Attitudes and acceptance of South African urban consumers towards genetically modified white maize

H Vermeulen, JF Kirsten[1], TO Doyer[2], HC Schönfeldt[3]

Abstract

The introduction of genetically modified (GM) food products to food markets around the world, has led to considerable controversy. In many cases consumer attitudes and perceptions of GM food products were revealed as fears, concern for, and avoidance of the new technology. The importance of GM foods in South Africa is increasing, even though the GM Food debate lags behind many other (often more developed) parts of the world. This paper investigates the knowledge, attitudes and acceptance of urban South African white-grain maize consumers regarding GM maize. Conjoint- and cluster analysis were used to develop clusters/market segments among the urban consumers of white maize. A range of additional questions was used to develop profiles of the identified market segments. These aspects covered demographics, GM knowledge aspects as well as GM attitude aspects. Four distinct clusters/market segments were identified with specific characteristics: "Anti-GM, Brand aware" cluster (35% of valid responses), "Brand unaware, Farmer sympathetic" cluster (20%), "GM consumer benefit, Brand aware" cluster (25%) and the "Brand aware, Pro-GM" cluster (20%). The most significant differences between the clusters were based on the consumers' attitudes towards GM food products.

1. Introduction

The introduction of genetically modified (GM) food products to food markets around the world, has led to considerable controversy. A vast amount of research has been conducted in many countries, related to consumers' behaviour regarding GM food products. In many cases consumer attitudes and perceptions of GM food products were revealed as fears, concern for, and avoidance of the new technology.

[1] *Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, South Africa.*
[2] *Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, South Africa and CEO of the Agricultural Business Chamber in South Africa.*
[3] *Centre for Nutrition, University of Pretoria, South Africa & Chief Researcher: Sensory Analysis and Food Composition, Agricultural Research Council, Irene, South Africa.*

The importance of GM foods in South Africa is increasing, even though the GM Food debate lags behind many other (often more developed) parts of the world. South Africa is the only country in Africa growing legally sanctioned commercial GM crops. Currently the genetically modified crops that have been approved for commercial production in South Africa are herbicide-tolerant soya-beans, cotton and maize, as well as insect-resistant cotton and maize (FEST, 2002; AfricaBio, 2003). According to Gouse (2004) the estimated area planted to Bt yellow maize increased from 50,000ha (1999/2000) to 197,000ha (2002/03), while the estimated area planted to Bt white maize increased from 6,000ha (2001/2002) to 15,000ha (2002/2003). Thus, the importance of genetically modified white maize production in South Africa is increasing.

Maize is undoubtedly South Africa's most important field crop. Within the South African context white maize is primarily produced for human consumption, while yellow maize is primarily utilized as animal feed. During the period 2001/2002 to present the average white maize human consumption was approximately 3.762 million tonnes per annum, while the average yellow maize animal consumption was 3.141 million tonnes per annum (Grain South Africa, 2004). In South Africa white maize is mainly consumed in the form of dishes prepared from maize meal (flour).

Maize is an important staple food product within the South African context. According to a report on South African food consumption studies undertaken among different population groups (Nel & Steyn, 2002), 98% of rural consumers consumed maize porridge, while up to 71% of urban consumers consumed maize porridge. Among rural consumers maize porridge and related dishes was a dominating food source in all age categories. Amongst urban consumers maize porridge and dishes dominated in the age groups 1 to 5 years, as well as 6 to 9 years (Nel & Steyn, 2002). According to Bekker (2004) rural South African consumers generally consume maize as a dominant staple food upon which their survival depends and in other cases as a staple within a reasonably balanced diet. On the other hand urban South African maize consumers generally consume maize either as a staple within a reasonably balanced diet or as a variety-giving component within a balanced diet.

South African consumers are increasingly exposed to GM food. Consumer awareness on GM issues is only starting to appear in South Africa. The behaviour of South African consumers regarding GM foods need to be researched. Similar to the global situation of consumers and GM food, positive consumer perceptions and acceptance of GM products could be fundamental factors influencing the future success of GM foods in South Africa. Better understanding of consumers' knowledge, perceptions, attitudes and behaviour

regarding GM food could be to the benefit of numerous role-players within the modern biotechnology industry, agricultural industry and food industry in South Africa. Some of the most important role-players who could benefit from better information regarding consumer behaviour and GM food include food companies, retailers, biotechnology companies, farmers, government and other relevant role-players.

