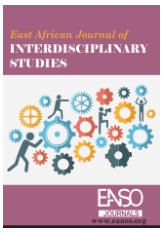

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Original Article

Assessing Knowledge and Understanding of Genetically Modified Organisms (GMOs) among University Students in Uganda

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ABSTRACT

Genetically Modified Organisms (GMOs) have sparked intense global debate, and Uganda is no exception. With a significant agricultural sector, GMOs are a critical issue for Uganda's economy and food security. However, limited research exists on university students' perceptions and attitudes towards GMOs. This study aimed to explore these perceptions, providing valuable insights for policymakers and educators. Specifically, it sought to determine students' knowledge and understanding of GMOs, identify their information sources, investigate their attitudes, and examine factors influencing the acceptance or rejection of GMOs. A cross-sectional study design employing both quantitative and qualitative approaches was used, with respondents selected across different departments to gather diverse opinions and enable comparison. This method offered flexibility and a deeper understanding of the students' perspectives. Findings revealed that university students possessed a moderate level of knowledge about GMOs, often informed by varied sources, and expressed concerns primarily related to potential health risks and environmental impacts. The study further revealed that university students' perceptions are shaped by socio-economic factors, cultural beliefs, and information sources, with notable gaps in understanding scientific concepts and implications of GMOs, emphasizing the need for integrating GMO education into university curricula to promote critical thinking and informed decision-making. Overall, the study highlighted the level of awareness, knowledge gaps, concerns, and general acceptance trends regarding GMOs among Uganda's university students. These insights emphasize the importance of targeted education and information dissemination to address misconceptions and guide informed discussions and policies among the youthful population in Uganda's higher education institutions.

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INTRODUCTION

Genetically Modified Organisms (GMOs) have become a topic of increasing concern and debate globally (National Research Council, 2016). These organisms, whose genetic material has been altered using biotechnological techniques, have the potential to address various challenges in agriculture, such as crop diseases, pests, and food security (ISAAA, 2018). However, the acceptance and adoption of GMOs depend largely on individuals' level of knowledge and understanding of these scientific advancements (McFadden & Lusk, 2016). Thus, assessing the knowledge and understanding of GMOs among university students is crucial, as they represent the future decision-makers, scientists, and stakeholders in Uganda as a Nation.

According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA, 2018), Uganda is among the leading countries in Africa embracing biotechnology for agricultural development. Specifically, genetically modified crops such as bananas, maize, and sweet potatoes have been field-tested and show promising potential to improve yields and nutritional content. Nevertheless, the acceptance and successful implementation of these biotechnological advancements depends on an informed and supportive society (Qaim, 2020).

University students in Uganda play a significant role in shaping public opinions and policies related to GMOs. As educated individuals, they are expected to possess a deeper understanding of the scientific, socio-economic, and environmental implications of GMOs (Chagwena et al., 2019). However, their level of knowledge and understanding may be influenced by various factors such as curriculum coverage, exposure to information sources, cultural perceptions, and personal beliefs.

This research aimed to assess the knowledge and understanding of GMOs among university students in Uganda, focusing on various disciplines such as Public Health, Agriculture, and Environmental Sciences. By examining their level of knowledge, sources of information, and attitudes towards GMOs, this research provided valuable insights into the current state of awareness among university students. The findings contributed to a better understanding of the challenges and opportunities associated with GMO acceptance and implementation in Uganda. Ultimately, these insights guided educational institutions, policymakers, and stakeholders in designing targeted educational programs, communication strategies, and policy interventions to enhance GMO literacy and promote evidence-based decision-making in Uganda as a Nation.

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Research Problem

There is a growing global conversation around genetically modified organisms (GMOs) and their potential to address food security, environmental challenges, and economic development, yet in Uganda, awareness and understanding of GMOs among university students remain unclear. As a critical demographic that will influence future policies and public opinions, university students need accurate knowledge to make informed decisions. However, limited access to reliable information, misconceptions, and the lack of integration of biotechnology topics in curricula may contribute to gaps in their understanding. This study aims to assess the knowledge and perceptions of GMOs among university students in Uganda, identifying the factors that shape their views and evaluating the implications for future educational and advocacy efforts.

