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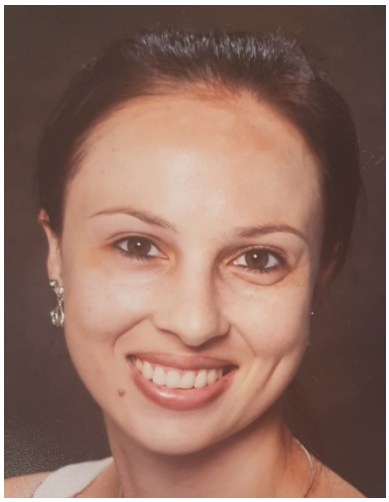
SOUTH AFRICAN CONSUMERS' KNOWLEDGE OF GENETICALLY MODIFIED (GM) FOOD PRODUCTS AND INFLUENCES THAT AFFECT THE PURCHASING DECISION OF GM FOODS

Van Zuydam SC[1]*, Kempen EL[2] and L Truter[3]



Soné Corné van Zuydam

*Corresponding author email: 55439594@mylife.unisa.ac.za
sone.zuydam1@gmail.com

[1]PhD student at the University of South Africa (UNISA), Department of Life and Consumer Sciences, College of Agriculture and Environmental Sciences

[2]Professor at the University of South Africa (UNISA), Department of Life and Consumer Sciences, College of Agriculture and Environmental Sciences

[3]Lecturer at the University of South Africa (UNISA), Department of Life and Consumer Sciences, College of Agriculture and Environmental Sciences

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ABSTRACT

Prevailing food insecurity has necessitated the leveraging of alternative food products if the Sustainable Development Goal 2 (SDG2), referring to zero hunger for the worldwide population, is to be achieved. Although the production of genetically modified (GM) plant-based crops has been adopted in South Africa (SA), and available for human consumption, a dearth of research exists in respect of SA consumers' knowledge of, and the influences that affect the purchase of GM food products. An exploratory survey study design included 326 consumers, purposefully selected through snowball sampling from Mooi river, in KwaZulu-Natal province, SA. Exploratory Factor Analysis (EFA) was used to identify underlying drivers for the knowledge and influences on the purchase decisions of GM food products. It was found that although respondents were aware of GM food products and understood the meaning of "genetically modified", they lacked general knowledge about GM food products, reflected in the minimal scope of their knowledge and uncertainty of GM components present in food products as identified through an EFA. Consideration for purchasing would include the potential to increase food supplies, the reduced usage of pesticides, carcinogenic effects, allergenicity, harmful effect on the environment, longer shelf life and the unnatural development of GM food products. Through EFA, consumption and production implications, consumer advantages, product identification elements, and agricultural pesticide practices were underlying drivers of the influencers of consumers' GM food product purchasing decisions. Food insecurity could persist if GM consumer education is not re-introduced in SA to address consumer apathy and sense of disengagement towards GM food products. This is attributed to the limited consumer knowledge about GM food products. This study has contributed towards a better understanding of the current consumer perspective on GM food products and what it will take to turn the GM food product aversion into informed consumer decisions and practices. Future research in SA is needed to determine the demographic profile of consumers and how that will influence GM food product purchases in the wake of addressing food security.

Key words: food insecurity, food security, GM agriculture, consumer education

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INTRODUCTION

Genetically modified (GM) food products may offer a solution to the ever-threatening food insecurity crisis South Africa (SA) faces [1] – a crisis which is evidenced by approximately 11 per cent (6.5 million) of the local population suffering from hunger in 2019 [2]. It is further estimated that 44.8 million people in 13 countries in the Southern African region are subjected to food insecurity [3], which brings the question whether current food production can address food security on the continent. In part, GM food products may hold the key to address Sustainable Development Goal 2 (SDG 2) which sets out to ensure that the world is free of hunger by 2030 [4]. Notably, the rapid GM plant-based food production rate [5] and enhanced nutritional content of such food products [6] may have the potential to address chronic malnutrition and nutritional deficiencies [7]. These and other traits such as improved taste, longer shelf life, better quality, and resistance to harsh conditions, pesticides and herbicides are found in several food products meant for human consumption on the international market [5, 6], such as maize and corn-based food products, papaya, squash, canola and sugar beets [8] – amongst others, which may go unnoticed by many consumers.

