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Article

Genetically Modified Foods: Victoria Islanders' Perspectives on the Common Good

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Abstract: Rationale: Genetically modified (GM) foods have the potential to reduce food insecurity and address economic and environmental issues. Despite these benefits, GM foods continue to face significant criticism and there is limited information on public awareness and understanding of their nutritional and environmental health benefits in Nigeria. This study aims to fill this gap by investigating public knowledge and perceptions of GM foods in Victoria Island, Lagos. **Methods:** A convenience sampling method was used to recruit 369 respondents from Victoria Island, Lagos. Data were gathered using a structured questionnaire. The target population comprised employed adults either residing or working on Victoria Island. Statistical analyses were conducted to examine the relationship between sociodemographic factors and awareness of GM foods. **Results:** The study found that a majority of respondents (62.9%, n=232) were knowledgeable about GM foods and their associated issues. However, many believed that their community was not well-informed on the topic. Awareness of GM foods was significantly associated with sociodemographic factors such as marital status and education ($P<0.01$). Most respondents were well-informed about the environmental and health benefits of GM foods, with 61.8% believing that GM food production could sustainably reduce reliance on chemical pesticides, fertilizers, and other energy inputs, thus mitigating their ecological impacts. Additionally, most respondents did not feel that purchasing or consuming GM foods conflicted with their beliefs or would affect their food choices. **Conclusion:** The study concludes that while individual awareness of GM foods is relatively high, there is a perception that community awareness is low. Sociodemographic factors play a significant role in shaping public awareness and perceptions of GM foods. **Recommendations:** This includes government should actively educate the public on the ecological and health benefits of GM foods and address any safety concerns; Implement strict border controls and food labeling for GM products to protect consumer rights and preferences for organic foods, provide sufficient technical and financial assistance to farmers who participate in organic seed programs to enhance national food security. **Significant Statement:** This study highlights the importance of public education on GM foods and underscores the need for government intervention to ensure informed consumer choices and support for sustainable agricultural practices.

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Keywords: environmental health; biotechnology; nutritional benefits; public perception; ecological impact; public awareness; perception; genetically modified foods; consumer education; individual rights; socio-demographic factors**;** food security**;** Victoria Island

1. Introduction

Biotechnology has revolutionized many facets of human life by enabling the seemingly impossible and ensuring rapid achievement of desired outcomes. It has shown remarkable potential in alleviating hunger and poverty, particularly in low-income regions [1–6]. At its essence, biotechnology involves using or modifying biological systems such as plants, animals, microorganisms, or their components to create innovative products like food, dairy items, antibiotics, and hormones, benefiting humanity extensively [7–11]. This field is vast, with successful applications in agriculture, food science, medicine, and environmental science. The origins of agricultural biotechnology trace back millennia when farmers selected crops with desirable traits such as enhanced pest and disease resistance, and larger seeds and fruits to improve crop yields and productivity [12]. Modern advancements in gene technology now enable the selection and incorporation of superior genes from other species for agricultural and industrial uses [7–11]. Genetically Modified Organisms (GMOs) are any plants, animals, microorganisms, or their derivatives that have undergone genetic modification [13]. The food market is increasingly saturated with GMOs, reflecting the widespread adoption of biotechnological innovations in agriculture [14–16]. This prevalence has significant implications for food production, distribution, and consumption, necessitating a nuanced understanding of its technical and socio-economic aspects. In Nigeria, the dynamic and unique cultural and political landscape is reflected in the diverse foods, indicating that food issues are not only essential for nourishment but are also central to cultural identity, economic stability, and political discourse [17–21]. Different regions and ethnic groups in Nigeria boast unique cuisines that are sources of pride and cultural heritage, recognized in social practices and celebrations. However, many families struggle daily to secure adequate meals, with numerous children suffering from malnutrition and food allergies. The country's porous borders allow the illegal entry of various foreign crops, reducing the availability of traditional Nigerian foods and limiting food choices [22–25]. Occasionally, affluent politicians and both domestic and international non-profit organizations provide food aid. Consequently, people's food purchasing and consumption decisions are influenced by their socio-economic circumstances and personal beliefs.

The African saying "Food is life" and Maslow's hierarchy of needs emphasize the critical importance of food stability for human existence and growth. Research highlights the advantages of GMOs in reducing food insecurity and providing resistance to pests and drought [26]. Since the introduction of genetically modified foods in the 1990s, crop yields have grown exponentially, leading to the cultivation of over 102 million hectares of GM crops worldwide [27]. This increase has significantly impacted developing countries most vulnerable to food security [28]. Scholars advocate for funding agricultural biotechnological research to develop GM foods, which could address global hunger and malnutrition while contributing to environmental conservation. By enhancing crop yields and reducing reliance on artificial pesticides, GM foods offer promising solutions to these critical issues [29]. Moreover, agricultural biotechnology not only meets the growing demands of an expanding global population by increasing yields but also reduces operational costs and prices of agricultural goods, resulting in economic savings for consumers [30]. While Nigeria, with its rapidly growing population, faces significant challenges in ensuring food security [1–6]. Despite advances in agricultural technology, malnutrition and hunger remain prevalent. This is a reality for Nigeria and many other developing countries striving to achieve the 2030 Sustainable Development Goals [31]. The rise of genetically engineered foods has been widely proposed as a solution to improve crop yields and enhance food security [22–25]. However, there is a lack of comprehensive data on the awareness, understanding, and patronage of GM foods among Nigerian consumers, particularly in urban areas like Lagos [28]. Addressing this issue is crucial because public perception and awareness

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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 [32].

