

**KNOWLEDGE, ATTITUDES AND PERCEPTIONS TOWARDS
GENETICALLY MODIFIED FOODS IN ZIMBABWE****Chagwena DT^{1,2*}, Sithole B¹, Masendu R¹,
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ABSTRACT

Controversy regarding use of genetically modified (GM) foods still persists in both developing and developed worlds. Proponents of genetically engineered foods argue this is a sustainable solution to resource-limited settings where food insecurity continues to increase. However, in this pertinent debate, there is deficiency of knowledge on the opinion of the general public from resource-limited African communities. The aim of this paper is to describe the general public's level of knowledge and perceptions towards use of GM foods in Zimbabwe. A descriptive cross sectional survey was conducted among 301 participants attending a country-wide Traditional and Organic Foods Festival in Harare. A self-administered questionnaire was used to collect data. Poor level of knowledge on GM foods was demonstrated among most respondents (60%) and associated with level of education ($p < 0.05$). More than a third of respondents (36%) believed that GM chicken was being sold on Zimbabwean local markets. Lack of understanding on the genetic engineering process in food production was common among respondents. Attitude towards GM foods was negative and intention to consume GM foods was low (38%). Genetic engineering on food production was viewed as driven by a few companies for profit maximization (72%) with consequences for GM foods complex and too risky for humans (70%). Consumers believed a total of 44 GM foods were available on the Zimbabwean market with chicken, maize and fruits being common foods reported as GM foods. More than half (54%) of respondents reported to have consumed GM foods in the past even though GM foods are not permitted in the country. People with increased knowledge on genetic engineering and GM foods were more receptive of GM foods in their diets. Although intention to consume GM foods was high among individuals with increased knowledge and positive perceptions towards GMOs, knowledge and understanding on GM foods among study participants was limited. Positive perceptions, increased knowledge on genetic engineering and GM foods makes people more receptive of GM foods in their diets. There is need to improve consumer awareness on genetic engineering in food production to empower consumers to make informed choices regarding GM food. Consumers in resource-limited settings are sceptical of genetic modification in food and should be consulted during policy formulations on GM foods. Mandatory labelling of GM foods could also improve confidence among consumers on the foods they consume.

Key words: Genetically-modified Foods, Knowledge, Attitudes, Beliefs, Public-perceptions, Acceptance, Resource-limited Communities, Zimbabwe



INTRODUCTION

There is still controversy regarding use of genetically-modified foods in both developed and developing worlds [1, 2]. Questions regarding their acceptance, safety and whether developing regions such as sub-Saharan Africa are ready for genetically-modified food technology and the implications of adopting such technology still need to be addressed. There seems to be more questions being raised than scientific solutions being provided [3].

Genetically modified organisms (GMOs) are organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally (transgenic) [4]. Thus, a genetically-modified food substance is any food that is produced using genetic engineering techniques or from genetically-modified ingredients. Biotechnology or genetic engineering is the name given to the science applied in GMO production [5]. Zimbabwe has an anti-genetic modified food policy [6] but there is a provision that genetically-modified foods can be allowed into the country on condition that the food is processed or milled [7]. The Zimbabwean government adopted a threshold level of 1% for technically unavoidable presence of Ingredients in food and feed. All products with less than 1% genetically-modified traces are therefore not regarded as genetically modified. The 1% threshold is the *de facto* international standard for labelling genetically-modified products [6].

Gene biotechnology has been publicized to have lots of benefits with little focus on implications to sustainability of agriculture and community food systems. However, a balanced approach is needed in this area. Proponents of genetic modification bring forward valuable arguments on positive use of genetic engineering including development of insect/pest-resistant crops, herbicide tolerant plants, therefore increasing food production and consequently improving food security [8]. Selective production of plants with specific desired characteristics like appearance, taste, texture and size has also been suggested as a progressive effect of this technology in food production [8]. In general, potential benefits can be grouped into four categories: environmental, health, economic and agronomical. Environmental benefits include reduced use of pesticides/insecticides in the case of insect-resistant genetically-modified plants. Health benefits also include fewer insecticides in food (reduced risk to insecticide-related diseases) and improved nutritional value and taste of foods [9]. From an economic point of view, less money is spent on pesticides/herbicides, drought management and land management. In the agronomy field, the result is increased yield utilizing the same amount of input and effort as compared to traditional seeds [10, 11].

