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CONSUMER AWARENESS AND PERCEPTION OF GENOME-EDITED FOOD: A CASE STUDY IN THE FEDERAL CAPITAL TERRITORY, ABUJA, NIGERIA

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ABSTRACT

This study was aimed at evaluating the acceptance of genome-edited food in Nigeria. Utilizing the Federal Capital Territory (FCT), Abuja as a case study, this study adopted a descriptive research design. Data was collected via a likert-scale based questionnaire administered to a sample population of 400 respondents to collect data on level of awareness on genome-edited food, factors influencing the attitude and perception, as well as strategies for enhancing consumer education and communication concerning genome edited food. Findings of this study indicate that respondents were familiar with genome-edited food to a little extent (30.1%) while a total of 48.5% were not aware of the availability of genome-edited food products currently available in the market. However, 36.8% of the respondents indicated willingness to consume genome-edited food once benefits are understood. Also, respondents indicated concerns about the safety of genome-edited foods to a very great extent (35.3%), while to a moderate extent (27.4%) respondents indicated that media report influenced their perception of genome-edited food to a moderate extent. Respondent also indicated that the reported current educational initiatives in informing the public about genome-edited food was not effective at all and therefore recommended that public discussions and forums about genome-edited food must be put in place by the government through the National Biosafety Management Agency.

Key words: Genome-edited food, Awareness, Perception, Biosafety
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INTRODUCTION

Global demographic shifts are happening at a rate never seen before. The population as a whole is still growing, notwithstanding a recent decline in the population growth rate (Mason & Lee, 2022). According to the United Nations (2017), the population of the world is predicted to reach 10 billion people by 2050. The economics and sustainable use of agricultural resources, such as

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food production and safety, are severely hampered by the yearly decline in water and arable land resources (El-Mounadi, Morales-Floriano & Garcia-Ruiz, 2020). By using sustainable farming practices, agricultural output must continuously increase its efficiency and quality in order to meet the growing need for food due to population growth.

High food and production yields are achieved using traditional breeding and selection methods (Geng et al., 2022). Nevertheless, several genes, rather than a single gene, frequently control crop traits. For instance, studies have demonstrated that fruit color is a polygenic trait and that it takes years and frequently experiences linkage drag to introduce all color-related genes into a single genetic background using standard breeding techniques (Yang et al., 2023). As a result, researchers are investigating other breeding strategies in response to the conventional, labor-intensive breeding procedures (Zhang and Zhu, 2024). Altman and Hasegawa (2012) state that agricultural production is becoming more and more reliant on the efficient application of biotechnology as a result of traditional breeding and selection techniques' incapacity to fulfill the world's food demands. The category of biotechnology known as agricultural biotechnology, according to Mamata and Lamichane (2021), is the use of scientific methods to the modification and enhancement of crops. Methods of agricultural biotechnology improves a plant's resistance to disease and pests, help it withstand environmental stress, and improve the flavor, texture, storage life, and nutritional worth of food (Mamata and Lamichane, 2021).

For a very long time, transgenesis was the primary method of genome alteration among the several technologies available. Shelake, Pramanik, and Kim (2018) claim that transgenesis modifies a plant cell's genetic makeup to produce a so-called genetically modified organism (GMO) that has a piece of foreign DNA incorporated into its genome that confers new, beneficial traits on the plant that are unattainable through traditional breeding techniques. In addition to allowing genes from other organisms (viruses, bacteria, animals, plants, etc.) to be incorporated into the plant genome, transgenesis also acts as a better way to induce mutagenesis and a tool for controlling the expression levels of host cell genes (gene silencing). In the meanwhile, in 2003 a novel technology known as gene-editing (GE) was developed.

Genome editing, also known as gene editing, is a commonly used technology that creates variations in DNA sequences at specific locations within a genome (Mitra et al., 2023). For instance, variations can be created in the promoter region to influence the timing or cell type specificity of promoter activity, or variations can be created within the coding region of a protein to alter the function of a specific enzyme, transporter, or receptor. Such polymorphisms may enhance or result in novel features, such as enhanced yield potential, stress tolerance, or disease resistance, depending on the target gene (Randall et al., 2022). The most well-known system in the genome editing toolkit is CRISPR/Cas9, which was awarded the Nobel Prize to Charpentier and Doudna, the genetic scissors' creators (Ledford & Callaway, 2020).