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. Additionally, previous studies have shown that people perceive risks differently, especially in relation to public health, ecological concerns, food safety, and exposure to toxins and allergens [33–68]. Thus, this study aims to examine the understanding of genetically modified (GM) sustenance and its nutritional benefits within the community and workforce of Lagos Island, assess societal knowledge about the agro-economic advantages of GM produce, measure public opinions on the ecological and health impacts of GM nourishment, scrutinize the sources of information about genetically modified sustenance, and explore the factors influencing the production, consumption, and distribution of GM foods. 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.

2. Literature Review

The discourse surrounding the emergence of transgenic organisms in agriculture and crop production has long been fraught with concerns regarding food safety, impacting consumers' rights and generating apprehension at multiple levels. The potential risks associated with GMOs, such as the transmission of antimicrobial resistance genes or unintended genetic transfers through cross-breeding, remain a focal point of global scrutiny [18,19,32,33,42,43]. Such concerns have prompted non-governmental organizations to caution the Nigerian government about the implications of integrating GM crops into the national food system, emphasizing the lack of conclusive scientific evidence on the safety of these products for both human health and the environment [9,11,13,41,47,55,59–61,63,68]. Key issues include the possibility of GM foods triggering allergies, causing immune dysfunctions, and leading to genetic disorders [39,40,44–46,49,50,53,54]. In response to these concerns, some countries have begun advocating for the labeling of GM products to enhance product surveillance and tracking while protecting consumer rights [69]. Regulatory agencies globally are stepping up by conducting thorough biosafety assessments to identify unauthorized and potentially hazardous GM food products in retail outlets such as markets and shops [70]. Despite these initiatives, public acceptance of GM food products remains tepid, with particular skepticism directed at herbicide-tolerant and pest-resistant GM varieties of soybean, corn, cotton, and rapeseed [71].

Nigeria faces additional challenges with the illegal importation of unlabeled GM foods through its porous borders. A notable study revealed that 26.7% of food products in Nigerian markets, including maize powder, bean powder, cookies, beverages, and various maize-based snacks, contained GMOs. This discovery has heightened consumer fears and prompted regulatory bodies to enhance detection methods, such as polymerase chain reaction (PCR), to ensure accurate documentation and safety [28]. Unlike many developed countries, Nigeria lacks robust consumer surveys to gauge public opinion on GM foods. Studies indicate that perceptions of genetically modified food products vary widely across different regions and time periods [30,72]. For instance, a survey in the United States revealed that 58% of respondents were unaware of GM foods [73], and a Pew Research Center study found persistent skepticism among Americans despite general beliefs in the healthiness of GM foods [74]. Similar sentiments were observed among college students, with many viewing GM foods as hazardous or lacking knowledge to recognize them [75]. Akinola [76] highlighted the socio-economic factors influencing agricultural information preferences. Negative opinions on gene technology prevail among consumers and professionals alike, with 35% of respondents expressing adverse views on GM foods. Economic hardship and inadequate knowledge about GM products further complicate acceptance [77]. Pachico and Wolf [78] linked consumer willingness to try GM products to the scarcity of quality food options. Resistance to GM foods is often rooted in moral, economic, ecological concerns, and worries about health and international trade [79]. Onyango [80] noted that well-informed consumers exhibited decreased willingness to try GM foods

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after understanding the risks involved. Baker and Burnham [81] found that 30% of American buyers based their decisions on a rational assessment of genetically modified cornflakes' content. In contrast, European consumers generally emphasized the uncertain risks of GMO consumption, while Americans did not scrutinize these risks as meticulously [82]. Additionally, research has shown a consumer preference for paying extra for non-GMO products [83].

The labeling of genetically modified foods aims at transparency, though international regulations vary. For instance, while labeling is optional in some US states, it is mandatory in Japan and Europe. Labeling upon consumer demand could potentially lead to widespread rejection, as evidenced by significant resistance in Taiwan [84]. Given the expanding biotechnology industry and the evolving retail food distribution networks, understanding public opinion and awareness of the health risks associated with GM foods is crucial. This context underscores the purpose of the current study, which seeks to fill the informational gap regarding Nigerian consumers' attitudes towards GM foods, examining their awareness, willingness to consume, and acceptability of prices for these products.

3. Materials and Method

3.1. Study Area

Victoria Island, located within the Eti-Osa Local Government Area (LGA) of Lagos State, Nigeria, is a thriving and prosperous district that includes Lagos Island, Ikoyi, and the Lekki Peninsula. Enclosed by the Lagos Lagoon (see Figure 1), Victoria Island stands as the primary hub for business and finance in Lagos State [85–87]. Renowned for its affluence, the district offers a wide array of recreational activities and ample job opportunities. It is recognized as an expensive yet relatively secure residential area, notably hosting numerous diplomatic missions, embassies, and consulates in Lagos. Additionally, Victoria Island is home to the headquarters of several government agencies, religious institutions, major corporations, and multinational companies [85,86]. The community on Victoria Island is predominantly composed of professionals, entrepreneurs, and individuals who are adventurous and open to new prospects. This district is marked by a strong sense of community among its residents, who represent a balanced mix of various socio-economic statuses. This diversity includes affluent residents, middle-class professionals, and workers from different economic backgrounds, making Victoria Island a microcosm of broader societal dynamics. We consider Victoria Island an appropriate study area because it epitomizes a diverse and dynamic civil community. Its mix of socio-economic statuses and the presence of educated professionals and expatriates provide a broad spectrum of opinions and experiences. This diversity is ideal for assessing public awareness and perception of genetically modified (GM) foods, as it reflects a range of perspectives that are crucial for our study. The residents' exposure to global discussions on biotechnology and GM foods further enhances the relevance of Victoria Island as a representative location for this research.