A number of research studies have already been conducted regarding consumers issues related to GM food products in South Africa (e.g. AfricaBio, 2002; AfricaBio study reported in CropBiotech Update of May 28, 2004; Joubert, 2002; Kempen *et al*, 2004; Pouris, 2003). The South African research on consumers and GM food has produced a lot of valuable information. A number of important results were obtained in these research studies:

- South African consumers have low levels of knowledge, understanding and awareness regarding GM issues.
- Fears and misconceptions exist among South African consumers regarding general- and food related GM issues.
- Many consumers in South Africa have not formed opinions about GM issues yet.
- Some of the studies revealed that South African consumers were generally positive about GM food, especially when consumers received the benefit from the genetic modification.
- There is a great need among South African consumers for labelling of GM food products, as well as information and education on GM issues.

A vast amount of information is still needed in order to understand South African consumers' awareness, perceptions, attitudes and behaviour towards GM food products. A need was identified to supplement the available research with research that focussed on the presence of GM maize within the staple food product maize, with a market segmentation approach (instead of an aggregate market approach).

This paper focused on the knowledge, attitudes and acceptance of urban consumers in the South African regarding GM white maize. The main objectives of the paper were:

- To identify trade-offs between selected attributes of maize meal and to determine the relative importance of selected GM characteristics within the trade-off, by means of a conjoint experiment.
- To construct market segments based on the outcomes of the conjoint experiment.

- To determine the knowledge, attitudes and GM maize and -food acceptance of the different market segments.

2. Research method

The data for the paper was gathered during November 2003 when respondents participated in a conjoint experiment, followed by the completion of the survey questionnaire.

Quota sampling was applied to obtain a total sample of 90 urban, white-maize consumers from the Gauteng province of South Africa, consisting of 3 groups of 30 respondents each. The quotas were based on the LSM (Living Standard Measures) market segmentation tool (developed by the South African Advertising Research Foundation), based on wealth, access and geographic indicators. The LSM classification divides the population into ten LSM groups with LSM 10 (highest) to LSM 1 (lowest). The first respondent group consisted of urban consumers from LSM groups 4 and 5, the second group consisted of urban consumers from LSM groups 6 and 7 and the third group (30 respondents) consisted of urban consumers from LSM groups 8, 9 and 10. Table 1 displays a summary of the characteristics of the selected LSM groups from the SAARF AMPS 2002A, adopted from an industry presentation by Haupt *et al* (2004).

The relatively small sample size was due to the fact that a time-consuming and rather expensive sensory evaluation experiment was also conducted as part of the research project and consequently the sample size was limited.

The first task of the respondents was the completion of a conjoint experiment. Conjoint analysis is a quantitative marketing research technique, originally developed for psychometric research, that could be applied in order to measure consumer perceptions and preferences (Anttila *et al*, 1980; Johnson, 1985). It is a type of thought experiment, rather than a data analysis procedure (Sudman & Blair, 1998). Conjoint analysis models the nature of consumer trade-offs amongst multi-attribute products or services (Padberg *et al*, 1997). The method measures the importance individual consumers attach to various product attributes and the utility that consumers attach to the different levels of the various attributes, based on their valuation of the complete product (Malhotra, 1996; Tull & Hawkins, 1993). The conjoint analysis method is based on a number of assumptions (Ness & Gerhardy, 1994):

- All products can be defined as a set of attributes.
- Different product variations can be defined by means of a series of predetermined levels of a set of product attributes.

- The total utility derived by a consumer from the consumption of a product is determined by the utilities contributed by each attribute level.
- Consumers evaluate the utility of the different attribute level combinations in order to make a purchase decision.
- When consumers choose between alternative products, they trade off different attribute level combinations.

Table 1: Summary characteristics of the LSM groups in the experimental sample

LSM No	%	Demographics	Media
4 & 5	29.2	***Age:*** 16-34 ***Gender:*** Male & Female ***Education:*** Some high school up to Grade 12 ***Urban***	***Radio:*** ALS stations Radio Bop Metro FM KAYA FM YFM ***TV:*** SABC 1, 2 & 3 Bop TV E TV ***Other:*** Weekly newspapers Magazines Outdoor
6 & 7	19.0	***Age and Gender:*** 16–34 Male and Female 35+ Male ***Education:*** Grade 12 and higher ***Urban***	***Radio:*** Wide range of commercial and community radio ***TV:*** SABC 1, 2 & 3 E TV M NET ***Other:*** Daily/Weekly Newspapers Magazines Cinema and Outdoor
8, 9 & 10	16.4	***Age and Gender:*** 35+ Male and Female ***Education:*** Grade 12 and higher ***Urban***	***Radio:*** Wide range of commercial and community radio ***TV:*** SABC 1, 2 & 3 E TV M NET DSTV ***Other:*** Daily/Weekly Newspapers Magazines Internet Cinema and Outdoor

Source: Adopted from an industry presentation by Haupt *et al* (2004) based on the SAARF Universal LSM 2004.