However, despite these purported benefits, genetic modification has faced some resistance especially in developing countries. This is clearly evidenced by the fact that some African governments (Zimbabwe, Zambia, Mozambique and Malawi) rejected genetically-modified food aid from USAID and World Food Programme (WFP) in 2001 [12], despite severe food insecurity challenges the countries were facing at the time. At the same time genetic modification opponents have raised concerns regarding genetically-modified foods and products. Safety, ethical considerations, negative impacts on human health, short and long-term uncertainties concerning genetically-modified



foods were some of the main reasons why genetically-modified foods and products have been rejected [11, 13]. However, scientific evidence shows that there is inconclusive evidence on harmful effects of genetically-modified foods on human health [7]. Apparently, there seems to be more valid arguments from ethical and economic perspectives rather than scientific. For instance, some studies show that most people feel that genetic modification technology is unethical and that it is “blasphemous” or it is “playing God” [10, 14].

Economic reasons have led to developing countries rejecting genetically-modified foods as well. For instance, the Zimbabwean government imposed a ban on all genetically-modified food imports because of the commercial threat they pose to locally-produced products. It was noted that chicken fed by genetically-modified feed lands on the Zimbabwean market at a cost well below local production costs. Genetically-modified feed maize costs \$160 per tonne against Zimbabwe’s genetically-modified free maize of \$325 per tonne [6].

Whilst all these debates among scientists continue, public’s perceptions on GMOs have been reported to have significant influence in genetically-modified crop debates and policies adopted by governments [15]. Therefore, public’s perceptions on genetically-modified foods is integral in policy development in a country. A study in Ghana revealed more than 80% of respondents from government ministries and ordinary Ghanaians were unwilling to accept genetically-modified foods and their rejection was based on the fear of unknown side effects and ethical considerations [16]. In other African countries, GMOs have been disapproved by many people [17]. Fulton and colleagues [17] reported that just over 11% of respondents approved the use of genetic modification technology while 67% disapproved and 22% were indifferent. In as much as other segments of the population are still indifferent on the use of genetic modification in the African context, some authors argued that genetic modification technology has a role to play in African countries’ food security; consumers, however, need more information about the technology [1].

Data on public knowledge and perceptions towards GMOs including genetically-modified foods in Zimbabwe is scarce and limited efforts have been attempted to close this gap of knowledge in comparison to other African countries. Little data available in a Zimbabwean based bulletin [18], reported as low as 24% of participants interviewed at the Harare Agricultural Show responded to have some understanding of the scientific basis of what constituted a GMO. Most held the perception that if an animal or plant grew faster than the average variety then that made it a GMO. Most respondents held negative perceptions towards genetically-modified crops and foodstuffs highlighting that genetic modification technology made food tasteless and some feared that genetically-modified foods would eventually cause them health problems in the future. However, this study had very few participants interviewed (N=17) to make any meaningful national population inference. This justified the need to conduct a larger survey to explore people’s perceptions regarding genetically-modified foods as a way to guide policy makers in planning.



The objective of this study was to describe Zimbabwean public's perceptions towards genetically-modified foods and the genetic engineering process being applied to crops and animals used for food production.

METHODS

Study design

A cross-sectional survey was conducted among adults attending the first annual Traditional and Organic Foods Festival (TOFF) in urban Harare. The Food Festival took place over one day in December, 2013, at Botanical Gardens in Harare. Participants of the Foods Festival were drawn country-wide in Zimbabwe.

Study population

Study participants (301 adults >18 years) were randomly sampled among attendants of a National Foods Festival to complete a self-administered structured questionnaire. Participants attending the National Foods Festival were drawn from all 10 provinces of the country. Data was collected by undergraduate nutrition students from the University of Zimbabwe during the one-day event.

Data Collection Instrument

A self-administered instrument with 29 questions was used to collect data. The structured questionnaire was developed from an instrument used by Monica Haro in a study aimed at identifying students' knowledge, attitudes and degree of support towards genetic modification and the use of GMOs in aquaculture [19]. The structured questionnaire was divided into three sections focusing on personal and demographic information (6 questions), general knowledge on genetically modified foods (10), and perceptions, attitudes and beliefs towards GMOs (13). Verbal consent was established first among all survey participants before administering the questionnaire.