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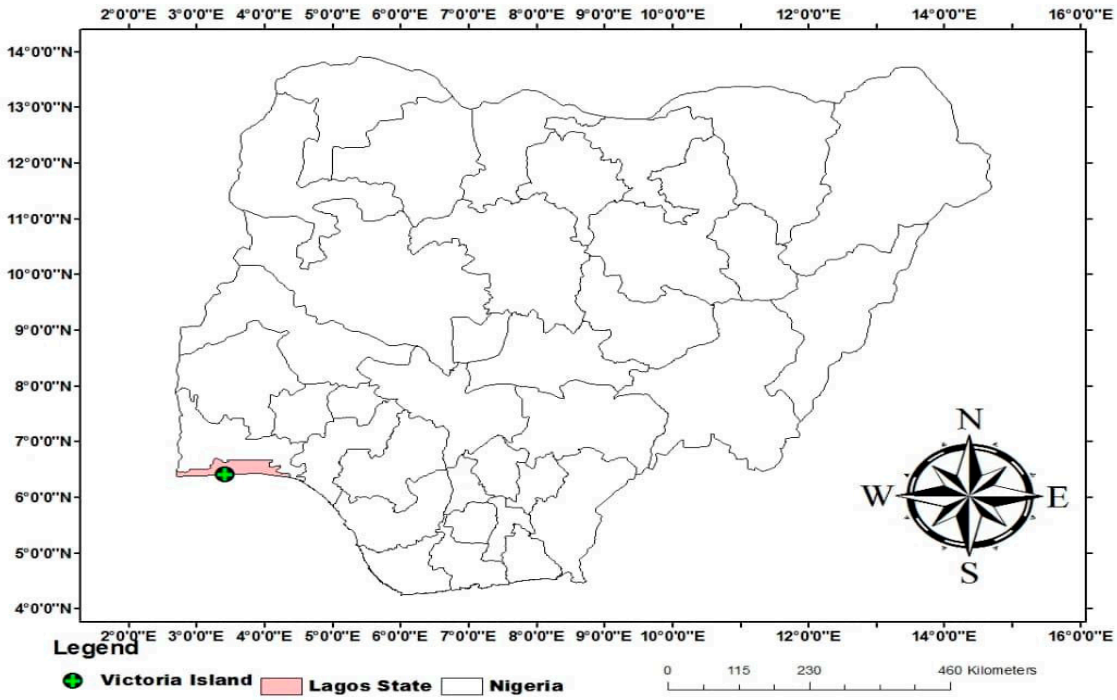

Figure 1. showing study Location.

3.2. Study Design

This study utilized a cross-sectional survey design to collect data on the awareness and opinions of residents and workers in Victoria Island, Lagos, Nigeria, regarding the environmental and health benefits associated with the production and consumption of genetically modified (GM) foods. The primary objective was to understand public perception and knowledge of GM foods, providing a basis for advocating consumer rights concerning GMOs.

3.3. Study Population

The study targeted adult residents and workers in Victoria Island, Lagos, Nigeria. Victoria Island is a commercial and residential area with a diverse population, making it an ideal location for assessing a wide range of opinions and awareness levels regarding GM foods.

3.4. Study Duration

The survey was conducted over a period of three months, from January to March 2024. This timeframe allowed for sufficient data collection and ensured that a diverse cross-section of the population could be included in the study.

3.5. Inclusion Criteria

Participants included in the study were:

i. Adults aged 18 years and above.
ii. Residents or workers in Victoria Island, Lagos.
iii. Willing and available to participate in the survey.
iv. Able to provide informed consent.

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3.6. Exclusion Criteria

Participants excluded from the study were:

i. Individuals below 18 years of age.
ii. Non-residents or those not working in Victoria Island.
iii. Unwilling or unavailable to participate in the survey.
iv. Unable to provide informed consent.

3.7. Sample Size Calculation

A sample size of 369 respondents was determined for this study. The choice of sample size was influenced by several factors. Firstly, the convenience sampling method was employed, where participants were selected based on their availability and willingness to participate rather than through random selection. This approach, while not providing a statistically representative sample, allows for quick and cost-effective data collection, which is suitable for preliminary research. The sample size of 369 was deemed sufficient for several reasons. It provides a large enough group to capture a wide range of opinions and levels of awareness about GM foods within the target population of Victoria Island. This number allows for meaningful statistical analysis, offering insights into general trends and patterns regarding the community's perceptions and knowledge. Additionally, the sample size was chosen to balance the need for comprehensive data collection with the practical constraints of time, resources, and accessibility of participants. Given the exploratory nature of the study, the goal was to gather a robust snapshot of the current state of awareness and opinions on GM foods, which can then inform further, more detailed research.