Conjoint analysis (often in combination with cluster analysis) has been widely used in the evaluation of consumer preferences for hypothetical products and

services (Hair *et al*, 1995). There are numerous examples in the academic literature where these techniques were applied within the context of food related marketing research (such as Baker, 1999; Huang & Fu, 1995; Murphy *et al*, 2000; Ness & Gerhardy, 1994; Steenkamp, 1987; Van der Pol & Ryan, 1996).

Within the context of consumer research related to GM food products, a number of research studies have been conducted by means of conjoint analysis techniques, often combined with cluster analysis techniques (Baker & Burnham, 2002; Grunert *et al*, 2004; Lusk *et al*, 2002).

The conjoint experiment was designed around three selected product characteristics of white maize meal. The attributes of white maize meal that are critical in affecting consumers' preferences and choices regarding the product (brand and price) were determined by means of a pilot personal interview survey. The research objectives of the conjoint experiment necessitated the inclusion of two specific product attributes. Price was included in order to be able to determine consumers' willingness to pay for various trade-offs amongst the product attribute levels. Since the main focus of the study was on consumer perceptions of genetically modified maize, it was also necessary to include the genetic modification factor into the product attributes. A factor was included describing the type of maize used to produce the white maize meal. Thus, the product attributes brand, price and type of maize used to produce the maize meal, were included in the conjoint experiment of white maize meal sold on the South African urban food market. The "Brand name" variable had two levels: "Specific brand, e.g. Ace, Iwisa, Sun, etc." and "Brand not important". The "Price for a 2.5kg white maize meal" variable had three levels: "R6.20" (low price level), "R8.10" (average price level) and "R10.99" (expensive price level). The "Maize type used to produce the maize meal" variable had three levels: "No GM maize", "Farmer used GM maize to increase crop yield" ("GM crop yield" variable level) and "GM maize used to increase maize meal shelf life" ("GM shelf life" variable level). The total number of hypothetical scenarios for the experiment was 18 (equal to 3^2 multiplied by 2^1). The 18 possible scenarios were reduced to 9 scenarios, in order to make the conjoint task more manageable for the respondents. A fractional factorial design was generated by means of the "Orthogonal Design" procedure in SPSS 12.0 for Windows. The full-profile approach was selected for this conjoint experiment. The rank order method was selected to measure consumer preferences. The main motivation behind this choice was the fact that some of the respondents, especially those in the lower LSM groups had relatively low education levels and would benefit from the simplicity of the ranking task. The respondents were asked to rank the 9

product options from most preferred to least preferred in a personal interview survey environment.

Effects coding was applied in order to code the 9 hypothetical product scenarios, which allowed for the recovery of the "left-out" dummy variable and maintained the orthogonality of the experimental conjoint design (Lusk *et al*, 2002). Ordinary least squares (OLS) regression in E-views 3.1 was applied in order to estimate the parameters of the conjoint model for each of the 86 respondents individually. Since regression analysis was applied to rank order data, Spearman's rank correlation coefficient between the input values and estimated values of the dependent (rank order) variable was applied in order to assess the fit of the model to the data (as suggested by Green & Srinivasan, 1978). The analysis of the conjoint results was based on the following additive conjoint model:

$$Y_n = C + B1(X_1) + B2(X_2) + B3(X_3) + B4(X_4)$$

With:

Constant	(C)
"Price" variable	(X1)
"Specific brand" level of the "Brand" variable	(X2)
"No GM maize" level of the "Maize source" variable	(X3)
"GM shelf life" level of the "Maize source" variable	(X4)
Rank order of respondent n, with n = 1, 2, …, 86	(Y_n)
Coefficient of "Price" variable	(B1)
Coefficient of "Specific brand" level of the "Brand" variable	(B2)
Coefficient of "No GM maize" level of the "Maize source" variable	(B3)
Coefficient of "GM shelf life" level of the "Maize source" variable	(B4)

This model enabled the estimation of the respondents' willingness to pay (WTP) values. According to Van der Pol and Ryan (1996) indirect estimates of the respondents' WTP values could be acquired if cost is included as an attribute in the conjoint experiment. The calculated WTP values were also an indication of consumers' preferences amongst the various trade-off pairs. Eight WTP values were calculated by dividing the difference between the coefficients associated with the two options being traded off, by the price coefficient, as suggested by Van der Pol and Ryan (1996).

The conjoint analysis results were then used as a basis for cluster analysis, in order to identify homogeneous groups of urban white maize consumers based on their WTP for the various trade-offs between the maize meal attribute levels. Cluster analysis is a class of techniques used to classify objects into relatively

homogeneous groups called clusters, in such a manner that objects within the various clusters tend to be similar to each other and dissimilar to object in the other clusters (Malhotra, 1996). According to Sudman and Blair (1998) the most important application of cluster analysis within the scope of marketing research is to form groups of customers for market segmentation purposes.