Data Analysis

Data was entered using Microsoft Excel for Windows and analysed using STATA version 13. Descriptive analysis and chi-square test of association was carried out. Simple regression analysis was conducted to determine factors influencing acceptance of genetically-modified foods.

RESULTS AND DISCUSSION

A total of 315 questionnaires were distributed and 301 were filled showing a high response rate of 96%.

General characteristics of respondents

More than half (51%) of respondents were females. Most respondents were from urban cities and towns (Table 1). The sample population was generally literate, 71% of the participants had post-secondary education while only 1% had no education at all. The median age was 28 years (Table 1).



Knowledge on Genetically Modified Organisms (GMOs)

Majority of the respondents (92%) reported having heard of GMOs prior to the survey. A significant proportion of respondents (62%) could not give a correct simple/layman definition of a GMO. Among those who reported to have heard of GMOs before, only 40% could give a simple accurate definition of a GMO. Respondents provided varied definitions of a GMO.

Common GMO definitions given by respondents include:

- I. Foods that cause cancer (n = 101)
- II. Tasteless food (n= 37)
- III. Plants that grow fast (n= 30)
- IV. Food that makes people grow fat (n= 23)
- V. Organism whose genetic material has been altered in a way that does not occur naturally (n= 93)

A total of 44 foods were provided by respondents as genetically modified food products being sold on the local Zimbabwean markets (Figure 1). More than a third (36%) of respondents reported that genetically-modified chicken was being sold on the local markets. three common foods listed as genetically-modified foods were chicken, maize and fruits. banana, apple, orange and grape were types of genetically-modified fruits reported as available on the local markets (Figure 1).

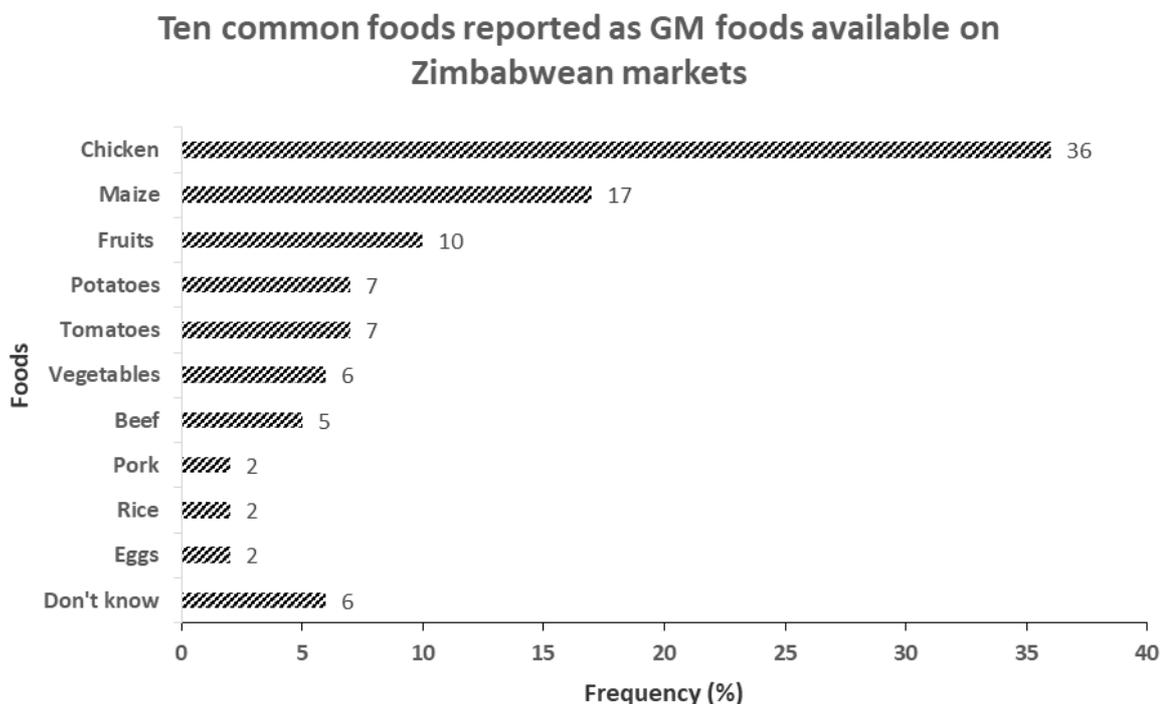


Figure 1: Ten common foods reported as genetically-modified foods available on the local Zimbabwean markets

A scoring system was developed to evaluate knowledge of respondents on genetically-modified foods and genetic engineering where at least 75% correct responses was considered high knowledge, 25% to 74% medium knowledge and less than 25% as low knowledge. Based on the scoring system, most of the study participants (60%) had poor general knowledge on genetically-modified foods (Figure 2). Few respondents demonstrated knowledge on the genetic engineering process in food production.