The genetic modification of plant-based food products refers to plant-based foods that have been produced from plant material of which the genetic composition has been altered to produce a particular characteristic such as nutritional, consumption or crop yield benefits [9]. Although many countries have opted for biotechnology-produced food products [10], it remains unclear whether SA consumers know enough about GM food products to successfully make the transition to such foodstuffs. Unfortunately, the available evidence suggests that consumers have little knowledge – which is not specifically quantified – and little interest in GM food products, particularly the benefits associated with the production and consumption thereof, as well as the purchase availability of such foods [11, 12,13]. Although many studies have focused on consumer GM food product knowledge [13, 14, 15, 16], no clear identification of the underlying drivers that constitute this knowledge, has been explored. Due to the strong relationship between knowledge and purchasing behaviour [17], it is necessary to determine whether consumers' current knowledge of GM food products has an effect on their decision to purchase such foodstuffs and what drives these decisions. Furthermore, various influences have been identified that affect consumers' purchasing decisions when it comes to GM food products [18]. These influences have mostly been established through surveys on consumer opinions of GM food products [15], leaving a dearth of knowledge about the main features that play a role in these influences and what drives these influences. Thus, the purpose of this study was to fill this gap in the

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SA context by determining SA consumers' GM food product knowledge, the influences that affect the purchasing decision of GM food products, and by identifying their respective underlying drivers.

GM Food Product Knowledge

For some time, researchers have endeavoured to determine the extent of consumers' knowledge of GM food products [19]. In general, knowledge is defined as what a person knows or thinks, as fabricated in his/her mind [20] – that includes the information and values a person has acquired through experience [21] and uses when performing a specific activity or behaviour [17]. Subsequently, decisions are led by all the knowledge a person has accumulated over time [22]. Knowledge is also interwoven with the attitudes and opinions which consumers form [16], which ultimately guide the purchasing decisions as far as GM food products are concerned [22].

Some developing countries have shown a very poor understanding of the term "genetic modification" [13] and have claimed to at least have heard (or have awareness) of GM food products [5]. Although such awareness is an expression of knowledge, it is largely lacking in many first- and third-world countries [13], judging from consumers' low level of awareness of what GM food product markets offer. Knowledge diversity, as regards GM food products, remains a concern [16], and that issue may affect the confidence with which consumers make informed purchasing decisions. Consumers seem more informed about the allergic risk reactions that may occur after consuming a GM food product [16], and less informed about products containing a GM component, such as rice and soybean [12]. Many consumers are familiar with corn and maize as GM foodstuffs [15]. Consumers' lack of interest in GM food product information [23], along with unclear labelling [13], may contribute to a lack of consumer knowledge and awareness of GM food products. This could affect the accuracy of consumer knowledge and the subsequent familiarity consumers' have with the characteristics of such foodstuffs [14]. Importantly, improving consumers' level of knowledge may not necessarily lead to a more positive attitude or opinion about a product [5]. Vecchione *et al.* [24] found that the more consumers knew about GM food products, the more they purchased non-GM food products, fueled by their knowledge of the potential risks of the former. It is important to determine not only SA consumers' knowledge of GM food products, but also the underlying drivers that represent this knowledge.

Influences that Affect the Purchasing Decision of GM Food Products

Consumers' GM food product purchasing decisions are influenced both positively and negatively by various influences [14], meaning there are various benefits, risks

and concerns [25]. Evidence suggests that purchases of GM food products have been compromised in countries such as the United States of America (USA) and Ghana, where consumers are largely unaware of the potential benefits of these products [12, 23]. Interestingly, the economically viable nature of GM food products has favourably influenced consumer purchases, due to the fact that these foodstuffs are drought, flood and insect resistant [5], and require fewer pesticides and insecticides [26]. As a result, the crops are less labour intensive [27] and require lower production costs [26], making them increasingly economically viable to cultivate [27]. The ability of GM food products to address food shortages [5] is one factor that largely influenced Mexican consumers' decision to purchase such products [28]. The availability of nutritionally healthier food options [16], and novel product colours such as the PinkGlow™ pineapple [29], have increased consumers' willingness to purchase GM food products [30]. Additionally, demographic influences such as age, gender, education level and income have also been found to influence consumers' decision to purchase GM food products [31]. Influences such as the availability and cost of GM food products compared to traditional food varieties can also affect the purchase decision of GM food products [30].