Research Questions

- What is the current level of knowledge and understanding of genetically modified organisms (GMOs) among university students in Uganda?
- What are the primary sources of information that influence university students' perceptions and knowledge about GMOs?
- What factors (such as academic background, access to information, or personal beliefs) affect the awareness and attitudes of university students in Uganda towards GMOs?

LITERATURE REVIEW

Few studies have specifically focused on assessing the knowledge and understanding of GMOs among university students in Uganda. A study conducted by Nattabi et al., (2017) in Uganda found that despite some students having a positive attitude towards biotechnology, a significant knowledge gap existed regarding GMOs. This knowledge gap could potentially hinder effective decision-making and policy formulation in the future. Therefore, there is a need for further research to provide an updated and comprehensive understanding of the knowledge and understanding of GMOs among university students in Uganda.

In a study, on the misconception of crop biotechnology in Uganda (Lukanda, 2018), it was discovered that two national newspapers that are New Vision and Daily Monitor covered the public perception regarding a contested science of biotechnology, the two papers promoted and de-campaigned simultaneously indicating that they lacked enough knowledge about genetically modified organisms.

Students' perceptions and attitudes towards GMOs in Uganda are impacted by various factors. For instance, Tumuhairwe et al., (2017) highlighted the influence of socio-economic background and cultural beliefs, with some students expressing concerns about environmental and health risks associated with GMOs. This finding is consistent with a study by Mukisa et al., (2015), which found that students exhibited mixed attitudes towards GMOs, ranging from cautious acceptance to outright rejection.

Mathew (as cited in Schmidt, 2023) identified the social networks that have been used to market genetically modified (GM) crops in new African markets. His study dismantles the network of corporate actors, development organizations, policymakers, and research scientists that uphold the undeniable domination of GM crops in Uganda, which is home to one of the continent's largest experimental programs devoted to agricultural biotechnology. Using Gramscian insights, Schmidt (2023) shows how these power constellations converge in favour of biotechnology at the expense of alternative technical options, and how this consensus maintains its supremacy despite generally going unrecognized and unopposed. All this is happening, yet the knowledge and activities surrounding it are not widely available in the public domain (Schmidt, 2023).

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Nathanael Ivan Lukanda, in his study *From Lab to Fork*, explored the structure of the controversy surrounding genetically modified organisms (GMOs) in Uganda (Lukanda, 2023). His research focuses on how two local newspapers, *The New Vision* and *The Daily Monitor*, cover the subject and on the public perception regarding a contested science (biotechnology), which is simultaneously promoted and de-campaigned on the same pages. The aim was to establish the different ways in which media coverage of biotechnology influences public perception of its products, especially crop (food) GMOs, in Uganda. Using the public realm, media logic, and the science-in-society model as lenses, the study examines Uganda's position within the broader international discussion. To gather information and analyze Uganda's complex position regarding the presence of GMOs on the market — in the absence of an enabling law to commercialize what exists in the country's laboratories — the study employed content analysis, a face-to-face survey, and in-depth interviews (Lukanda, 2023). The main conclusions showed that the outlines of capitalism, scepticism against governmental institutions, and outright misinformation, all linked to individual and societal ideas, impact both the media coverage and public perception of GMOs.

The sources of information accessed by university students significantly influence their knowledge and understanding of GMOs. A study by Kyazze et al., (2018) revealed that students heavily relied on the internet and social media for GMO-related information. However, these sources often provided biased or incorrect information, leading to knowledge gaps and misconceptions. Conversely, a study by Okeny et al., (2020) identified that personal networks, including family and friends, also played a significant role in shaping students' perceptions of GMOs.

In the study, consumer awareness by Wunderlich and Smoller (2020) investigated consumer awareness and knowledge about two methods of food production and possible environmental impact, specifically organic farming and genetically modified or engineered food production. Their study notes that consumers are often unaware of the details of the first steps of the food supply chain, which is the food production method and its environmental impact. It is believed that organic farming causes the least damage to the environment as it uses no pesticides or herbicides in agriculture. However, genetically modified food is used frequently to increase yield and to meet the growing demand for food. Consumers generally are becoming more interested to learn about the food they purchase and the possible environmental impact of how it is produced.