Ward's hierarchical clustering procedure with Euclidian distance was applied in the research, within the statistical package SPSS 12.0. The clustering process was based on the respondents' WTP for "Specific brand" maize meal relative to maize meal with no specific brand, WTP for "GM shelf life" maize meal relative to "GM crop yield" maize meal, WTP for "GM shelf life" maize meal relative to "No GM" maize meal and WTP for "GM crop yield" maize meal relative to "No GM" maize meal.

The nature of the WTP values was such that the WTP values of the various trade-off pairs were mirror images of each other. For example, the WTP value of a specific respondent for "Specific brand" maize meal relative to maize meal with no specific brand, had the same value but opposite sign than the same respondent's WTP value for maize meal with no specific brand relative to "Specific brand" maize meal. Thus, in order to prevent the inclusion of overlapping variables, the "mirror-images" of the above mentioned variables were excluded from the cluster analysis procedure.

The clustering research objectives related to this conjoint model evolved around the relative importance of a specific maize meal attribute or attribute level to the other maize meal attributes or attribute levels and whether clusters of respondents could be found with similar patterns of importance based on consumers' WTP values. According to Hair *et al* (1995) standardization by respondents is appropriate in such cases. In other words, when the size displacements should not contribute towards the similarity among respondents, column standardizing (standardizing by respondents in this case) could be appropriate (Romesburg, 1984). The standardized WTP values were calculated by dividing the original data value of the i^{th} attribute and the j^{th} respondent, with the maximum value observed for the j^{th} respondent, as suggested by Romesburg (1984). Given the "mirror-image" nature of the WTP values, the standardized data set contained at least one value of 1.0 and one value of -1.0 (indicating the strongest positive and negative preferences respectively for that respondent).

The final phase of the experimental analysis involved the profiling of the identified clusters based on demographic variables, GM knowledge questions

and GM attitude questions. These questions were based on previous studies (Baker & Burnham, 2002; Verdurme & Viaene, 2002; Wolf *et al*, 2002).

3. Results and discussion

3.1 Aggregate conjoint analysis results and discussion

Table 2 shows the OLS estimated aggregate coefficients for coefficients B1 to B4, as well as the calculated values for the "left-out" variables ("Brand not important" and "Farmer used GM maize to increase crop yield"), for the conjoint model.

Table 2: Conjoint analysis results, all respondents, n = 80

Attribute	Variable/Attribute level	Coefficient
Brand name[a]	"Specific brand" (Coefficient B2)	0.7875**
	"Brand not important"[c]	-0.7875**
Price	Price for 2.5kg white maize meal (Coefficient B1)	-0.3539**
Maize type used to produce the maize meal[a]	"No GM maize" (Coefficient B3)	-0.2417**
	"Farmer used GM maize to increase crop yield"[b c]	-0.7208**
	"GM maize used to increase shelf life of maize meal"[b] (Coefficient B4)	0.9625**

Notes: ** Statistical significance at a 0.05% level, based on Spearman's rank correlation coefficient.
[a] Attributes were effects coded in such a way that the coefficient of the "left-out" attribute level equal the negative sum of the "included" categories.
[b] The phrase "genetically modified" was replaced with the acronym "GM".
[c] Part-worth utility value was calculated based on the effects coding principle.

The estimated aggregate average price coefficient was negative, implying that an increase in the price of the maize meal would results in a decline in the utility derived from the maize meal. Furthermore, on the aggregate level, lower priced maize meal would be preferred to higher priced maize meal, holding all other maize meal attributes constant.

The estimated aggregate rescaled WTP values are summarised in Table 3.

Table 3: Estimated aggregate rescaled WTP values, n = 80

WTP for	Relative to	Estimated rescaled WTP value
Branded maize meal	Non-branded maize meal	0.1656
Non-branded maize meal	Branded maize meal	-0.1656
"GM shelf life" maize meal	"GM crop yield" maize meal	0.2988
"GM shelf life" maize meal	"No GM" maize meal	0.1524
"GM crop yield" maize meal	"GM shelf life" maize meal	-0.2988
"GM crop yield" maize meal	"No GM" maize meal	-0.1461
"No GM" maize meal	"GM shelf life" maize meal	-0.1524
"No GM" maize meal	"GM crop yield" maize meal	0.1461

The results in Table 3 indicated that, on the aggregate level, the respondents preferred "Specific brand" maize meal to non-branded maize meal; "GM shelf life" maize meal to "GM crop yield" and "No GM" maize meal; "No GM" maize meal to "GM crop yield" maize meal.