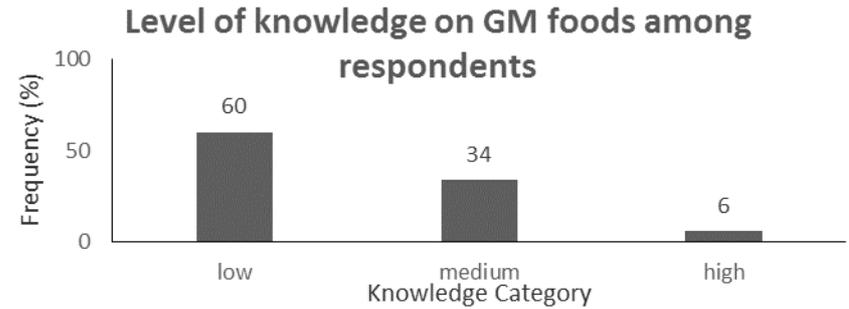


Figure 2: Respondents' general knowledge on genetically modified foods

More than half (59%) of study participants demonstrated adequate knowledge on genetic engineering increasing productivity and resistance of plants against diseases and on the other hand almost half of respondents (47%) reported that genetically modified foods destroys human genes (Figure 3).

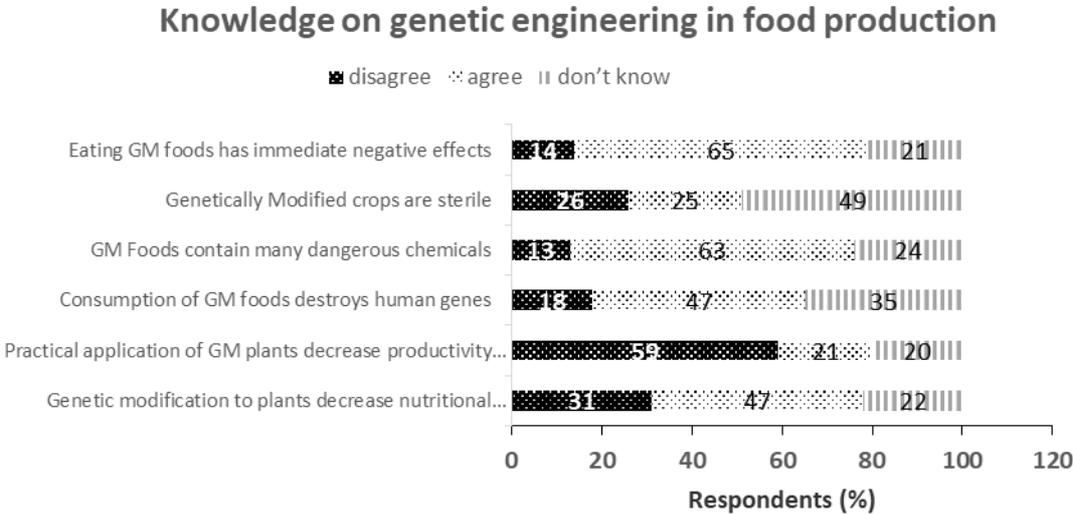


Figure 3: Knowledge of respondents on genetic engineering process in food production (N=300)

Consumption of genetically modified foods

More than half of the respondents (54%) reported they had consumed genetically modified foods prior to this survey (Figure 4). This was based on respondent assumption or certainty guided by food labels or source of food. Only 8% of the respondents were



confident to report that they had not consumed any genetically modified food prior to the survey (Figure 4). Intention to consume genetically modified foods was low among respondents, only 38% of the respondents reported they would consume a genetically modified food product knowingly given a choice.