Zinc-finger nucleases (ZFNs), which are also useful for editing, and transcription activator-like effector nucleases (TALENs) are two more superior methods (Li et al., 2012). Targeting a

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particular sequence in the genome, each of the three editing tools causes chromosomal breaks at or near the target location, which are then inadequately repaired by the cell, producing sequence variations at the target region (Wada et al., 2020).

GE, in contrast to GM technology, does not include introducing genes from outside species; instead, it identifies the target genes and uses scissors to cut and modify them to improve certain crop traits (Bullock, Wilson & Neadeau, 2021). Because of its improved accuracy, ease of use, and success rate, GE is rapidly displacing GM (Ishii and Araki, 2016). Also known as "genetic scissors," GE is more widely accepted by consumers than genetic modification (GM) because it does not require introducing foreign genes. The third-generation Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technology is primarily being used (Shew et al., 2017). While some nations, like the United States, have been leading the way in applying this technique, many other nations still need time to give the products and even the technology itself a clear positioning that goes beyond technical, normative, ethical, and political considerations (Tachikawa, 2017; Schultz-Bergin, 2018).

The lack of consumer acceptability has often been mentioned as a primary obstacle to the broad adoption of genome editing in plant breeding and agriculture, aside from regulatory difficulties (Qaim, 2020). Concerns over genome editing technologies are also shared by consumers on the safety and environmental effects of genetic modification (Busch et al., 2021). In order to investigate the barriers to consumer acceptance of genome-edited crops, Araki and Ishii (2015) and Ishii and Araki (2016) carried out research on consumers acceptance of food crops developed through genome editing. They suggested that developers should prioritize features that are appealing to consumers at first. Consumer acceptability of CRISPR-produced foods is lower in Belgium and France than in the USA and Canada, according to a multi-country review of consumers' readiness to eat and willingness to pay (WTP) for CRISPR-produced foods in comparison to GM foods (Shew et al., 2018).

There is a global push to comprehend GE technology's future trajectory. Stakeholders including farmers, businesses, and legislators must assess the level of danger that consumers perceive from GE technology and its potential influence on future consumer demand based on these trends in GE technology. They must then take proactive measures to address these concerns. Studies on consumers' assessments of GE technology are required for this reason (Ishii and Araki, 2016; Shew et al., 2018; Vasquez-Arreaga, 2020; Shigi and Seo, 2023). There is a paucity of empirical research on consumer views and their acceptability of genetically engineered foods because the focus in Nigeria has mostly been on genetically modified goods. This study, which focuses on consumers in the Abuja Metropolis, aims to evaluate the acceptance of genome-edited food in Nigeria based on the aforementioned information. The specific objectives are to;

i. evaluate people’s awareness of genome-edited foods in the FCT, Abuja;
ii. explore the factors influencing people’s attitudes and perceptions relating to genome-edited food; and

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iii. Identify strategies for enhancing consumer education and communication regarding genome-edited foods in the FCT, Abuja

METHODOLOGY

Study area

Abuja, the Federal Capital Territory (FCT) is located north of the River Niger and Benue in the Center of Nigeria. It covers a total land mass of 7,315 square kilometers located between latitudes 7 45' and 7 39'. It shares border with Niger State to the East, Kaduna State to the North, Nassarawa State to the West and Kogi State to the South (Emmanuel, 2021). Six area councils make up the FCT namely: Gwagwalada, Abaji, Kuje, Kwali, Bwari and Abuja Municipal Area Council (Etuk, 2022). Abuja was created in the year 1976, however, it became the Federal Capital of Nigeria on 12th December, 1991 (Etuk et al., 2022). Over the years, the economy has experienced tremendous growth as a result of a growing population, expanding households, real estate investments etc. A large number of residents of the area are civil servants, artisans, traders, farmers and other individual service providers (Etuk et al., 2022).

The climate of the FCT is characterized by two distinct seasons which are the dry and rainy season. The rainy season begins from April and ends in October while the dry season starts from November to March. The vegetation in Abuja varies with the seasons. During the rainy season the grasses and plants are green and fresh while during the dry season, the leaves fall off and there seems to be a dry out of vegetation. The FCT falls within the Guinean forest-savanna mosaic zone of the West African sub-region (Bashir et al., 2021).

Population and sampling procedure

The population for this study comprised of residents of the Federal Capital Territory, Abuja. According to the National Population Commission Census in 2006, the FCT had a population of 1,406,209 people. To obtain the population of the study area as at 2023, the 2006 population figures of the FCT was projected to 2023 (i.e. 17 years' interval). With the aid of an exponential formula, the projection was done using growth rate of 3% (NPC, 2006) resulting to a total of 6,171,178 people.