Certain influences could, however, result in GM food products not being purchased. These include consumers' concerns about allergenic health risks [13, 16] and possible carcinogenic effects after consumption [32]. The safety of GM food product consumption [28] and the harmful effects of its production on the environment are also major concerns expressed by consumers [32]. Consumers' decision to purchase GM food products have been impeded through the potential loss of biodiversity [13] and ethical issues related to the production of GM food products [23]. Strongly felt ethical convictions – partially explained by the unnatural order of GM food product production – conflict with many consumers' moral beliefs [10] and subsequently negatively affect their purchasing decision. It is uncertain whether these concerns are based on knowledge or on deductions and unsubstantiated beliefs which shape consumers' opinions of GM food products. Ambiguity exists around the influences that influence SA consumers' decision to purchase GM food products, as well as the underlying drivers of those influences, all of which warrants the current investigation.

MATERIALS AND METHODS

Study Design

A quantitative exploratory survey research design was used to explore a less researched consumer topic [33], to gain further insight into consumers' knowledge

and influences that affect their purchase decision of GM food products. Purposive sampling was used to recruit respondents, whereby the researcher could choose respondents who warranted inclusion in the study, by adhering to specific inclusion criteria as these respondents were most likely to provide optimal and valuable information on the research topic [34]. To increase the sample size of respondents [35], snowball sampling was also used as the study sample was very specific for this study.

Study Population

Considering the exploratory nature of the study, the sample population, conveniently situated near the researcher, formed part of the agricultural community of Mooi River, KwaZulu-Natal, SA. Male and female consumers who generally purchased their own food and who had some experience with purchasing and/or consuming GM and non-GM food products were included in the study. This resulted in 326 respondents (adults >18 years) participating in the study. The intent was not to generalise the results to the broader South African population. The purpose of the study was rather to gain better insight of consumers' knowledge and influences that affect their purchase decision of GM food products from a target sample of consumers as currently, little research has determined these aspects.

The respondents were employees from different local businesses, recruited through signed permission obtained from the owners of these businesses. The researcher distributed the questionnaires during work hours to voluntary, eligible employees willing to participate in the study. The respondents could, in their own time, complete the questionnaire at home after which the researcher was contacted to collect the questionnaire from the respondents' workplace. To ensure that the sample size increased during data gathering, snowball sampling was also applied in which instance the researcher approached the respondents' to also identify other potential respondents who met the inclusion criteria and could make a meaningful contribution to the study [35]. From the snowball effect, a referral was obtained of a potential respondent, who was asked to contact the researcher via email resulting in more potential respondents.

Data-Collection Instrument

A structured, self-administered questionnaire consisting of 30 questions/statements was used to collect data. The questionnaire consisted of three sections, which focused on demographic information (seven questions), statements that best extracted knowledge of GM food products from previous studies by Mandal and Paul [19] as well as Wunderlich and Gatto [16], and the influences affecting

purchasing decisions regarding GM food products used from studies by Dizon *et al.* [7], Popek and Halagarda [13], and Ozkok [32]. All statements were measured using a five-point Likert scale with neutral as the middle scale item. The respondents indicated their level of agreement between Strongly Disagree (1) and Strongly Agree (5), but due to the small difference between 'Strongly Disagree' and 'Disagree', these two scale items were merged to form 'Disagreement', and 'Strongly Agree' and 'Agree' were merged to form 'Agreement', for data-analysis purposes with neutral remaining as the third scale item.

Ethics

For this study, the Health Research Ethics Committee in the College of Agriculture and Environmental Sciences from the University of South Africa granted ethical approval for the researcher to collect data from human participants (2018/CAES/162). Written consent was obtained from the respondents before administrating the questionnaire.

Data Analysis

Data were entered in Microsoft Excel and analysed using the SPSS Statistics 25 package to perform descriptive analyses on the data set whereby frequencies, percentages, central tendency (mean) and standard deviation were performed, after which inferential analysis was done by determining the normal distribution of the quantitative datasets using the Shapiro-Wilks test. Internal consistency reliability was tested using Cronbach alpha (α). Exploratory factor analysis (EFA) was performed to reveal the underlying drivers constituting knowledge of GM food products, and the influences that affect the purchasing decision of GM food products respectively.