An online survey was conducted to evaluate consumers' knowledge about food production systems and their preferences (Wunderlich, 2018). Two hundred and four adult participants answered all the survey questions. Almost half (48%) of the participants believed that genetically modified food production has a harmful impact on the environment, while 31.4% had no knowledge about this method of food production and its possible environmental impacts. There was a significant association between preference for non-genetically modified food and individuals' beliefs regarding how this food production system may affect the environment. Seventy-five percent of the 98 participants who believed that genetically modified food production has a harmful impact on the environment preferred foods to be labelled. A majority — almost 80% — of participants acknowledged that their food purchasing decisions are contingent on the method of food production and its potential environmental impact (Wunderlich, 2018). Limited research exists on students' awareness of GMO-related policies and regulations in Uganda. A study by Kisaame-Kikandwa (2018) found that students had limited knowledge of the regulatory framework surrounding GMOs and its implications for decision-making. This lack of awareness highlights the need to explore students' understanding of policies and regulations related to GMOs in Uganda.

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In a study that examined students' levels of educational awareness, beliefs, and attitudes regarding biotechnology and technology at the United Arab Emirates University (UAEU), an internet survey was administered to undergraduate students in several colleges of the institution to collect data on literacy, environmental, social, and economic areas related to biotechnology (Abedi & Quick, 2021). Student responses were gathered and statistically analysed. The findings revealed that educational awareness in biotechnology literacy and environmental domains differed considerably depending on the student's enrolled college and academic achievement. In summary, the study concluded that students' overall knowledge performed poorly (Abedi & Quick, 2021). Gaps and Limitations in Previous Studies

There are several gaps in previous studies that have assessed the knowledge and understanding of genetically modified organisms (GMOs) among university students. One gap is the lack of studies that specifically focus on the knowledge and understanding of GMOs among university students. Most existing studies have mainly focused on the general public or specific groups such as farmers or healthcare professionals (Wilson, 2018). Another gap is the limited geographical scope of previous studies. Many studies have been conducted in developed countries, particularly in North America and Europe, which may not fully represent the diverse perspectives and knowledge levels of university students globally (Leiserowitz et al., 2019).

Additionally, previous studies have predominantly used quantitative methods, such as surveys or questionnaires, to assess knowledge and understanding of GMOs. These approaches may not provide a comprehensive understanding of students' perceptions, attitudes, and beliefs towards GMOs, which are crucial for fully assessing their understanding (Bredahl, 2001). Moreover, there is a lack of studies that explore the influence of educational background and academic discipline on students' knowledge and understanding of GMOs. Understanding how different disciplines and educational contexts shape students' understanding of GMOs can provide valuable insights for targeted educational interventions (Marion et al., 2019). Finally, previous studies often focus on factual knowledge about GMOs but fail to assess students' deeper understanding of the ethical, social, and environmental implications of GMOs. It is important to explore students' critical thinking skills and their ability to make informed decisions regarding the use of GMOs (Simon et al., 2014).

METHODOLOGY

The study employed a cross-sectional study design and both quantitative and qualitative approaches to collect data. The study intended to select respondents across different departments (Faculty of Clinical Medicine and Dentistry, School of Allied Health Sciences, School of Nursing Sciences, Faculty of Biomedical Sciences, School of Pharmacy, Faculty of Education, and Faculty of Business and Management) with the purpose of soliciting their opinions and analysing them for comparison. This enabled flexibility in the study while the researcher achieved a deeper understanding of the respondents' world.

The Study Area

The study was carried out in Ishaka-Bushenyi municipality, Bushenyi district. It mainly focused on assessing knowledge and understanding of genetically modified organisms (GMOs) among university students in Uganda. The primary data was collected using a face-to-face survey of students enrolled in different departments at Kampala International University in Ishaka. The participants were randomly selected and completed individual responses which were collected on the spot. The survey focused on the following aspects; assessing the students' knowledge of genetically modified organisms, where they were asked about their knowledge and understanding of genetically modified organisms. The respondents were required

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to answer questions to assess whether they look at genetically modified organisms positively or negatively. The third part focused on demographics in order to understand the background of respondents with regard to their education and family.