Proportion of study participants who reported to have consumed GM Foods in the past

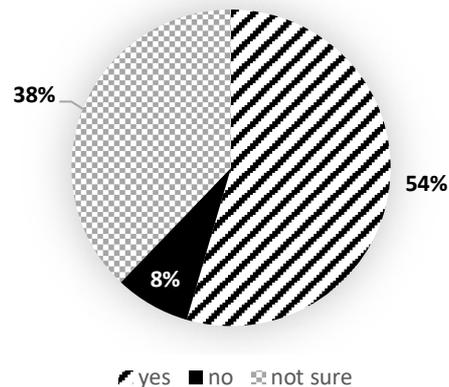


Figure 4: Proportion of study participants reported to have consumed prior to the survey

Attitudes towards genetic modification technology in food production

Generally, most respondents demonstrated a negative attitude towards application of genetic modification technology in food production. A significant proportion of respondents had neutral views on whether genetic modification technology in food production was acceptable (27%), ethical (27%) or against one's belief or religion (29%) (Figure 5). More than half of the respondents (51%) reported that genetic modification technology in food production was not acceptable and 72% reported that genetic modification technology was mainly driven by a few private companies with a desire for profit maximization (Figure 5). More than two-thirds (70%) of respondents reported that consequences of GMOs were too complex and humans had not gained enough knowledge to reduce all possible risks (Figure 5).

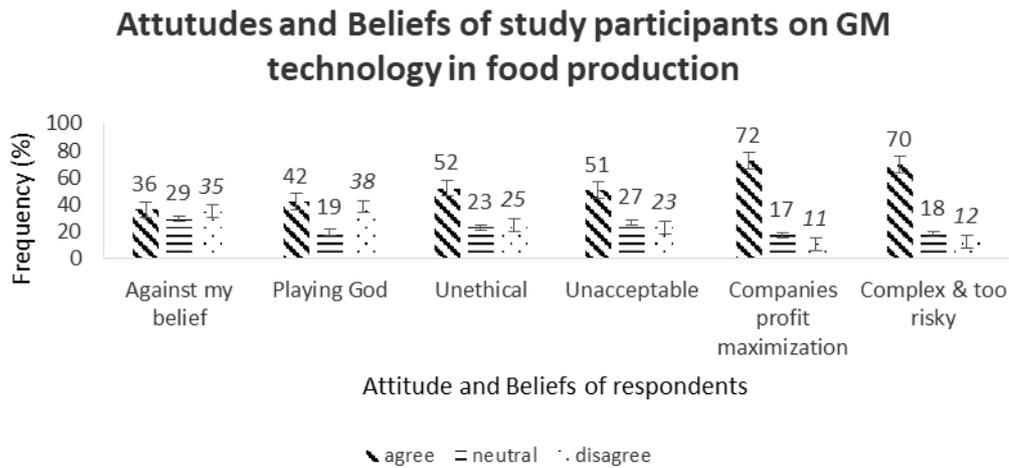


Figure 5: Attitudes and Beliefs of respondents towards genetic modification technology in food production

Perceptions on genetically modified foods

The section on perceptions on GM foods asked respondents the extent to which they would support the use of GM technology for various reasons which included production of cheaper food, better tasting food and production of longer shelf-life food products. Respondents perceived genetic engineering as a technology that aids in production of cheaper foods but did not perceive GM technology as something that enhances food taste (60% disagreed), nor the nutritional value (52% disagreed) (Figure 6).