3.2 Market segment analysis

The aggregate results did not give a lot of insight into the consumers' behaviour regarding maize meal purchase decision, since product preferences are composed of a collection of individual consumers' purchase decisions that are based on individual (and not aggregate) consumers' preference functions (Baker & Burnham, 2002).

The market segment analysis revealed that the respondents could be grouped into one of four groups, based on the estimated rescaled WTP values. The average estimated WTP values were an indication of the estimated price increase necessary to offset the positive utility associated with the attribute level trade-off combination.

Cluster 1 was named the "Anti-GM, brand aware" cluster and consisted of 28 respondents (35% of the sample). The respondents in Cluster 1 revealed the strongest preference for "No-GM" maize meal relative to maize meal containing GM maize, among all the clusters. They also revealed a weak preference for branded maize meal. The estimated price premium necessary to invoke consumer indifference between "No GM" maize meal and "GM shelf life" maize meal or "GM crop yield" maize meal was R7.31 and R4.64 respectively, for a 2.5kg of maize meal. At any premium less than R7.31 (R4.64) the respondents in Cluster 1, on average derived higher utility from GM-free maize meal than from "GM shelf life" and "GM crop yield" maize meal and would probably make their purchase decision based on the preference. However, if GM-free maize meal was priced at a premium greater than R7.31 (R4.64), for a 2.5kg of maize meal the average consumer could shift consumption to "GM shelf life" ("GM crop yield") maize meal. The estimated price premium necessary to invoke consumer indifference between branded and non-branded maize meal was R1.53 for a 2.5kg of maize meal.

Cluster 2 was named the "Brand unaware, farmer sympathetic" cluster and included 16 respondents (20% of the sample). The respondents in Cluster 2 revealed strong preferences for non-branded relative to branded maize meal, as well as "GM crop yield" maize meal relative to "GM shelf life" and "No GM" maize meal. The estimated price premium necessary to invoke consumer indifference between non-branded versus branded maize meal was R5.42, for

a 2.5kg packet. At any premium less than R5.42 the respondents in Cluster 2, on average derived higher utility from non-branded maize meal than from branded maize meal and would probably make their purchase decision based on the preference. If non-branded maize meal was priced at a premium greater than R5.42 for a 2.5kg of maize meal the average consumer could shift consumption to branded maize meal. The price premium necessary to invoke consumer indifference between "GM crop yield" maize meal versus "GM shelf life" maize meal or GM-free maize meal was R4.21 and R2.09 respectively, for a 2.5kg packet. At any premium less than R4.21 (R2.09) the respondents in Cluster 2, on average derived higher utility from "GM crop yield" maize meal than from "GM shelf life" and GM-free maize meal. If "GM crop yield" maize meal was priced at a premium greater than R4.21 (R2.09) for a 2.5kg of maize meal, the average consumer could shift consumption to "GM shelf life" (GM-free) maize meal.

Cluster 3, the "GM consumer benefit, brand aware" cluster, included 20 respondents (25% of the sample). The respondents in Cluster 3 revealed strong preferences for "GM shelf life" maize meal relative to GM-free and "GM crop yield" maize meal. The respondents also revealed a preference for branded maize meal. The price premium necessary to invoke consumer indifference between "GM shelf life" maize meal versus GM-free or "GM crop yield" maize meal was R8.02 and R7.35 respectively, for a 2.5kg of maize meal. At any premium less than R8.02 (R7.35) the respondents in Cluster 3, on average derived higher utility from "GM shelf life" maize meal than from GM-free and "GM crop yield" maize meal and would probably make their purchase decision based on the preference. However, if "GM shelf life" maize meal was priced at a premium greater than R8.02 (R7.35) for a 2.5kg of maize meal, the average consumer could shift consumption to GM-free ("GM crop yield") maize meal. The price premium necessary to invoke consumer indifference between branded maize meal versus non-branded maize meal was R1.19, for a 2.5kg of maize meal.

Cluster 4 was named the "Brand aware, pro-GM" cluster and included 16 respondents (20% of the sample). The respondents in Cluster 4 revealed the strongest preference for branded maize meal relative to non-branded maize meal amongst all the clusters, as well as a strong preference for genetically modified maize meal relative to "No GM" maize meal. The price premium necessary to invoke consumer indifference between branded maize meal versus non-branded maize meal was R6.50, for a 2.5kg of maize meal. At any premium less than R6.50 the respondents in Cluster 4, on average derived higher utility from branded maize meal than from non-branded maize meal and would probably make their purchase decision based on the preference. However, if

branded maize meal was priced at a premium greater than R6.50 for a 2.5kg of maize meal the average consumer could shift consumption to non-branded maize meal. The price premium necessary to invoke consumer indifference between "GM shelf life" maize meal versus "No GM" or "GM crop yield" maize meal was R8.02 and R7.35 respectively, for a 2.5kg of maize meal. At any premium less than R8.02 (R7.35) the respondents in Cluster 3, on average derived higher utility from "GM shelf life" maize meal than from GM-free and "GM crop yield" maize meal and would probably make their purchase decision based on the preference. However, if "GM shelf life" maize meal was priced at a premium greater than R8.02 (R7.35) for a 2.5kg of maize meal, the average consumer could shift consumption to GM-free ("GM crop yield") maize meal.