Study Population

The population of the study consisted of university students and lecturers at Kampala International University in Ishaka, located in the Ishaka-Bushenyi municipality, Bushenyi district, Uganda. The study targeted students enrolled in various departments to assess their knowledge, understanding, and perceptions of genetically modified organisms (GMOs). Participants were randomly selected, with data collected through face-to-face surveys. The survey covered three key areas: knowledge of GMOs, perceptions of GMOs (positive or negative), and demographic information to provide context regarding the participants' educational backgrounds and family environments.

Sample Size Determination

The sample size for this study was determined to be 30 respondents, consisting of university students at Kampala International University in Ishaka. Given the study's focus on assessing knowledge, understanding, and perceptions of genetically modified organisms (GMOs), participants were randomly selected from various departments to ensure diversity in educational backgrounds. The choice of 30 respondents aligns with the principles of exploratory research, where a minimum sample of 30 is often considered sufficient for preliminary insights and trend identification (Creswell, 2014). Additionally, resource constraints and logistical considerations influenced the decision to limit the sample size, ensuring feasibility while maintaining data quality. Data collection was conducted through face-to-face surveys, covering key areas such as knowledge of GMOs, perceptions (positive or negative), and demographic factors to provide a contextual understanding of participants' backgrounds.

Inclusion and Exclusion Criteria

The study included university students at Kampala International University in Ishaka who were actively enrolled or employed in various departments, ensuring a diverse representation of academic backgrounds. Participants were required to be at least 18 years old to provide informed consent and be available for face-to-face survey participation. Those who were not affiliated with the university, were below 18 years of age, unwilling to participate, or unavailable during the data collection period were excluded. Additionally, individuals who had previously taken part in similar GMO-related studies at the university were excluded to minimize response bias and ensure data integrity.

Ethical Considerations

The study adhered to ethical considerations to ensure the rights, privacy, and well-being of all participants. Prior to data collection, informed consent was obtained from each participant, ensuring they fully understood the study's purpose, procedures, potential risks, and their right to withdraw at any stage without consequences. Confidentiality and anonymity were maintained by coding responses and refraining from collecting personally identifiable information. Ethical approval was sought from relevant institutional review boards to ensure compliance with research guidelines. Additionally, the study upheld the principles of voluntary participation, ensuring that no participant was coerced or pressured into involvement. The data collected was used solely for academic purposes and securely stored to prevent unauthorized access, maintaining the integrity and credibility of the research process.

RESULTS

The study captured information on characteristics like gender, age and Education level.

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Table 1: General Statistics

		Gender	Age	Education Level	Heard of GMOs	Familiar with GMOs	Source of information
N	Valid	30	30	30	30	30	30
	Missing	0	0	0	0	0	0
Mean		1.53	1.97	2.07	1.23	1.63	2.40
Mode		2	1	2	1	1	1
Std. Deviation		.507	1.033	.785	.504	.765	1.192
Range		1	4	3	2	3	3
Minimum		1	1	1	1	1	1
Maximum		2	5	4	3	4	4
Sum		46	59	62	37	49	72

As shown in Table 1 above, the study had thirty (30) valid participants who participated with means and modes of the different categories.

Table 2: Categorical Measures for Gender, Age, Education Level, Source of Information

Variable		Category	Frequency	Percent	Valid percent	Cumulative percent
Gender						
	Valid	male	14	46.7	46.7	46.7
		female	16	53.3	53.3	100.0
		Total	30	100.0	100.0	
Age						
	Valid	18-24	12	40.0	40.0	40.0
		25-34	10	33.3	33.3	73.3
		35-44	6	20.0	20.0	93.3
		45-54	1	3.3	3.3	96.7
		55-64	1	3.3	3.3	100.0
		Total	30	100.0	100.0	
Education Level						
	Valid	diploma	7	23.3	23.3	23.3
		bachelors	15	50.0	50.0	73.3
		masters	7	23.3	23.3	96.7
		doctorate	1	3.3	3.3	100.0
		Total	30	100.0	100.0	
Source of information						
	Valid	journals or articles	9	30.0	30.0	30.0
		new media	8	26.7	26.7	56.7
		social media	5	16.7	16.7	73.3
		friends and family	8	26.7	26.7	100.0
		Total	30	100.0	100.0	

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As shown in Table 2 above, female participants were the majority at 16 (53.3%) compared to 14(46.7%) for males.