The FCT is made up of 6 Area Councils from which 3 were randomly selected namely Abuja Municipal Area Council (AMAC), Bwari and Gwagwalada. The 2023 projected population of these Area Council totalling 2,341,306 served as the population of this study as presented in Table 1 in the Appendix Section.

Based on the total population of 2,341,306, sample size for ±5% precision levels where confidence Level is 95% and P=.5 was gotten to be 400. Thus, a total of 400 questionnaires were administered in this study. On the basis of the total number of questionnaires administered, 400 respondents were targeted in this study. A proportion formula was employed in determining the

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number of questionnaire to be administered per Area Council and the results are presented in the Table 1 in the Appendix section.

Research design and instrument for data collection

The study used a survey to collect data from the respondents as part of its descriptive research design. It was a descriptive research that looked at people's knowledge of foods that have been altered to change their genetic makeup, the factors that affect their attitudes and perceptions, and suggestions and tactics for raising awareness of these foods. An interviewer-administered questionnaire was used to gather data for this investigation. The self-administered nature of the questionnaire necessitated its straightforward and comprehensible design.

Measurement of variables

A five-point likert scale based questionnaires capturing level of awareness of genome edited foods, factors influencing their attitude and perceptions and strategies and recommendations for improving their education about genome-edited food in the study area was utilised in this study. Rating scores employed ranged from 1 signifying a “very great extent” and 5 signifying “not at all.” The data generated from the study were analyzed using IBM SPSS software version25.0. The results were presented descriptively in the form of tables.

RESULTS

Out of the total questionnaire administered during this survey, a total of 342 was returned for analysis, hence results presented are based on this number.

Socio-economic characteristics of respondents

Results on data collected on the socio-economic characteristics of the respondents are presented in Table 2 in the Appendix section. The results indicate that a total of 101 representing 29.5% of the respondents were aged between 39 and 48 years, closely followed by respondents aged between 18 and 25 representing a total of 22.8% of the respondents. In relation to gender, a total of 175 representing 51.1% of the respondents were male while a total of 167 representing 48.8% of the respondents were female.

Results on the level of educational attainment of the respondents revealed that 207 representing 60.5% of the respondents have attained tertiary education, while 112 representing 32.7% had attained tertiary education. In relation to household income, a total of 121 representing 35.3% earned between 100,000 and 200,000 while 101 representing 29.5% earned between 200,000 and 500,000. Finally, the results on employment status reveal that a total 97 (28.3%) were employed full-time while 77(22.5%) indicated being unemployed.

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Level of awareness and understanding among consumers in Abuja Metropolis regarding genome-edited foods

Respondents were asked to indicate the extent of their familiarity and understanding of genome-edited food based on statements provided and the results are presented in Table 3 in the Appendix section. Respondents were asked to indicate their familiarity with genome-edited food, the response provided indicate that a total of 30.1% of the respondents were familiar with genome-edited food to a little extent. Respondents were also asked to indicate their level of understanding of the process involved in genome-editing to provide food and a total of 34.2% of the respondents indicated they didn't have an understanding of the process at all. Results presented indicate also that 48.5% were not aware of the availability of genome-edited food products currently available in the market. Also, results on the likelihood of respondents consuming genome-edited food once benefits are understood and results indicate that 36.8% of the respondents indicate they would do so to a great extent. Finally, a total of 47.0% of the respondents indicate to a very great extent that it is important for consumers to be informed about genome-edited food.

Factors influencing consumer attitudes and perceptions towards genome-edited foods in Abuja Metropolis

Results presented in Table 4 in the Appendix section indicate that 35.3% of the respondents have concerns about the safety of genome-edited food to a very great extent. Also, the beneficial nature of genome-edited food to human health was indicated to be a factor influencing consumer attitudes and perceptions to a moderate extent. A total of 27.4% of the respondents indicated that media report influenced their perception of genome-edited food to a moderate extent, while 57.6% indicated that to a very great extent, subjecting genome edited food to rigorous testing and regulation before market entry influenced their attitudes and perception. Finally, a total of 31.8% of the respondent indicated that the extent of information provided by government agencies regarding genome-edited foods influenced their attitudes and perceptions to a moderate extent.