By involving 369 respondents, the study aims to achieve a level of diversity and variability in responses that can highlight different perspectives within the population. This size helps ensure that the findings are not overly influenced by outliers or atypical responses, providing a more reliable basis for understanding the broader trends in public opinion regarding GM foods in the region. In summary, the sample size of 369 respondents, chosen through convenience sampling, is intended to provide a valuable preliminary overview of awareness and opinions on GM foods. This initial data collection serves as a foundation for future research, which may utilize more rigorous sampling methods and larger sample sizes to build on these preliminary findings.

3.8. Sampling Techniques

The study employed a convenience sampling approach, a non-probability method where participants were selected based on their availability and willingness to participate. This method was chosen for its simplicity and cost-effectiveness, making it suitable for preliminary research.

3.9. Study Instrument

A structured questionnaire was developed in English for data collection. The questionnaire consisted of multiple sections, including demographic information, awareness and knowledge of GM foods, opinions on environmental and health impacts, willingness to purchase and consume GM foods, and past experiences with GM foods. The questionnaire was validated by two scholars specializing in cell biology, genetics, biotechnology and environmental health to ensure content validity.

3.10. Study Procedure

Participants were approached face-to-face in various locations within Victoria Island, including commercial areas, residential neighbourhoods, and public spaces. The survey was introduced with a brief explanation of GM foods and their characteristics to ensure all respondents had a basic understanding before answering the questions. This approach helped address any unfamiliarity among participants and reduce potential biases.

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3.11. Data Collection Tools

The primary data collection tool was the structured questionnaire. It was designed to be completed in approximately 10 minutes, with statements framed both positively and negatively to mitigate response bias. Data collection was facilitated by trained research assistants who ensured the accurate and consistent administration of the questionnaire.

3.12. Study Variables

The study variables included:

i. **Independent Variables:** Demographic information (age, gender, education level, occupation), awareness and knowledge of GM foods, opinions on environmental and health impacts, willingness to purchase and consume GM foods, past experiences with GM foods.

ii. **Dependent Variables:** Awareness and opinions on the environmental and health benefits of GM foods.

3.13. Data Analysis

Data analysis was conducted using IBM SPSS Statistics 28.0. Descriptive statistics, including means and percentages, were used to summarize the data. Correlation analysis and contingency tables were employed to explore relationships between variables. P-values were adjusted using the Bonferroni Method to ensure accuracy and minimize the risk of Type I errors. The results were presented in tables and figures to facilitate clear interpretation and understanding.

4. Results and Discussions

The examination of sociodemographic data provides valuable insights into the relationship between social identity and other variables [88,89]. Participants in this study were employed across various sectors of the Nigerian economy, reflecting the diversity of the workforce. Specifically, 33.1% were involved in the service sector, 27.6% were engaged in academia and research institutions, 25.5% worked in government roles, 8.4% were employed in manufacturing, 3.0% were part of non-profit organizations, and 2.4% were involved in agriculture. The age distribution of the respondents showed that a majority (54%) were between 26 and 35 years old, while 23.8% were between 16 and 25 years old, indicating a predominantly young and socially active cohort. Gender distribution revealed that females constituted 64.5% of the sample, while males made up 35.5%. Marital status was nearly evenly split, with 50.1% of participants being married and 49.9% being single (see Figure 2 below).

Religious affiliation among respondents was predominantly Christian (91.3%), with a minority (8.7%) identifying as Muslim. In terms of 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 (see Figure 3 below). This demographic profile indicates that the respondents were generally well-educated, young, and socially active, which suggests a heightened attentiveness to public and food-related issues. This demographic is likely to hold diverse views on food-health matters, including genetically modified (GM) foods. These demographic trends align with findings from previous public awareness surveys [89–92]. Akinola [76] suggested that socio-economic factors can significantly impact public awareness, particularly in terms of information acquisition and decision-making processes. This underscores the importance of considering sociodemographic variables when assessing public perceptions and awareness, as they offer critical insights into how different segments of the population engage with and respond to various issues, including biotechnology and GM foods.

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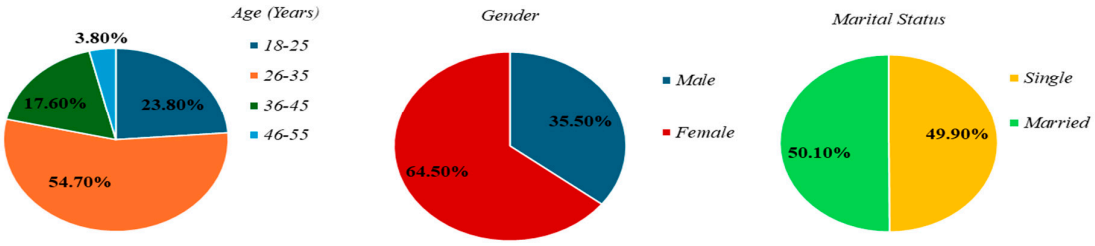

Figure 2. Respondents' Demographic data (Age, Gender, Marital Status).