RESULTS AND DISCUSSION

Demographic Profiles of Respondents

More than half of the respondents who participated in the study were female (58%), and 42 per cent were male. The respondents reported an average working age of 39 years, with an average monthly household income of R27 602. They also indicated that they had a Grade 12 or further qualification, were married or living with a partner, and were employed or not (Table 1).

Respondents' Knowledge of GM Food Products

Descriptive statistics of the ten GM knowledge statements (Table 2), indicated that 87 per cent (n=284) of the respondents had heard of GM food products. Deffor [5] obtained similar results from a study conducted in the Greater Accra region of

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Ghana. Eighty-six per cent (n=281) of the respondents in the current study knew that GM food products were available to purchase in supermarkets, and 74 per cent (n=241) knew what "genetically modified" meant in terms of food products. By contrast, Popek and Halagarda [13], who conducted a study in European Union (EU) countries, found that respondents were not fully aware and did not know that GM food products were available to purchase in supermarkets, most likely due to ineffective labelling. The discrepancy between these studies suggests the importance of such products locally, and the possible unimportance of GM food products in countries where food insecurity might not be a concern.

Sixty-nine per cent (n=226) of respondents knew that maize contained a GM component, while 50 per cent (n=161) admitted they were not very knowledgeable about GM food products. Less than half of the respondents agreed that they knew a fair amount (49%, n=162) or a little (48%; n=158) about GM food products. Less than 50 per cent (45%, n=147) reported knowing that soybean contained a GM component. A similar study conducted by McFadden and Lusk [12] on consumers in the USA showed that most respondents did not know that soybean was genetically modified.

Studies conducted in Switzerland by Lucht [11] and in New Jersey by Wunderlich and Gatto [16] respectively, also established that, generally, respondents considered themselves to know very little about GM food products or to be largely uninformed about the topic. Various other studies conducted in the USA, Malaysia and Ghana reported similar results, in that consumers were found not to be very knowledgeable about GM food products, did not have knowledge of the potential benefits that GM food products had to offer, and only a few truly understood the concept of GM food products [12, 15, 23]. South African consumers' limited GM food product knowledge is consistent with studies from other countries [16] – a finding that could be attributed to the lack of awareness resulted from insufficient consumer updates on GM food product development across the globe.

Exploratory Factor Analysis of Respondents' Knowledge of GM Food Products

Exploratory factor analysis was conducted on the statements as illustrated in Table 2 to establish factors that could be extracted, to determine if underlying drivers of respondents' knowledge of GM food products could be identified. Exploratory factor analysis could be used to determine these drivers, as it establishes the underlying relationships that exist between variables, although the data were skewed in this case. As non-normal distribution is common in data sets, the data were still acceptable for use for purposes of analysis [36]. The Kaiser-Meyer-Olkin

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(KMO) Measure of Sampling Adequacy was used to determine whether the data were suitable for EFA [37], and Bartlett's Test of Sphericity was applied to determine the significance of the statements in the data [38]. No specifications were indicated as to the number of components desired. The KMO measured at 0.88, therefore, along with Bartlett's Test, these were commendable as a measure of >0.8 was achieved, indicating that the data were creditable for EFA [39], as any value of 0.6 or above is deemed acceptable [40]. In Table 3 the Eigenvalues indicate how much variance the statements of a factor account for [36], two factors loaded greater than 1 therefore retaining these factors as Chan and Idris [40] recommend that factors with a loading of .400 or less should not be included. The two factors extracted account for 60.12% of consumers' general knowledge of GM food products.