Strategies and recommendations for improving consumer education and communication about genome-edited foods in Abuja Metropolis

Results on the strategies and recommendations for improving consumer education and communication about genome-edited food in Abuja Metropolis in Table 5 in the appendix indicate that 31.2% reported that the current educational initiatives in informing the public about genome-edited food was not effective at all. Also, a total of 28.9% of the respondents indicate that to a great extent, more public discussions and forums about genome-edited food must be put in place. In addition, 31.8% of the respondents agreed to a very great extent on the importance of food companies in transparently labelling products containing genome-edited ingredients.

Finally, 32.7% of the respondents indicated that to a very great extent, building trust about genome-edited food coming a trusted health professional will lead to an improvement in consumer education and communication about genome-edited foods in FCT.

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DISCUSSION

The socioeconomic profile of the respondents indicated that male and female respondents were nearly equally represented, with the majority of them being between the ages of 39 and 48. It has been discovered that attitudes and acceptability of genome-edited materials are influenced by gender. For example, in a study by Heiman et al. (2011), when demographic traits and attitudes toward the use of biotechnologies were analyzed, women thought that eating GM products could have a negative impact on their health and had a significantly more negative attitude toward the use of genome editing in humans and animals. Additionally, women are less certain about the usage of GM products and their potential harm to their health than men are (Heiman et al 2011). The majority of research participants, according to the study's findings, have completed postsecondary education. Higher education and more understanding regarding genetically modified organisms (GMOs) have been linked in earlier research (Heiman et al 2011, Lopez et al 2016). Popek and Halagarda (2017) also found that residents with less education had a lower degree of awareness of genetically modified organisms (GMOs). As a result, those with greater education, particularly those in the natural sciences, may be more familiar with the terminology and have a better understanding of these biotechnologies.

An analysis of respondents' knowledge levels revealed that, when it came to being familiar with genome-edited food, they showed both a low awareness and a total lack of comprehension of the procedure involved in producing genome-edited food. The results of another survey conducted in Chile by Tadich and Escobar-Aguirre (2022) show that respondents had little knowledge of the idea of genome editing. A different poll conducted in the UK by the Food Standards Agency (2021) revealed that consumers generally knew very little about genome-edited food and tended to be unaware of it. Most were unaware of genome-edited food or mistaken it for genetically modified food. According to the same survey's findings, people knew less about genome editing's scientific method than they did about genetically modified organisms. Respondents to this research also show that they would be willing to eat food that has been genetically altered if the advantages are fully recognized, despite the minimal understanding of the idea and its scientific methodology. Similarly, limited understanding and awareness of genome-edited food was also revealed in an examination of the perception and attitudes toward the production and prospective consumption of CRISPR/Cas9 crops in Costa Rica by Gatica-Arias et al (2019). On the other hand, almost 71% of the participants said they would be prepared to eat crops that have had their genomes altered if doing so will result in better nutrition and cheaper costs. According to Shaw et al. (2020), roughly half of their respondents were open to consuming goods made through genome editing. They discovered that 56 percent of respondents from the United States of America, 47 percent from Canada, 46% from Belgium, thirty percent from France, and fifty-one percent from Australia would eat foods that have been genome edited and/or CRISPR-modified.

On the variables affecting consumer attitudes and perceptions of food that has been altered through genetic engineering, a significant portion of the respondents expressed worry regarding

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the safety of such food. Concerns about whether eating food that has undergone genome editing is good for human health were also raised by respondents. Studies, according to Smith (2021), have revealed that sentiments toward genome editing are not unanimous among the general public. Many people fall in between these two extremes: some think it is too hazardous to use, others think it is highly useful to society. Furthermore, a significant portion of the participants stated that their opinion was significantly influenced by media stories. Consumer information sources and methods are crucial because, according to research by Calabrese et al. (2020), people who learn about technology through social media rather than conventional media are more likely to disagree with genome editing. According to Kessler et al. (2020), among other sources, consumers may obtain the majority of their knowledge on scientific technologies, including gene editing and other biotechnologies, from the internet. This suggests that in order to inform these customers, the scientific community has to be more visible on social media. In order to promote understanding, scientists should contribute to these social media forums and have insightful dialogues.

This study also found that stringent testing and regulation prior to market introduction has an impact on attitudes and perceptions of food that has undergone genome editing. It is anticipated that consumer attitudes and perceptions of food that has been genetically modified would suffer in the absence of testing and regulation. According to an IPSOS MORI study from 2021, the majority of consumers thought it would be reasonable to regulate genetically modified foods and genome edited foods separately because they are two independent processes. Many participants, however, believed that the degree of examination, testing, and control need to be equivalent to that of genetically modified organisms (GMOs) (IPSOS MORI, 2021).