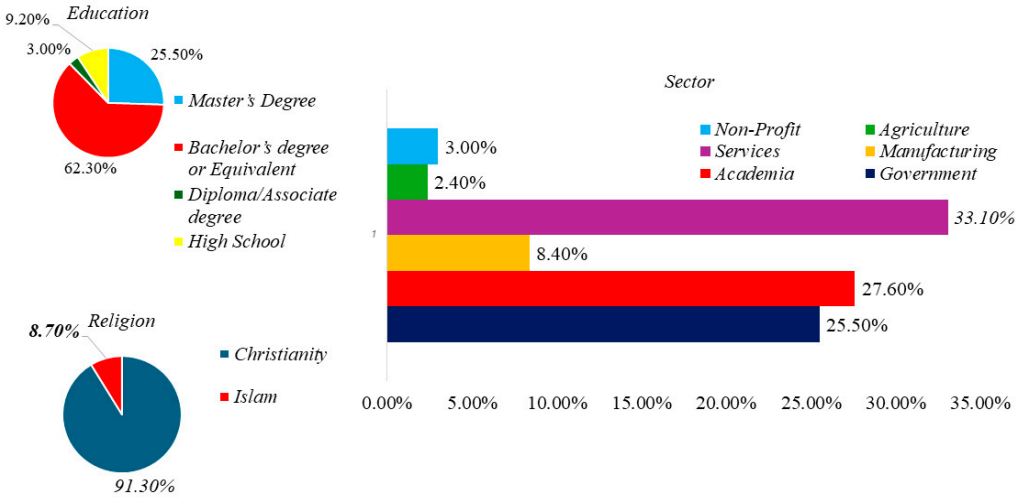

Figure 3. Respondents' Demographic data (Education, Religion and Job Sector).

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 [90]. Specifically, understanding genetically modified (GM) foods can significantly 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. Conversely, 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. [93] revealed that two-thirds of urban consumers had heard about GM foods, although their understanding of biotechnology was limited. The Hartman Group [94] reported near-universal consumer awareness of GM foods at 97%, with an increasing number of consumers seeking to avoid them. In contrast, Pattron [95] 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 [96] observed disparities in awareness among Pakistani farmers: over 90% were knowledgeable about

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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. Such education initiatives are essential for ensuring that the public is well-informed, which in turn supports the adoption and integration of GM foods into everyday life.

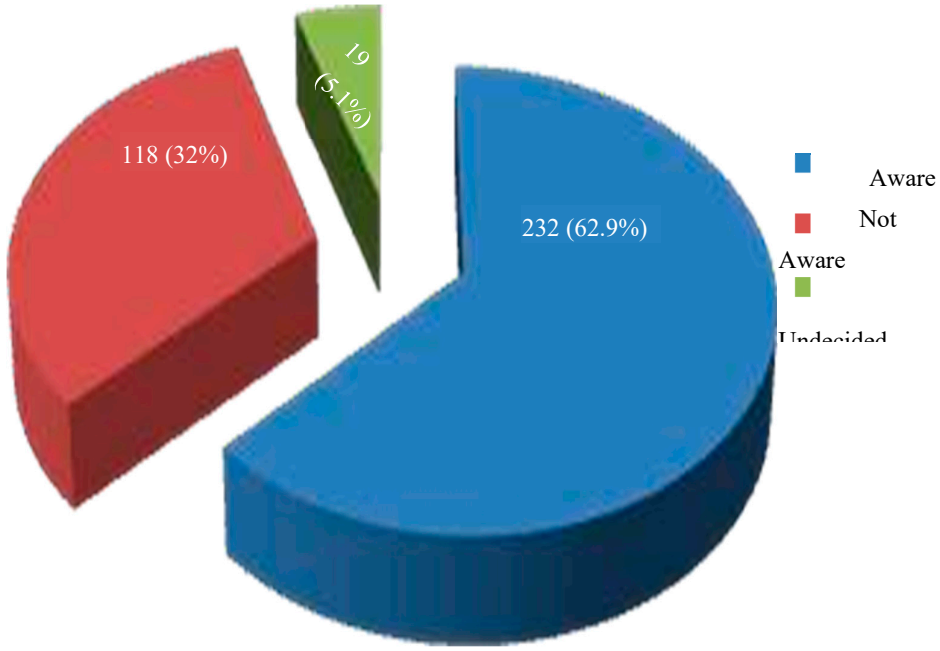

Figure 4. Level of Awareness on GM foods (n=369).

Table 1 illustrates public perceptions on the acceptance of genetically modified (GM) foods. A significant portion of respondents (46.1%) indicated varying degrees of agreement (16.3% somewhat agree; 10.6% agree; 19.2% strongly agree) that there is a lack of awareness in their communities regarding the nutritional and health benefits of GM foods/products. This perceived lack of awareness aligns with previous studies by Pattron, [95] and Huang *et al.*, [93]. Insufficient awareness about public health, safety, and socio-economic significance can impede national development, underscoring the need for continuous public education on both the benefits and potential risks of GM foods. 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. Proper distribution of GM seeds by agricultural agencies could encourage farmers to grow more drought- and pest-resistant crops, enhancing national food security (35, 36, 38-40, 44, 5157, 58). Previous reports indicate farmers opt for GM seeds due to increased yields and cost savings [97]. GM crops have helped reduce hunger by boosting incomes for 18 million smallholder farming families, benefiting over 65 million people in developing countries [97].

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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	49 13.3%	73 19.8%	56 15.2%	82 22.2%	15 4.1%	30 8.1%	64 17.3%

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consumption of GM foods may cause in the future							
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.

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 might 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 [97]. However, in public sector projects like the Hawaiian papaya and insect-resistant eggplant in Bangladesh, farmers can save and share GM seeds without royalty obligations [97]. Over 40% of respondents believed that educational and technical expertise required for GM food production 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. Thus, concerns about losing local cultivars may not significantly impact 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 suggests that most respondents perceive government support for GM food production and distribution, consistent with previous findings among the American population [98]. Around 37% believed 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 [98]. 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 engage in anthropogenic activities driven by deep spirituality or religious beliefs [91]. In this study, the majority of respondents (58.5%) disagreed with the statement that 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 [87,99].