The results of the EFA are reported in Table 4. As seen in Table 4, items 8, 10–15 and 17 can be regarded as Factor 1 with the highest eigen value (4.622) and thus account for most of the variation in the data. The mean scores for each of the 326 respondents on each of the items of Factor 1 indicate 51% (n=167) of the respondents with a mean score ≥3.63 and ≤4.88, 42% (n=136) of respondents averaged a mean score ≥2.50 and ≤3.50 with only 7% (n=23) of the respondents averaging a mean score ≥1.00 and ≤2.38. Factor 1 is labelled the "scope of consumers' knowledge about GM food products" as an acceptable factor with a Cronbach's Alpha of 0.88 exceeding the reliability value threshold of 0.7. This suggests that respondents' answers were consistent on the knowledge about GM food products. Items 9 and 16 can be regarded as Factor 2, which points to "consumers' lack of knowledge about GM food products and the uncertainty of the presence of a GM component in food products". As only two items loaded onto Factor 2, the correlation value R^2 0.11 was calculated, although low, further scale development of items to effectively measure the factor, is required. The means for both these factors were 3.5 and 3.2 respectively suggesting that consumers were possibly more inclined to be unsure about their responses to the statements in this factor. While two factors emerged from the EFA, they essentially measured the same concept from two different perspectives – the scope of consumers' knowledge of GM food products and confirmation of the lack of such knowledge, together with the uncertainty of the presence of a GM component in food products - which drive SA consumers' knowledge of GM food products.

The scope of SA consumers' GM food product knowledge signifies uncertainty about the product ranges (that is, which foods are genetically modified; for example, whether rice and soybean contain a GM component). Consumers' admission of not being very knowledgeable of GM food products demonstrates that

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there is general uncertainty about such products, as confirmed by Lucht [11] as well as McFadden and Lusk [12]. This also suggests that consumers have not kept up with new developments in GM food production which could account for their uncertainty regarding which food products have undergone genetic modification and are available for human consumption.

Influences that Affect the Purchasing Decision of GM Food Products

Study respondents' opinions on the statements related to the influences that affect the purchasing decision of GM food products are presented in Table 5. Sixty-six per cent (n=217) agreed that the production of GM food products could increase food supplies. Notably, Lopez *et al.* [28] achieved similar results in a study conducted in Mexico, which showed that respondents' purchasing decisions were influenced by an awareness that the production of GM food products could help to address food insecurity. Fifty-six per cent (n=178) agreed that the production of GM food products required a reduced use of pesticides. A study by Popek and Halagarda [13] found that this influenced EU respondents' purchasing decisions of GM food products.

More than half of the respondents in the current study agreed that cancer (52%; n=169) and possible allergenicity developed after GM food consumption (51%; n=166) could influence their purchasing decision. In this regard, respondents in the EU and USA echoed these concerns [13, 16]. Fears about allergenicity may be common among consumers, rather than specific to GM food products. Such concerns may stem from lay perceptions that substantially overestimate the actual frequency of food allergies [41].

More than half of the respondents agreed that GM food products had a harmful effect on the environment (51%; n=167). Notably, respondents in the country of Georgia believed that even by using GM food products, consumers were harming the environment [42] by encouraging the production of these foodstuffs, which could potentially disturb the ecosystem and food chain, thereby creating undesirable pests and the development of pesticide-resistant pests [13]. The respondents also conceded that GM food products had a longer shelf life (50%; n=165) (a major advantage for EU consumers) [13] and were unnaturally developed (50%; n=163) which subsequently influenced their purchasing decision. Respondents in this study were found to be less certain in terms of agreeing on whether or not the development of GM food products was unethical (45%; n=147), which is contrary to what consumers in Ghana believed [23]. The unnatural order of producing GM food products may go against many consumers' moral beliefs and religion, thereby negatively affecting their related purchasing decisions [11].

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Less than half of the respondents in this study agreed that reduced prices (47%; n=153) and increased nutritional value (47%; n=153) would influence their purchasing decision, which echoes the findings of a study conducted amongst Australian consumers [30]. Very few consumers agreed that the availability of food products in different colours (36%; n=118) with an improved taste (39%; n=129) – despite being an attractive attribute for Australian consumers [30] – would influence their purchasing decision. Although this study did not set out to determine the demographic influences (age, educational level, economic background, and others) on GM food product purchases, these factors have been found to influence consumers' decisions [31] and may still have an underlying influence irrespective of factors consumers, in this study, considered influential. The perceived cost of GM food products, in relation to other traditional food products, has been found to influence GM food product decisions [30] which may be a further underlying driver related to the economic situation of consumers. However, the lack of consumer information about the positive prospects of cost-effective GM food product development to benefit the consumer may stifle consumer awareness.