This study emphasized the inadequacy of present educational programs in educating the public about genome-edited food, while also exploring techniques and recommendations for increasing consumer education and communication regarding genome-edited food in Nigeria. The need for more public forums and conversations around food that has been genetically modified was mentioned by the respondents. It was also emphasized how crucial it is for food companies to openly label goods that include substances that have undergone genome editing.

CONCLUSION

The results of this survey research offer significant insight into the consumer awareness and perception of genome-edited foods in the Federal Capital Territory, Abuja. Based on the findings of this study, while awareness and understanding of genome-edited food among consumers was generally low, many respondents showed willingness to consume these foods if the benefits are clearly known. Concerns relating to safety as well as the need for rigorous testing and regulation has a strong influence on consumer attitudes. A crucial role is also played by media reports and information made available by government. Findings of this study offer indication that

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educational initiatives are ineffective, highlighting the need for more public discussions, transparent labeling as well as trust-building with the help of health professionals.

It is critical to strengthen present educational activities, expand public forums and conversations, enforce transparent labeling standards by food corporations, and enlist the assistance of reliable health professionals in communication efforts in order to address these issues and improve consumer knowledge. Building trust and empowering customers to make knowledgeable decisions regarding foods that have undergone genome editing will facilitate the acceptability and use of this technology in Nigeria's food business.

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APPENDICES

Table 1: Population of selected Area Councils and proportion of questionnaire administered

Area Council	2023 Projected Population	Proportion of Questionnaire
AMAC	1,561,401	267
Bwari	461,017	79
Gwagwalada	318,888	54
Total	2,341,306	400

Table 2: Socio-economic characteristics of respondents

Variable	Frequency	Percentage
Age		
18-25	78	22.8
28-38	69	20.2
39-48	101	29.5
49-58	60	17.5
59 and above	34	9.9
Gender		
Male	175	51.1
Female	167	48.8
Educational Level		
Primary	23	6.7
Secondary	112	32.7
Tertiary	207	60.5
Household Income		
Less than 50,000	41	11.9
50,001-100,000	69	20.2
100,001-200,000	121	35.3
200,000-500,000	101	29.5
Above 500,000	10	2.9
Employment Status		
Full-time	97	28.3
Part-time	86	25.1
Unemployed	77	22.5
Student	50	14.6
Retired	32	9.3

Source: Author's Survey (2023)

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Table 3: Level of awareness and understanding among consumers in Abuja Metropolis regarding genome-edited foods

Statement	Response Categories (%)				
	VGE	GE	ME	LE	NA
Familiarity with genome-edited food	10.5	16.0	24.8	30.1	21.1
Understanding of the process involved in genome-editing to produce food	12.5	14.3	19.6	19.3	34.2
Availability of genome-edited food products currently available in the market	-	2.6	18.7	30.1	48.5
Likelihood of consuming genome-edited food once benefits are understood	29.5	36.8	16.6	10.2	5.8
Importance of consumers being informed about genome-edited foods	47.0	29.8	19.7	3.5	-

Source: Author's Survey (2023)

Table 4: Factors influencing consumer attitudes and perceptions towards genome-edited foods in Abuja Metropolis

Statement	Response Categories (%)				
	VGE	GE	ME	LE	NA
Concern about the safety of genome-edited food	35.3	27.4	23.9	16.2	2.9
Beneficial nature of genome-edited food to human health	19.5	25.4	33.0	15.1	8.77
Influence of media report on perception of genome-edited food	16.0	22.8	27.4	19.5	14.0
Importance of subjecting genome editing food to rigorous testing and regulation before market entry	57.6	22.2	14.0	5.8	3.2
Extent of information provided by government agencies regarding genome-edited foods	13.7	19.2	31.8	21.9	13.1

Source: Author's Survey (2023)

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Table 5: Strategies and recommendations for improving consumer education and communication about genome-edited foods in Abuja Metropolis

Statement	Response Categories (%)				
	VGE	**GE**	**ME**	**LE**	**NA**
Effectiveness of current educational initiative in informing the public about genome-edited food	10.8	16.1	19.0	22.9	31.2
More public discussion and forums about genome-edited food must be put in place	28.3	28.9	22.2	10.2	10.2
Importance of food companies in transparently labelling products containing genome-edited ingredients	31.8	22.6	20.1	16.3	8.7
Trust in information about genome-edited food coming from a trusted health professional	32.7	27.4	23.0	10.8	5.84

Source: Author's Survey (2023)