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 seeing no difference between GM and conventional foods, while others view GM foods as risky for health [98]. Younger adults and those concerned about health risks are more likely to view GM foods skeptically [98]. 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 [32].

Figure 5 reveals that respondents primarily obtained information about GM foods from the internet and social media, which accounted for 52.5% of the responses. This was followed by family and friends or word of mouth, at 30.7%, and government agencies, at 15.7%. These findings align with previous public awareness surveys on information sources, such as those by Mittal and Mehar [100] and Omoyajowo *et al.* [89,92]. This study highlights the pivotal role of internet and social media

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platforms in disseminating information and raising awareness about public health issues [101–116], including GM foods. The substantial reliance on digital platforms indicates a shift in how people access and trust information, emphasizing the need for credible and accurate content online to inform public opinion and decision-making [87].

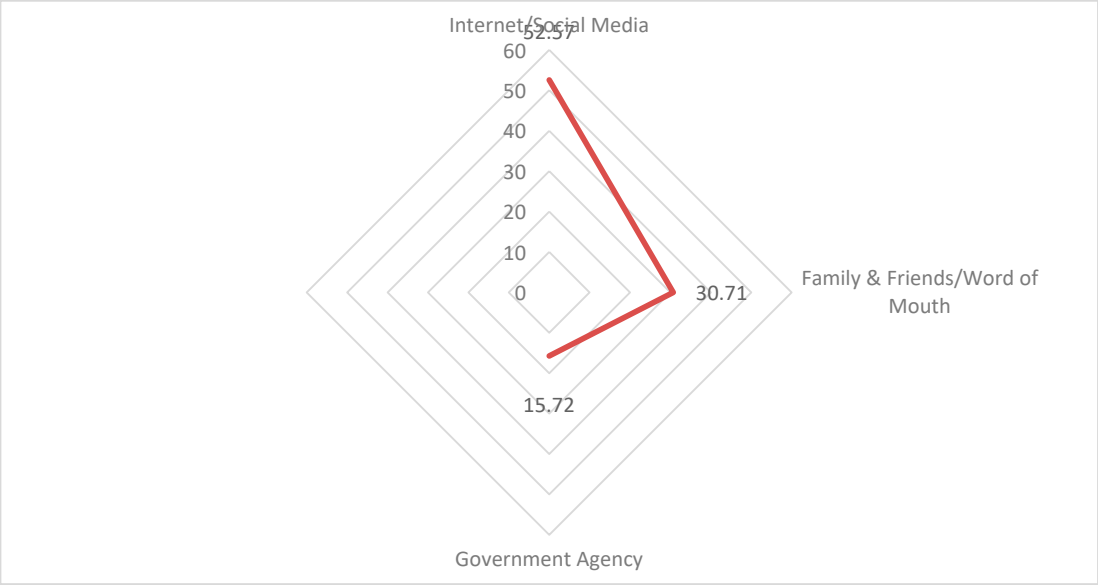

Figure 5. Source of Information on GM foods Awareness. Source: Field Survey 2019.

According to Figure 6, a significant portion of participants (50.41%) reported that they seldom purchase or consume genetically modified (GM) foods. This is followed by 28.83% who indicated occasional consumption. Additionally, 14.91% of respondents stated that they purchase or consume GM foods "very frequently," while 8.13% reported that they "always" do so. In a related study, despite limited knowledge of biotechnology, consumers in Beijing generally showed a positive attitude towards GM foods, particularly those with enhanced product qualities. Their willingness to pay for such products was significantly influenced by positive opinions and self-reported knowledge [117]. On the other hand, research highlighted that Americans' food preferences are strongly shaped by their focus on healthy and nutritious eating habits [98]. These findings illustrate diverse consumer behaviors and attitudes towards GM foods across different regions. They emphasize the complex interplay between knowledge, perception, and cultural factors in shaping food choices. The varied frequency of GM food consumption observed in our study, combined with insights from previous research, underscores the importance of public education and transparent information to guide informed decision-making regarding GM foods.

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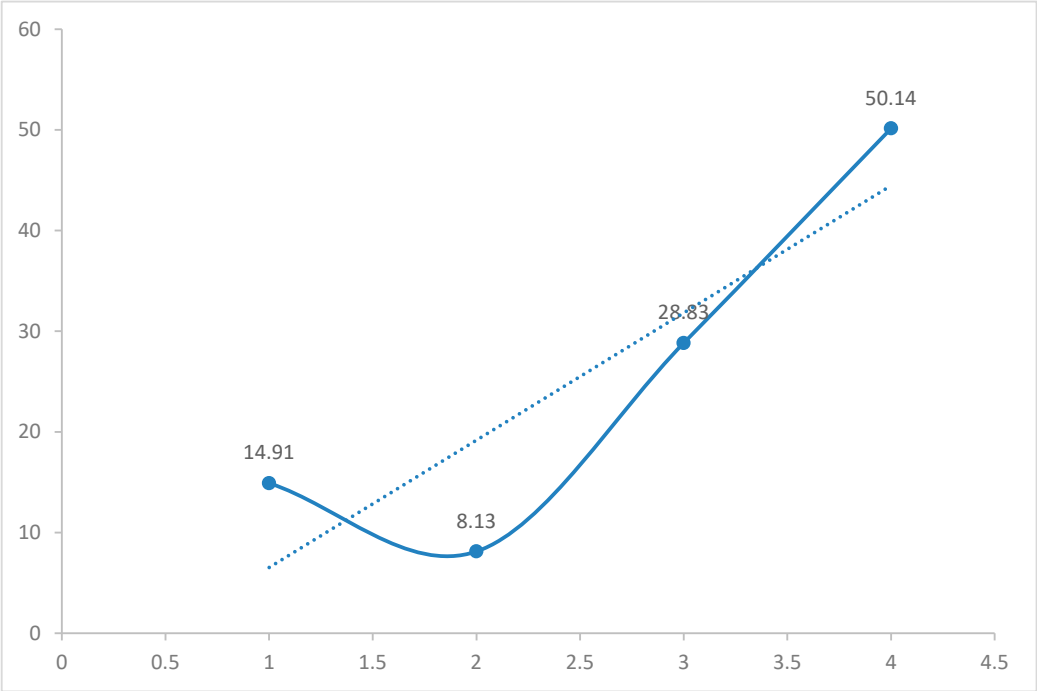