For age, the majority 12 (40.0%) aged between 18 to 24 years followed by 10 (33.3%) aged between 25 to 34 years, whereas the least was 2 (6.6%) participants aged between 45 to 64 years.

Most of the participants were pursuing bachelors 15 (50.0%), 7(23.3%) were pursuing diploma and 7(23.3%) master's degrees and only 1(3.3%) participant was pursuing a doctorate.

Only 9 (30.0%) participants had an authentic source of information and the rest 21 (70.0%) got information about GMOs from sources that can easily be biased such sources include; friends and family at 8(26.7%) participants, social media 5(16.7%) participants and new media were 8(26.7%) participants.

General Perception of GMOs

This captured information on how familiar students are with GMOs, which perception they have toward GMOs and the factors contributing to their perception.

Table 3: Measure for How Familiar are Students with Their Overall Perception on GMOs

Variable			Frequency	Percent	Valid Percent	Cumulative Percent
Familiar with GMOs						
	Valid	yes	15	50.0	50.0	50.0
		no	13	43.3	43.3	93.3
		not much	2	6.7	6.7	100.0
		Total	30	100.0	100.0	
Rate of Perception						
	Valid	very positive	3	10.0	10.0	10.0
		Somewhat positive	6	20.0	20.0	30.0
		neutral	8	26.7	26.7	56.7
		somewhat negative	7	23.3	23.3	80.0
		very negative	6	20.0	20.0	100.0
		Total	30	100.0	100.0	

As shown in Table 3 above, 15 (50.0%) of students are familiar with GMOs, 13 (43.3%) are not familiar and 2 (6.7%) say not much. This means that only 50% of the participants have interacted with GMOs in one way or another. The overall rate of perception stands at 3 (10.0%) participants with a very positive perception, followed by 6 (20.0%) participants. 8 (26.7%) of the 30 participants are neutral whereas 7 (23.3%) are somewhat negative and 6 (20.0%) participants are very negative. This means that 13 (43.3%) of the participants have a negative perception about GMOs and 8 (26.7%) have a neutral perception.

Table 3: Factors Contributing to Students' Perception of GMOs

Variable			Frequency	Percent	Valid Percent	Cumulative Percent
Safety concerns						
	Valid	yes	22	73.3	73.3	73.3
		no	8	26.7	26.7	100.0
		Total	30	100.0	100.0	
Environmental impact						

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Variable			Frequency	Percent	Valid Percent	Cumulative Percent
	Valid	yes	18	60.0	60.0	60.0
		no	12	40.0	40.0	100.0
		Total	30	100.0	100.0	
Potential Health Benefits						
	Valid	yes	18	60.0	60.0	60.0
		no	12	40.0	40.0	100.0
		Total	30	100.0	100.0	
Access to more affordable foods						
	Valid	yes	17	56.7	56.7	56.7
		no	13	43.3	43.3	100.0
		Total	30	100.0	100.0	
Perception of natural vs Modified foods						
	Valid	yes	18	60.0	60.0	60.0
		no	12	40.0	40.0	100.0
		Total	30	100.0	100.0	
Ethical concerns						
	Valid	yes	12	40.0	40.0	40.0
		no	18	60.0	60.0	100.0
		Total	30	100.0	100.0	
Lack of trust in biotech companies						
	Valid	yes	23	76.7	76.7	76.7
		no	7	23.3	23.3	100.0
		Total	30	100.0	100.0	

As shown in Table 3 above, the perception of 22 (73.3%) students is affected by safety concerns and only 8 (26.7%) students are not affected at all. In other words, 73.3% of the total participants have fears concerning the use of GMOs due to how safe these products are and this contributes to their perception. 18 (60.0%) of the participants' perception is affected by the impact these products may have on the environment whereas 12 (40.0%) isn't affected. 18 (60.0%) of the students' perception is affected by the potential health benefits these products have on the human population whereas 12 (40.0%) isn't affected. 17(56.7%) of the participants' population have their perception affected by accessibility to more foods that are affordable whereas 13(43.3%) isn't affected by access to more affordable foods. 23(76.7%) of the participants' population, have their perception affected by the lack of trust in the biotech companies whereas 7(23.3%) isn't affected. This means most of the students don't believe in these companies and thus, fear to perceive and use GMOs with ease. On a ten-point Likert scale examination of the participants' knowledge, attitudes, and views regarding genetically modified organisms. According to the study, students' approval of GM animal products was generally low. Participants gave GMO benefits a low benefit rating (average value of 3 or less), however, they did say that if GMOs were more environmentally friendly, they would be more acceptable. Participants also voiced concern about the safety of GMOs, with the majority of them holding that these organisms are not safe for the environment, animals, or people.