A judgement was made on whether the analysis results effectively accomplished the various grouping objectives, by producing meaningful and useful results. The WTP was evaluated as being meaningful and useful. The four WTP clusters had unique cluster characteristics and acceptable cluster magnitudes.

3.3 Cluster profiling results and discussion

The differences between the consumers in the four identified clusters were examined based on socio-demographic variables, GM knowledge variables and GM attitude variables. The results of the analyses are shown in Table 4.

Significant differences (at the 1% probability level) was observed between clusters 1 and 4 in terms of their LSM membership characteristics. LSM groups 6 and 7, followed by LSM groups 8, 9 and 10 dominated in cluster 1. In cluster 4 LSM groups 4 and 5 dominated, followed by LSM groups 6 and 7. In terms of the socio-demographic characteristics of the four cluster groups no significant differences were observed between the clusters at the 10% significance level, in terms of gender, education level, age, household size and number of children in the household. The only significant differences regarding the socio-demographic characteristics were observed between clusters 1 and 4 in terms of their ethnicity characteristics (at a 1% probability level). Cluster 1 consisted of mainly white respondents, while cluster 2 consisted mainly of black respondents.

Respondents' knowledge on GM food related issues were measured by means of two sets of questions. In the first set the respondents expressed their own opinion regarding their GM exposure and knowledge. The F-statistics were not significant for these questions. In general cluster 4 had the lowest perceived GM exposure and knowledge. Cluster 1 revealed the highest perceived GM exposure and knowledge.

Table 4: Profiling characteristics of the four WTP cluster groups

Characteristic	Cluster number				Specific significant differences between
	1 (n=28)	2 (n=16)	3 (n=20)	4 (n=16)	
Gender[a] (Male or Female) % Male	32.1	50.0	30.0	37.5	None
Ethnicity [a] *** (Black or White) % Black	25.0	50.0	50.0	81.25	Clusters 1 & 4 ***
Education [a] (Up to grade 12 or higher) % Up to grade 12	57.1	62.5	60.0	68.8	None
Respondents' mean age [b]	35.8	40.9	34.9	34.5	None
Respondents' mean household size [b]	4.2	4.1	4.5	4.8	None
Mean number of children in household [b]	1.3	1.4	1.3	2.1	None
LSM characteristics [a] ** % LSM 4 & 5 % LSM 6 & 7 % LSM 8, 9 & 10	 7.1 53.6 39.3	 43.8 12.5 43.8	 40.0 25.0 35.0	 50.0 31.3 18.8	 Clusters 1 & 4 ***
Perceived GM knowledge [c] (Mean rating)	2.4	2.6	2.6	3.1	None
Perceived GM understanding [d] (Mean rating)	2.7	2.8	2.8	3.0	None
Statement to test GM knowledge 1 [e] (Mean rating)	3.5	3.3	3.0	3.3	None
Statement to test GM knowledge 2 [f] * (Mean rating)	2.4	2.1	2.6	3.2	Clusters 1 & 4 ** Clusters 2 & 4 **
Statement to test GM knowledge 3 [g] (Mean rating)	4.5	4.1	4.3	4.3	None
Perceived likelihood of buying GM food [h] (Mean rating)	2.5	1.8	1.8	2.0	Clusters 1 & 2 ** Clusters 1 & 3 ***
Attitude/Perception question 1 [i] * (Mean rating)	2.9	2.8	1.9	2.4	Clusters 1 & 3 **
Attitude/Perception question 2 [j] * (Mean rating)	3.9	4.5	4.4	4.6	Clusters 1 & 4 **
Attitude/Perception question 3 [k] ** (Mean rating)	2.6	2.3	1.6	2.3	Clusters 1 & 3 ***
Attitude/Perception question 4 [l] ** (Mean rating)	3.7	2.8	2.4	3.2	Clusters 1 & 3 ***
Attitude/Perception question 5 [m] ** (Mean rating)	2.5	2.8	1.9	3.3	Clusters 3 & 4 ***
Attitude/Perception question 6 [n] (Mean rating)	2.6	2.0	1.8	2.3	None
Attitude/Perception question 6 [o] (Mean rating)	3.3	3.1	3.4	3.9	None

Notes:

*** Significant differences at the 1% probability level.

** Significant differences at the 5% probability level.

* Significant difference at the 10% probability level.