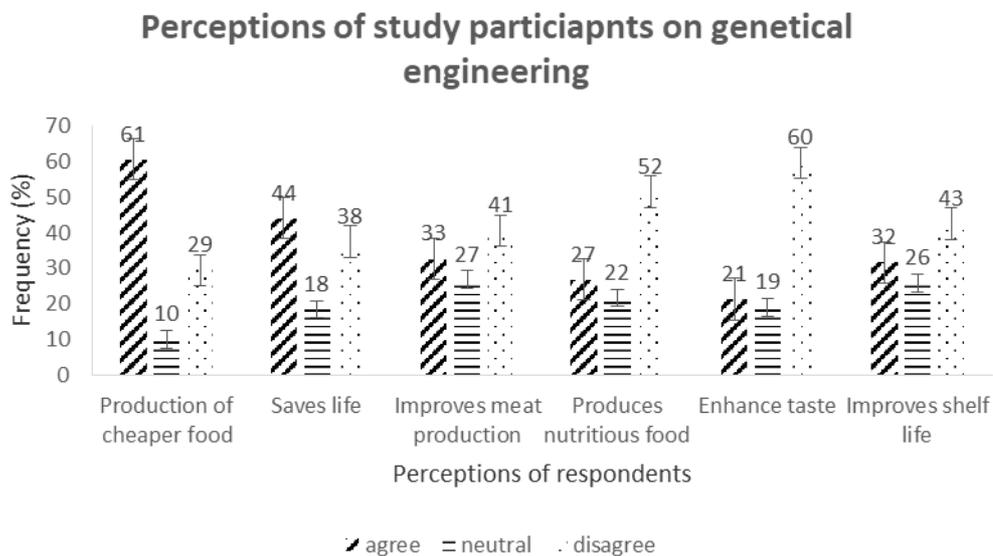


Figure 6: Perceptions on use of genetic engineering in food production

Factors influencing acceptance of genetically modified foods

Average scores on GM knowledge among those with intention to consume GM foods was compared to those who had no intention to consume genetically modified foods and scores were significantly different ($p=0.000$) showing that knowledge on GMOs influences an individual's dietary decision. Respondents with high knowledge on GMOs

and those that had previously consumed GMOs demonstrated intention to consume genetically modified foods (Table 2).

Respondents' knowledge on genetically modified foods was significantly associated with level of education ($p < 0.05$). Intention to consume genetically modified foods was associated with individual's level of knowledge on genetically modified foods and past exposure to genetically modified foods (Table 2). Among respondents who reported having consumed genetically modified foods in the past, over half (55%) did not intend to consume genetically modified foods in future. Intention to consume genetically modified foods was driven by an individual's perception and attitude towards genetically modified foods. For every unit increase in total perception score there was a 16% higher odds of intention to consume genetically modified foods ($p = 0.000$) and for every increase in total attitude score there was a 17% higher odds ($p = 0.000$) of intention to consume genetically modified foods.

Influence of knowledge and attitudes on acceptance of genetically modified foods

Assessing the public's knowledge, attitudes and perceptions towards genetically modified foods is relevant in the Zimbabwean context since no prior studies have been conducted in this area. Absence of the general public's perspective on such a topical issue affects policy implementation and outcome as consumers have a significant role to play. Majority of respondents (92%) indicated that they had heard of GMOs prior to the survey, yet only 38% could define a GMO in simple and accurate terms. Increased awareness of GMOs among the public was expected as the subject of GMOs had been discussed often in the Zimbabwean and international media. However, the subject could have been presented to the public in a misleading way as most respondents demonstrated negative attitudes and perceptions (Figure 5, Figure 6). Other studies elsewhere have emphasised the need for reliable sources of information on topical issues such as genetically modified foods as it was pertinent in shaping people's attitudes towards certain food products [3, 16, 17].

Majority of respondents who had consumed genetically modified foods in the past, did not intend to include genetically modified foods in their diet. This demonstrates rejection of genetically modified foods by the public and could suggest past exposure to genetically modified foods was not intentional. This justifies the need to label genetically modified foods so that consumers are aware of what they are consuming. Rejection of genetically modified foods could be attributed to the negative perception towards certain components of GMOs such as animal genetically modified products used in food for human consumption that are viewed as having potential negative effects to health [20].

Understanding of genetic engineering and its application to food is important. This study demonstrated poor knowledge on GMOs (Figure 2) and genetic engineering which is consistent with other studies in developing countries [21]. Buah [16] asserts that topics on biotechnology and genetically modified foods are topics of global concern and public education is a necessity for a better understanding of the issues involved [16]. Increased knowledge on GMOs was associated with acceptability of GM foods (Table 2) as shown in other studies as well [22, 23, 24]. Knowledgeable individuals were receptive of genetically modified foods in their diets (Table 2). This has implications to the food



industry in relation to informed decisions made by consumers regarding genetically modified foods. It can then be argued that negative attitudes demonstrated by participants in this study towards genetically modified foods could be driven by lack of understanding on processes involved in food genetic modification.

Some of the definitions on GMOs are worth discussing. Scientifically, there has been no substantiated evidence that consumption of genetically modified foods causes cancer or any other adverse health effects [25], and yet some of the respondents defined genetically modified foods as cancer-causing foods. Genetically modified foods are generally new in Zimbabwe, and their advent has been coincidental with increase in the prevalence of non-communicable diseases (NCDs) such as cancer, obesity and diabetes [26]. In the absence of a strong epidemiological basis and effective public health communication, the general populace is inclined to infer an association between the increased prevalence of NCDs and consumption of genetically modified foods. If genetically modified foods were to be adopted in Zimbabwe, there is need for strong advocacy and education campaigns aimed at empowering the public so that they can make informed-consumer decisions.