Figure 6. How often do Respondents buy or eat GM Foods.

Based on the results presented in Table 2, a significant majority of respondents acknowledged the potential benefits associated with genetically modified (GM) food production. Specifically, 75.6% of participants believed that farmers and other stakeholders in the national food production system would experience economic advantages from GM foods. Moreover, 61.8% agreed that GM food production could effectively reduce the reliance on chemical pesticides, fertilizers, and energy resources [36,38–40,44,53,118]. Additionally, a noteworthy 59.6% expressed willingness to participate in GM food production initiatives. Although this study did not delve deeply into the factors influencing public participation in such programs, previous research by Ali and Rahut [96] suggested that households with higher incomes and larger landholdings were more inclined to engage in GM food production. Furthermore, 56.9% of respondents recognized that GM plant production could contribute to resource conservation, including space, water, and energy, underscoring a favorable perception of GM technology's environmental benefits. These findings resonate with Sönmezoğlu and Keskin's [71] observations that GM crops, such as herbicide-tolerant and insect-resistant soybeans, maize, cotton, and rapeseeds (Brassica napus), are increasingly cultivated worldwide, sparking discussions about their implications for health and safety. Nevertheless, public opinion on GM foods remains diverse. A report referenced by PRC [98] highlighted varying concerns among different populations regarding the environmental and health impacts of GMOs, indicating that perceptions of GM food production's benefits can vary significantly across regions and cultures.

Table 2. 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%)

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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.

The correlation matrix presented above (table 3) provides insights into the relationships between sociodemographic factors such as age, gender, marital status, and education and awareness and perceptions of genetically modified (GM) foods. Notably, age demonstrates a statistically significant positive correlation with perception ($P < 0.01$), albeit weak, suggesting that older respondents tend to hold more favorable views towards GM foods. This finding contrasts with research on the US population, which suggests that younger individuals are more likely to perceive health benefits in organic produce and express concerns about health risks associated with GM foods [98]. Similarly, gender and religious affiliation (Christianity or Islam) also exhibit weak but positive correlations with perception ($P < 0.01$). This implies that being male or belonging to either Christian or Muslim religious groups may influence how GM foods are perceived in Nigeria. Previous studies indicate that men generally hold more positive attitudes towards GM foods compared to women [98]. However, the influence of religious affiliations on perceptions of GM foods remains less substantiated by current evidence. Interestingly, awareness of GM foods and their perceived benefits shows weak but positive correlations with both marital status and educational attainment. This suggests that marital status and level of education may shape individuals' perspectives on GM foods. Higher educational attainment and scientific literacy are likely associated with more favorable views towards GM foods. In summary, these findings underscore the significant impact of sociodemographic factors on public perceptions of GM foods in Nigeria. They emphasize the necessity of integrating these variables into future research and policy initiatives aimed at understanding and shaping public opinion towards GM foods. Such considerations are crucial for developing targeted strategies that effectively communicate the benefits and address the concerns associated with GM food technologies.

Table 3. 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

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6						1	-.007 .898
7							1

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

The comparative analysis provided valuable insights (in table 4) into the relationships between sociodemographic factors and awareness of genetically modified (GM) foods. Across different age groups, except for individuals aged 18-25 years, there were no statistically significant differences ($P > 0.05$) in awareness levels. Notably, respondents in the 18-25 age bracket exhibited significantly higher awareness compared to other age groups. Gender did not exert a significant influence on awareness levels ($P > 0.05$), despite studies indicating that women generally tend to be more informed and cautious about GM foods compared to men [98]. In terms of religious affiliation, while the majority of respondents identified as Christians, there was a significantly higher level of awareness ($P < 0.05$) observed among Christians compared to Muslims. Conversely, awareness levels were significantly lower among Muslim respondents. Educational attainment emerged as a critical factor influencing awareness levels. Individuals holding a master's degree demonstrated significantly higher awareness ($P < 0.05$) of GM foods, whereas those with an associate degree equivalent (OND/NCE) or a high school diploma exhibited significantly lower awareness levels. Marital status, however, did not have a significant impact on awareness levels ($P > 0.05$). In summary, these findings deepen our understanding of how sociodemographic factors intersect with awareness of GM foods. They highlight the heightened awareness among younger adults, particularly those aged 18-25 years, and the varying levels of awareness across different educational backgrounds and religious affiliations. Addressing these disparities is crucial for developing targeted educational campaigns and policy initiatives aimed at enhancing public understanding and engagement with GM food technologies.

