biotechnology: How Crop Development Has Evolved. *Nature Education Knowledge*, 3(10), 9.
- Zhu, Y. (2022). Advances in CRISPR/Cas9. *Biomedicine & Pharmacotherapy*, 2022, 9978571. <https://doi.org/10.1155/2022/9978571>