Keeley and Scoones [27] gave an insightful analysis of the Zimbabwean GMO regulations that are of relevance to the perspectives discussed in this paper. Labelling of genetically modified food is not mandatory in Zimbabwe and one cannot, therefore, with certainty classify any food especially imports as non-genetically modified foods [27]. The Zimbabwe Import Control authority lacks financial and technical capacity to monitor genetically modified components in foods, and this therefore means that genetically modified foods can be imported into the country. This becomes complicated in that officially genetically modified food imports are not allowed in the country, with the only exception being genetically modified grain flour for food aid. At the same time Zimbabwe imports a lot of its food from neighbouring countries such as South Africa, which embraced genetic modification technology a few years back [28, 29]. Considering that more than a third (38%) of respondents in this study were not sure if they had consumed genetically modified foods ((Figure 4), it could be speculated that people were not confident of the food they were consuming with regard to genetically modified foods. It only goes to cement a point already made on the need for consumer awareness programmes, not only concerning genetically modified foods but general foods available on Zimbabwean markets. This would enable the consumer to enjoy their right to choice of food, as shown by 62% of respondents who indicated that given a choice they would not consume genetically modified food products. It is also possible that consumers end up consuming genetically modified foods unintentionally and without their knowledge if regulation of foods is not effectively employed. High possibility of unintentional consumption of genetically modified foods is likely, even in instances where genetically modified food is labelled, as previous studies have shown that most Zimbabwean consumers do not read or understand food labels [30]. Therefore, efforts to improve public understanding of food labels could complement legislation of mandatory genetically modified food labelling.

Some studies have demonstrated the role of religion in influencing beliefs and perceptions on food eating habits. It was assumed that religion would have an influence

on acceptance of genetic engineering. On the contrary, decision to consume genetically modified foods was not associated with religion. This is consistent with findings by Haro [19] where religion was found not to be an influence on public attitudes towards acceptance of GMOs. Whether one was aware of GMOs or not, it did not influence decision to consume genetically modified foods in future. Clearly, intention to do something does not really translate in that behaviour being adopted in all cases, but it gives an indication of how people are likely to behave in certain circumstances. Our study was conducted among participants of a traditional and organic foods festival which could have had an influence on selection of the kind of people interviewed. The assumption was that people attending a Foods Festival would exhibit some interest in the subject of food and provide meaningful perceptions towards genetically modified foods. Elsewhere we have demonstrated that generally Zimbabweans were not attentive to foods they consume [30] and interviewing a population with high food literacy and interest would provide us with the perceptions we intended to assess, so it was assumed.

CONCLUSION

Knowledge and understanding of genetically modified foods and its processes among the public is limited. Intention to consume genetically modified foods is influenced by people's knowledge and perception towards genetic food modification processes. There is need to improve people's awareness and knowledge on genetic engineering processes in food production so that they make informed dietary food choices. Negative attitudes towards genetically modified foods influences low desire to consume genetically modified foods among the Zimbabwean public. Most people perceived that genetic engineering was driven by a few companies for profit maximization and the consequences for genetically modified foods were complex and too risky for humans. Positive perceptions, increased knowledge on genetic engineering and genetically modified foods makes people receptive of genetically modified foods.

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Table 1: Demographic characteristics of respondents

Characteristic	Disaggregation	Number	Percent (%)
Gender (N=301)	Male	147	49
	Female	154	51
Age (N=294)	28	IQR (21;38) years	
Residence (N=299)	Urban	267	89
	Rural	32	11
Religion (N=301)	Christian	273	91
	Muslim	2	1
	Traditional African	10	3
	Rastafarian	4	1
	No religion	10	3
	Other	2	1
Educational Level	No education	2	1
	Primary	7	2
	Secondary	79	26
	Post-Secondary	211	71
Employment status (N=299)	Formally employed	124	41
	Self-employed	38	13
	Unemployed	137	46

Table 2: Factors influencing intention to consume genetically modified foods

Factor	p-value
Knowledge on GM foods and genetic engineering process	0.000*
Religion	0.835
Residential area	0.466
Past exposure to GM foods	0.007*

*Level of association significant ($p < 0.05$)

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