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Additionally, participants concurred that GMOs are simply unnatural, which they find to be undesirable.

Knowledge of GMOs

This section measured and captured information on how much knowledge and understanding students have about GMOs on a scale of very low to very high.

Table 4: Knowledge of GMOs

Variable			Frequency	Percent	Valid Percent	Cumulative Percent
Understanding what GMOs are						
	Valid	very low	11	36.7	36.7	36.7
		a bit low	9	30.0	30.0	66.7
		average	7	23.3	23.3	90.0
		a bit high	1	3.3	3.3	93.3
		very high	2	6.7	6.7	100.0
		Total	30	100.0	100.0	
Knowledge of how GMOs are developed						
	Valid	very low	21	70.0	70.0	70.0
		a bit low	7	23.3	23.3	93.3
		average	2	6.7	6.7	100.0
		Total	30	100.0	100.0	
Understand the Potential benefits of GMOs						
	Valid	very low	4	13.3	13.3	13.3
		a bit low	11	36.7	36.7	50.0
		average	11	36.7	36.7	86.7
		a bit high	1	3.3	3.3	90.0
		very high	3	10.0	10.0	100.0
		Total	30	100.0	100.0	
Knowledge of potential risks						
	Valid	very low	1	3.3	3.3	3.3
		a bit low	6	20.0	20.0	23.3
		average	9	30.0	30.0	53.3
		a bit high	7	23.3	23.3	76.7
		very high	7	23.3	23.3	100.0
		Total	30	100.0	100.0	

11(36.7%) have a very low understanding of what GMOs are and 9 (30.0%) say that their understanding of GMOs is a bit low. This implies that 20(66.7%) of the respondents have little knowledge about GMOs and only the remaining 10 (33.3%) have some understanding of what GMOs are. This affects the acceptability of these foods among the populations. When it comes to understanding how GMOs are developed, this knowledge is not in the public domain since 21 (70.0%) have very little understanding and 7 (23.3%) have their understanding at a bit low. This means that 28 (93.3%) don't understand how GMOs are developed and this imparts fear into the population on the acceptability of these products. 15 (50.0%) of the respondents have low knowledge

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about the potential benefits of GMOs, 11 (36.7%) of the respondents averagely understand the potential benefits of GMOs and 4 (13.3%) have some understanding about the potential benefits of GMOs. This means that, generally the respondents don't understand the potential benefits of the products. 14 (46.6%) of the participants believe that there are risks involved in using these GMOs, and 7 (23.33%) have average knowledge of the potential risks that are associated with GMOs.

DISCUSSION

What is the Level of Knowledge and Understanding of Genetically Modified Organisms (GMOs) among Students in Uganda?

The findings indicate that the level of knowledge and understanding of genetically modified organisms (GMOs) among university students at Kampala International University in Ishaka is generally low. A significant proportion of respondents (36.7%) reported a very low understanding of what GMOs are, with an additional 30% rating their understanding as a bit low, suggesting that over half of the participants have limited awareness of GMOs. These results are consistent with previous studies, such as those by Bonah et al. (2017) and Achieng et al. (2020), which found similarly low levels of awareness and knowledge about GMOs among university students in sub-Saharan Africa. Similarly, knowledge of how GMOs are developed is notably poor, with 70% of respondents indicating very low awareness and only 6.7% demonstrating an average understanding. This aligns with the findings by Chagwena et al. (2019), who reported that even among university-educated populations, technical understanding of genetic engineering processes remains minimal. However, when considering the potential benefits of GMOs, the distribution is more balanced, with 36.7% reporting an average understanding and 13.3% indicating very low knowledge, suggesting that some students have been exposed to information highlighting the advantages of GMOs. Interestingly, awareness of the potential risks of GMOs appears to be higher, as 30% of respondents reported an average understanding, and 46.6% demonstrated a high or very high awareness of the risks involved. This trend echoes earlier studies, such as those by Frewer et al. (2013), who observed that risk-related information tends to be more widely disseminated and retained by the public compared to information about benefits. The discrepancy between knowledge of risks and benefits suggests that while students may be more familiar with the perceived dangers of GMOs, there remains a significant knowledge gap regarding their development and potential positive impacts. These findings highlight the urgent need for targeted educational interventions that provide a balanced perspective on GMOs, enhancing understanding of both their risks and benefits, as recommended by McFadden and Lusk (2016).