Exploratory Factor Analysis of the Influences that Affect the Purchasing Decision of GM Food Products

Exploratory factor analysis was conducted to establish the underlying drivers of the influences that affect consumers' purchasing decision of GM food products, from which four factors emerged. The KMO was measured at 0.779, which can be referred to as middling, and was acceptable for performing a EFA as a value greater than the minimum threshold of 0.50 [37] was achieved. Bartlett's Test of Sphericity's significance value was measured at 0.000, and was thus deemed suitable for principal component analysis [39].

After inspection of the Eigenvalues (Table 6), four factors emerged which loaded more than 1 and thus retained. The first factor has the highest eigenvalue (3.926); thus accounting for most of the variation in the data. The four factors extracted accounted for a total variance of 71% in the influences that affect the purchase decision of GM food products.

As seen in Table 7, items 23–25 and 27–29 formed part of Factor 1 with a Cronbach's Alpha of 0.87 and mean of 3.37. The mean scores for each of the 326 respondents on each of the items of Factor 1 indicate 44% (n=143) of the respondents with a mean score ≥2.50 and ≤3.50, 42% (n=138) of respondents averaged a mean score ≥3.67. and ≤5.00 with only 14% (n=45) of the respondents averaging a mean score ≥1.00 and ≤2.33. Factor 1 suggests a relationship

between items relating to health and environmental effects, as well as the development of GM food products thus referring to it as "consumption and production implications from GM food product development". The implications of GM food products may not be relevant to many consumers. Although consumers in Georgia [42] and Nigeria [43] were able to identify the possible health and environmental effects of GM food products, it does not mean that these concerns stem from a well-defined knowledge base of information and reliable sources. Items 18–21 and 30 form part of Factor 2 with a Cronbach's Alpha of 0.79 and mean of 3.39, which represents the "consumer advantages" of GM food products. The mean scores for each of the 326 respondents on each of the items of Factor 2 indicate 43% (n=142) of the respondents with a mean score ≥2.60 and ≤3.40, 36% (n=116) of respondents averaged a mean score ≥3.60. and ≤4.20 with only 11% (n=37) of the respondents averaging a mean score ≥1.00 and ≤2.40. These statements related to product quality and the production of such products, which has been known to create consumer optimism [5]. Item 22, which refers to the colour of some GM food products, forms part of Factor 3. Although only one item loaded onto Factor 3 with a mean of 2.81, further scale development of items that effectively measure the factor is necessary. The mean scores for each of the 326 respondents on each of the items of Factor 3 indicate 36% (n=118) of the respondents with a mean score ≥1.00 and ≤2.99, 36% (n=118) of respondents averaged a mean score ≥3.00. and ≤3.99 with only 28% (n=90) of the respondents averaging a mean score ≥4.00 and ≤5.00. However, Factor 3 presents the "product identification elements" of GM food products which visually aid in consumers' related purchasing decisions [29]. Other product identification elements could also include labelling, as this could assist consumers' in identifying which food products in store have been genetically modified – this could lead to a more informed purchasing decision [16]. Statement 26 makes up Factor 4, which consists of a single statement that was used to determine which influences affected consumers' purchasing decisions regarding GM food products in terms of reduced pesticide usage. Only one statement classifying the opinion of "agricultural pesticide practices" was measured, which loaded quite strongly, and therefore needed to be considered separately from Factor 1–3. Although only one item loaded onto Factor 4 with a mean of 3.57, further scale development of items that effectively measure the factor, is necessary. The mean scores for each of the 326 respondents on each of the items of Factor 4 indicate 54% (n=178) of the respondents with a mean score ≥4.00 and ≤5.00, 35% (n=115) of respondents averaged a mean score ≥3.00. and ≤3.99 with only 11% (n=90) of the respondents averaging a mean score ≥1.00 and ≤2.99. From the EFA, it is therefore suggested that consumption and production implications from GM food products (for example, allergic reactions, harmful effect on the environment and the man-made process of

GM food product development), consumer advantages (improved product characteristics such as better product quality, and production aspects such as increased food supplies), product identification elements (for example, availability of food in different colours) and agricultural pesticide practices (for example, reduced pesticide usage) are the underlying drivers of the influences which influence purchasing decisions related to such food products.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