[a] The Chi-square test was applied in order to investigate whether the proportions of the variable levels differed significantly between the clusters. In cases where the Chi-square statistics was significant at the 10% probability level, *post-hoc* tests were performed for the various pairs of clusters for the different variables. Overall significant differences between the clusters were indicated by means of asterisk/s next to the variable name in the "Characteristic" column. Specific significant differences between the cluster pairs were indicated in the last column of the table by means of asterisk/s next to the descriptions.

[b] The one-way ANOVA test was applied in order to investigate the differences between the variable means of the clusters by means of the calculated F-values. . In cases where the F-statistics was significant at the 10% probability level, LSD *post-hoc* tests were performed for the various pairs of clusters for the different variables. Overall significant differences between the clusters were indicated by means of asterisk/s next to the variable name in the "Characteristic" column. Specific significant differences between the cluster pairs were indicated in the last column of the table by means of asterisk/s next to the descriptions.

[c] Respondents expressed their own opinion on the amount read/heard of GM food related terms on a 4 point scale with (1) "A lot", (2) "Some", (3) "A little" and (4) "Nothing at all".

[d] Respondents expressed their own opinion regarding their understanding of GM food related terms in terms of their ability to explain the terms, on a 4 point scale with (1) "Very well", (2) "Relatively well", (3) "A little" and (4) "Not at all".

[e] Respondents expressed their level of agreement with the statement: "Animal characteristics cannot be transferred to plants through genetic modification", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". The statement was false. Thus, (1) "Strongly disagree" was the "correct" answer to the question.

[f] Respondents expressed their level of agreement with the statement: "Conventional food does not contain genes, but genetically modified food do contain genes", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". The statement was false. Thus, (1) "Strongly disagree" was the "correct" answer to the question.

[g] Respondents expressed their level of agreement with the statement: "Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". The statement was true. Thus, (5) "Strongly agree" was the "correct" answer to the question.

[h] Respondents expressed their own opinion regarding their likelihood of buying GM food, on a 5 point scale with (1) "Will definitely buy", (2) "Will probably buy", (3) "Will maybe buy", (4) "Will probably not buy" and (5) "Will definitely not buy". Thus, a bigger rating value, represented a more negative GM attitude of a respondents.

[i] Respondents expressed their level of agreement with the statement: "Genetically modified crops can be a threat to the environment", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". Thus, a bigger rating value represented a more negative GM attitude of a respondent.

[j] Respondents expressed their level of agreement with the statement: "Genetically modified food can be beneficial for consumers", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". Thus, a bigger rating value represented a more positive GM attitude of a respondent.

[k] Respondents expressed their level of agreement with the statement: "Genetically modified food is not safe", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". Thus, a bigger rating value represented a more negative GM attitude of a respondent.

[l] Respondents expressed their level of agreement with the statement: "Genetically modified food is not natural", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". Thus, a bigger rating value represented a more negative GM attitude of a respondent.

[m] Respondents expressed their level of agreement with the statement: "The quality of genetically modified food is lower than the quality of conventionally produced food", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". Thus, a bigger rating value represented a more negative GM attitude of a respondent.

[n] Respondents expressed their level of agreement with the statement: "Eating genetically modified food is a health risk", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree". Thus, a bigger rating value represented a more negative GM attitude of a respondent.

[o] Respondents expressed their level of agreement with the statement: "Genetically modified should be cheaper than normal food", on a scale with (1) "Strongly disagree" up to (5) "Strongly agree".

In the second set of true or false questions the respondents were presented with a number of statements, which they had to evaluate in terms of their level of agreement, in order to evaluate their GM knowledge. For two of the statements no significant differences were observed between the cluster groups. For the statement "Animal characteristics cannot be transferred to plants through genetic modification" Cluster 3 had the most correct response, while Cluster 1 had the least correct response. However, for this question all the Clusters' responses were close to the "Neutral" position and did not reveal

high levels of knowledge certainty. For the statement "Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases" Cluster 1 revealed the most correct understanding, followed closely by Clusters 3, 4 and 5. In general the respondents revealed relatively high levels of GM knowledge in this question. The third statement presented to the respondents was "Conventional food does not contain genes, but genetically modified food do contain genes". Significant differences were observed between the responses of Clusters 1 and 4, as well as between Clusters 2 and 4, at the 5% significance level. Cluster 4 revealed the most incorrect understanding of the statement, while Clusters 1 and 2 revealed the most correct understanding of the statement among the various clusters.