What are the Sources of Information that Influence University Students' Perceptions and Knowledge About GMOs?

The varying levels of knowledge and understanding of genetically modified organisms (GMOs) among university students at Kampala International University in Ishaka suggest that their perceptions are shaped by different sources of information, some of which may be limited or biased. Given that a significant proportion of students exhibit low understanding of GMOs (a total of 66.7% having very low and a bit low understanding), and 70% have very little knowledge about how GMOs are developed, it is likely that formal education on this topic is either insufficient or not widely integrated into their curriculum. Instead, students may rely on informal sources such as social media, peer discussions, and general news media, which often present GMOs in a controversial or polarized manner. The higher awareness of GMO risks (46.6% rating their knowledge as a bit high or very high) compared to benefits (only 13.3% reporting very high knowledge) suggests that negative narratives may dominate the information students encounter. This trend highlights the influence of

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public discourse, advocacy groups, and possibly government policies that emphasize GMO-related risks more than their potential advantages. To bridge this knowledge gap, universities should incorporate more structured and evidence-based GMO education within their academic programs, ensuring that students receive balanced and scientifically accurate information from credible sources such as research institutions and biotechnology experts.

What Factors (Such as Academic Background, Access to Information, or Personal Beliefs) Affect the Awareness and Attitudes of University Students in Uganda towards GMOs?

The awareness and attitudes of university students in Uganda towards genetically modified organisms (GMOs) are influenced by multiple factors, including academic background, access to information, and personal beliefs. The data reveals that safety concerns (73.3%) and lack of trust in biotech companies (76.7%) are the most significant factors shaping students' perceptions, suggesting that scepticism towards GMOs is widespread. This could be due to misinformation, limited access to scientifically accurate resources, or negative portrayals in media and public discourse. Academic background also plays a role, as students in science-related fields may have more exposure to biotechnology concepts, whereas those in non-science disciplines might rely on social narratives rather than scientific evidence. Additionally, ethical concerns (40%) and perceptions of natural versus modified foods (60%) indicate that cultural and personal beliefs influence acceptance, with some students viewing GMOs as unnatural or potentially harmful despite scientific advancements. On the other hand, a notable proportion of students recognize the environmental impact (60%) and potential health benefits (60%) of GMOs, showing that positive awareness exists but is not dominant. To improve understanding and foster informed decision-making, there is a need for targeted educational programs that address misconceptions and provide balanced, research-based insights into GMOs.

CONCLUSION

The knowledge and understanding of genetically modified organisms (GMOs) among university students in Uganda, particularly at Kampala International University in Ishaka, is generally low, with many students lacking awareness of both the development and potential benefits of GMOs. The primary sources of information, such as social media, peer discussions, and biased news media, contribute to the widespread scepticism and safety concerns, while formal education on the topic appears insufficient. Personal beliefs, ethical concerns, and academic background also significantly shape students' perceptions, with students in scientific fields demonstrating somewhat better understanding.

Recommendations

Based on the findings, it is recommended that universities in Uganda, including Kampala International University, integrate comprehensive GMO education into their curricula. This should focus on providing balanced, evidence-based information that highlights both the benefits and risks of GMOs. Educational interventions should aim to bridge the knowledge gap, particularly around the development and potential benefits of GMOs, by offering students access to credible sources, such as research institutions and biotechnology experts. Additionally, universities should incorporate practical learning opportunities, such as seminars, workshops, and guest lectures, to engage students in informed discussions. By improving access to scientifically accurate information and addressing misconceptions, universities can play a key role in shaping students' perceptions and fostering a more balanced understanding of GMOs.

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