South African consumers have very limited knowledge of GM food products and have not remained informed and expanding their knowledge about GM food products since these products were first introduced. The lack of knowledge manifests in consumer uncertainty of the range and specific products containing GM components which may have caused a disconnect, failing interest and general apathy towards GM food products in SA. This may not be ideal when GM food products are considered as a potential solution through which to address food security in SA. Consumers may need to be re-educated about GM food products if the issue of zero hunger as set out in SDG 2 is to be achieved. This may trigger the interest as well as informed identification and decisions about GM-containing food products on the market, thereby benefitting from attributes GM food products hold. Improved knowledge will further assist consumers in dismissing misconceptions that have developed because of the inability to rectify unfounded and unscientific claims related to GM food products. Consumer knowledge may reverse current consumer apathy towards GM food products and bring about a better understanding of the value GM food products may bring to alleviating hunger and food insecurity in SA.

The demand for sustainable, environmentally and health friendly features, were some of the most important influences that affect the South African consumers' purchasing decision of GM food products. Underlying drivers that hamper the decision to purchase GM food products are the potential effect that consumption of GM food products may have on consumers as well as the production process of these products. Such negative influences continue to make consumers fearful of GM food products which may negatively influence the decision to purchase these products. However, consumers do identify the perceived advantages, differentiating identifiable product attributes and reduced agricultural pesticide practices as positive GM food product influences that would drive the decision to purchase GM food products. Improved consumer education initiatives could change the consumer approach to GM food products as these food products have the potential to change the well-being of many South African citizens.

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This study has contributed to a better understanding of the underlying drivers that may hamper the intended purpose of GM food products and consumers decision to purchase these products. Future research should determine the effect of demographics and education initiatives on the knowledge and influences on consumers' GM food product purchasing decisions. This will assist in identifying consumer groups that may need specific interventions to favourably influence the purchase of GM food products. The current study presented a limited view of SA consumers' current knowledge of GM food products which limits the generalisability of the findings. Further research may need to expand the sample of consumers to achieve a better representation of consumer perspectives on GM food products. Marketing and GM food product development agencies will benefit from these findings, as the study identified a few important consumer knowledge gaps and influencers that need to be addressed in future marketing strategies of GM foodstuffs. The findings of this study clearly point to the importance of consumer education if the occurrence of food security and food insecurity in SA is to be addressed as apathy and ill-informed consumers may not reap the benefit of the use of GM food products.

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Table 1: Demographic Profiles of Respondents

Demographic Profile	Number of Respondents (n)	Percentage (%)
Gender		
Male	136	42
Female	190	58
Age		
18–24 years	61	19
25–30 years	40	12
31–40 years	53	16
41–50 years	64	20
51 years or older	108	33
Income		
Monthly household income	326	Average: R27 602
Highest Level of Education		
Lower than matric/Grade 12	24	8
Matric/Grade 12	138	42
Grade 12 + a degree/diploma	164	50
Marital Status		
Single	93	29
Married/living with a partner	212	65
Divorced/separated	12	3
Widow(er)	9	3
Type of Employment		
Permanent full time	197	60
Permanent part time	18	6
Contract work	6	2
Self-employed	61	19
Unemployed	44	13
Core Business of the Establishment		
Agriculture	94	29
Education	68	21
Construction	5	2
Food	17	5
Finance	10	3
Medical	21	6
Other	111	34

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Table 2: Respondents' Knowledge of GM Food Products

Statement Number	Statement	Respondents		
		Disagreement	Neither	Agreement
8	I know what "genetically modified" means in terms of food products	39* 12**	46 14	241 74
9	I do not feel very knowledgeable about GM food products	106 32	59 18	161 50
10	I know that GM food products are available to purchase in supermarkets	17 5	28 9	281 86
11	I know a fair amount about GM food products	87 27	77 24	162 49
12	I know that maize contains a GM component	49 15	51 16	226 69
13	I have heard about GM food products	23 7	19 6	284 87
14	I know which food products have been genetically modified	140 43	103 32	83 25
15	I know that rice contains a GM component	100 31	110 34	116 35
16	I know a little about GM food products	100 31	68 21	158 48
17	I know that soybean contains a GM component	87 27	92 28	147 45

Note: The frequencies (n)* appear at the top of each row, and the percentages (%)** at the bottom

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Table 3: Total Variance Explained for the General Knowledge of GM Food Products