Table 4. Cross Tabulation between Respondents' level of awareness and Socio-Demographic information.

Variables		**Respondents' Level of Awareness on GM Foods**				
		Categories	Yes	No	Not Sure	Total
1.	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**
2.	Gender	Male	84$_a$	47$_a$	0$_b$	131

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Variables		Respondents' Level of Awareness on GM Foods				
		Categories	Yes	No	Not Sure	Total
		Female	148$_a$	71$_a$	19$_b$	238
		Total	**232**	**118**	**19**	**369**
3.	Religion	Christianity	217$_a$	101$_b$	19$_{a, b}$	337
		Islam	15$_a$	17$_b$	0$_{a, b}$	32
		Total	**232**	**118**	**19**	**369**
4.	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**
5.	Marital Status	Single	124$_a$	60$_a$	0$_b$	184
		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).**

5. Conclusions

Based on the findings of this study, it is evident that residents of Victoria Island, like many globally, recognize the significance of genetically modified (GM) foods in addressing food security challenges. Despite initial apprehensions regarding potential health risks, respondents demonstrated a nuanced understanding of the benefits associated with GM crops. These benefits include enhanced crop yields, increased resistance to diseases and pests, and the provision of nutritious food options that respect various cultural identities. The study highlighted the pivotal role of GM foods in fostering sustainability within the food production system and generating socio-economic opportunities for farmers and food producers. Victoria Islanders acknowledge that GM technology

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can effectively tackle critical agricultural issues such as limited arable land, water scarcity, and the imperative for environmentally friendly farming practices. A noteworthy discovery was the widespread awareness among respondents regarding GM foods, with many accessing information through internet and social media platforms. This indicates a growing interest and active engagement in discussions about GM technology, underscoring a desire for well-informed decision-making regarding food choices. Furthermore, the study revealed a solid understanding among Victoria Islanders of the environmental and health benefits associated with GM food production systems, suggesting a high level of literacy and awareness regarding the potential impacts of GM technology on both human health and the environment. However, it is crucial to prioritize consumer rights and recognize that perceptions of GM foods can 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 be tailored to address these diverse perspectives effectively. Based on these findings, the study proposes the following recommendations to guide informed policy decisions:

i. **Public Education:** Governments and relevant stakeholders should prioritize efforts to educate the public comprehensively about the environmental and health benefits of GM foods, while also addressing safety concerns. This educational campaign should leverage diverse media channels to effectively reach various audiences.

ii. **Regulatory Measures:** Governments should implement proactive measures to strengthen border controls and enforce robust food labeling regulations for GM products within the Nigerian market. This initiative will empower consumers to make informed choices and safeguard their rights, particularly those who prefer organic foods.

iii. **Support for Farmers:** Adequate training and financial support should be provided to farmers and interested citizens to facilitate the cultivation of GM crops. This support will contribute significantly to addressing food insecurity challenges in Nigeria and promote sustainable agricultural practices.

iv. **Risk Management:** 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 considerations for environmental, human, and animal health to ensure the overall safety of GM foods and their production processes.

Future research should focus on evaluating the effectiveness of current regulatory frameworks governing GM foods in Nigeria and beyond. This includes assessing areas for improvement in safety assessment, labeling standards, and enforcement protocols. Additionally, research efforts should investigate the health and environmental impacts associated with consuming and producing GM foods. Understanding how demographic variables such as gender, education, religion, and socio-economic status influence consumer perceptions and attitudes towards GM foods is crucial for informed policymaking and the promotion of sustainable agricultural practices. Furthermore, studying the factors influencing farmers' decisions regarding the adoption or rejection of GM crops will provide valuable insights for shaping future agricultural policies.

6. Significant Statement

The study conducted on Victoria Islanders provides compelling insights into their perceptions and awareness of genetically modified (GM) foods, highlighting a nuanced understanding of its potential benefits amidst initial concerns. Residents demonstrate a clear recognition of GM crops' ability to address pressing challenges in food security through increased yields, resilience against pests and diseases, and the provision of culturally sensitive nutritional options. This awareness underscores the role of GM technology in fostering sustainability within agricultural practices while

creating socio-economic opportunities for local farmers and producers. Moreover, the study reveals a notable trend in information access through digital platforms, indicating a growing interest and engagement in discussions surrounding GM foods among Victoria Islanders. Furthermore, the findings underscore the importance of tailored educational initiatives to enhance public understanding of GM technology, emphasizing its environmental and health benefits while addressing safety considerations. Effective communication strategies are crucial in bridging knowledge gaps and promoting informed decision-making among diverse demographic groups, influenced by factors such as gender, education level, and religious affiliation. The study advocates for proactive regulatory measures that strengthen food safety standards and labeling requirements for GM products in the Nigerian market, empowering consumers to make choices aligned with their preferences and values. Looking forward, the study proposes strategic recommendations for policy development and research focus areas. These include bolstering support for GM crop cultivation through targeted training and financial assistance for farmers, as well as advancing comprehensive risk management frameworks to ensure the continued safety and sustainability of GM foods. Future investigations should delve deeper into the societal implications of GM technology adoption, exploring its impacts on health, environment, and socio-economic dynamics to inform evidence-based policymaking and sustainable agricultural practices nationally and globally.

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