Total Variance Explained						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.622	46.220	46.220	4.622	46.220	46.220
2	1.390	13.901	60.120	1.390	13.901	60.120
3	.846	8.461	68.581			
4	.643	6.426	75.007			
5	.549	5.487	80.495			
6	.490	4.900	85.394			
7	.441	4.414	89.809			
8	.416	4.160	93.969			
9	.308	3.081	97.050			
10	.295	2.950	100.000			

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Table 4: Exploratory Factor Analysis of Respondents' Knowledge of GM Food Products

Statements		Component Matrix	
		Components	
		1	2
8	I know what "genetically modified" means in terms of food products	0.776	0.194
9	I do not feel very knowledgeable about GM food products	-0.588	0.444
10	I know that GM food products are available to purchase in supermarkets	0.657	0.438
11	I know a fair amount about GM food products	0.791	-0.143
12	I know that maize contains a GM component	0.767	0.179
13	I have heard about GM food products	0.718	0.401
14	I know which food products have been genetically modified	0.694	-0.303
15	I know that rice contains a GM component	0.674	-0.184
16	I know a little about GM food products	-0.199	0.791
17	I know that soybean contains a GM component	0.736	
	Mean	3.52	3.18
	Standard deviation	0.73	0.91
	% Variance explained	46.22	13.901
	Cronbach α	0.88	

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Table 5: Influences that Affect the Purchasing Decision of GM Food Products

Statement Number	Statement	Respondents		
		Disagreement	Neither	Agreement
18	Reduced price	75 23	98 30	153 47
19	Increased nutritional value	77 24	96 29	153 47
20	Improved taste	85 26	112 35	129 39
21	Longer shelf life	60 19	101 31	165 50
22	Availability of foods in different colours	118 36	118 36	90 28
23	Possible allergic reaction after consumption	65 20	101 31	160 49
24	Possible cancer development after consumption	65 20	92 28	169 52
25	Possible cause of allergenicity after consumption	60 18	100 31	166 51
26	Reduced usage of pesticides	33 10	115 35	178 55
27	Harmful effect on the environment	59 18	100 31	167 51
28	The development of GM food products is unethical	80 25	147 45	99 30
29	The development of GM food products is unnatural	58 18	105 32	163 50
30	The production of GM food products can increase food supplies	18 6	91 28	217 66

Note: The frequencies (n)* appear at the top of each row, and the percentages (%)** at the bottom

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Table 6: Total Variance Explained for the Influences Affecting the Purchasing Decision of GM Food Products

Total Variance Explained						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.926	30.201	30.201	3.926	30.201	30.201
2	3.017	23.210	53.411	3.017	23.210	53.411
3	1.216	9.356	62.767	1.216	9.356	62.767
4	1.078	8.289	71.056	1.078	8.289	71.056
5	.879	6.758	77.815			
6	.641	4.934	82.749			
7	.621	4.774	87.523			
8	.417	3.205	90.728			
9	.400	3.073	93.801			
10	.268	2.061	95.862			
11	.221	1.701	97.563			
12	.207	1.594	99.157			
13	.110	.843	100.000			

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Table 7: Exploratory Factor Analysis of the Influences that Affect the Purchasing Decision of GM Food Products

Statement Number	Statement	Component Matrix			
		Components			
		1	2	3	4
18	Reduced price	-0.409	0.550		
19	Increased nutritional value	-0.504	0.637		.120
20	Improved taste	-0.463	0.651		
21	Longer shelf life	-0.396	0.625	0.373	-.195
22	Availability of foods in different colours	-0.178	0.437	0.580	-.408
23	Possible allergic reaction after consumption	0.645	0.526	-0.236	-.281
24	Possible cancer development after consumption	0.774	0.465	-0.245	-.145
25	Possible cause of allergenicity after consumption	0.773	0.449	-0.234	-.185
26	Reduced usage of pesticides		0.492		.669
27	Harmful effect on the environment	0.734	0.332		.127
28	The development of GM food products is unethical	0.692		0.491	.198
29	The development of GM food products is unnatural	0.659		0.560	.267
30	The production of GM food products can increase food supplies	-0.194	0.507		.385
	Mean	3.37	3.39	2.81	3.57
	Standard deviation	0.86	0.77	1.10	0.89
	% Variance explained	30.20	23.21	9.36	8.29
	Cronbach α	0.87	0.79	-	-

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