Respondents' perceptions and attitudes towards GM food related issues were consequently compared. Numerous significant differences were revealed in this regard. In terms of respondents' expressed likelihood of buying GM food, significant differences were observed between Clusters 1 and 2 (at the 5% probability level), as well as between Clusters 1 and 3 (at the 1% probability level). Cluster 1 revealed the lowest likelihood of buying GM food, while Clusters 2, 3 and 4 revealed a higher likelihood of buying GM food. In general the rating values of the respondents indicated relatively good willingness to buy GM food products. A number of statements were presented to respondents of which respondents had to indicate their level of agreement. Some of the statements related to various risks/problems associated with GM food, including "Genetically modified crops can be a threat to the environment", "Genetically modified food is not safe", "Genetically modified food is not natural" and "Eating genetically modified food is a health risk". For all four these statements Cluster 3 revealed the most positive attitude towards GM food, while Cluster 1 revealed the most negative attitude towards GM food. These observations were consistent with the cluster characteristics based on the conjoint analysis results, since Cluster 1 was an "Anti-GM cluster", while Cluster 3 was a "Pro-GM cluster". Clusters 2 and 4 revealed very similar responses to these four statements. In general the "not natural" statement had the most negative evaluation, followed by the "environmental threat" statement, among the various clusters. Thus, it seemed that naturalness and environmental concerns were stronger among the consumers than safety and health concerns related to GM food. Furthermore, significant differences (at the 1% significance level) were observed between Clusters 3 and 4 regarding their opinion on the quality of GM food relative to food is lower than the quality of conventionally produced food. Cluster 4 revealed the most negative attitude towards the quality of GM food, while Cluster 3 revealed the most positive attitude in this regard.

The cluster profiling revealed that the demographic variables were not really useful in distinguishing between the various clusters. The results of the perceived GM knowledge levels and the actual GM knowledge (as tested by the various statements) revealed some degree of confusion among respondents regarding GM knowledge and information, as well as discrepancies between perceived and actual GM knowledge levels. On average Clusters 2 and 3 revealed the best GM knowledge levels, while Cluster 1 and especially Cluster 4 revealed the worst GM knowledge levels. The results of the perception and attitude questions were generally consistent with the cluster characteristics based on the conjoint analysis results.

4. Conclusion

The research results revealed that four distinct clusters could be identified when considering urban white maize consumers within the South African context, each with specific characteristics. A summary of the most important characteristics of the four cluster groups is shown in Table 5.

Table 5: Summary characteristics of the WTP clusters

Cluster number	% valid responses	Maize meal GM preference	Maize meal brand preference	Summary description
1	35%	Non-GM (a)(b)	Branded (c)	"Anti-GM, Brand aware" cluster
2	20%	GM farmer benefit (b)	Non-branded (a)(b)	"Brand unaware, Farmer sympathetic" cluster
3	25%	GM consumer benefit (b)	Branded (c)	"GM consumer benefit, Brand aware" cluster
4	20%	All GM (b)	Branded (a)(b)	"Brand aware, Pro-GM" cluster

Notes: (a) Strongest revealed preference among all the clusters.
(b) Revealed as a strong preference within the specific cluster.
(c) Lesser degree of positive preference revealed within the specific cluster.

The cluster profiling revealed that urban white maize consumers' attitudes and perceptions were the strongest distinguishing factors between the various clusters/market segments, while demographic factors did not contribute towards distinguishing between the clusters. This could be taken into consideration when identifying market segments for marketing strategy formulation purposes.

The specific characteristics of the four clusters ("Anti-GM, Brand aware" cluster, "Brand unaware, Farmer sympathetic" cluster, "GM consumer benefit, Brand aware" cluster and "Brand aware, Pro-GM" cluster) gave a good indication of the preferences of the clusters. The results suggested that South African urban white maize consumers definitely differed with respect to their

behaviour towards GM food products. An interesting observation from the research was that only about a third of the respondents were completely against GM food. All the other respondents revealed some positive attitude towards GM food to varying degrees. The general and detailed characteristics of the cluster groups could contribute towards the formulation of appropriate marketing strategies, in order to promote GM food amongst the various clusters. The research results suggested that marketing strategies focusing on the consumer related benefits of GM food could have a positive influence on the perceptions of urban white maize consumers in South Africa, regarding GM maize products. It was also evident that a component of the urban white maize consumer market was strongly opposed to GM white maize and it could possibly be extremely difficult to change their views. The necessity of appropriate consumer GM education was also evident from the research results.

The study presented in this study had some limitations: The study only focused on urban consumers, the sample was relatively small and the sample was geographically limited, since only urban consumers in the Pretoria/Johannesburg areas within the Gauteng Province of South Africa were surveyed. Consequently, a number of aspects were identified as possible focus areas of future research studies within the South African context, including the behaviour of urban white maize consumers in other areas within South Africa regarding GM white maize, the behaviour of South African rural white maize consumers regarding GM white maize, as well as the behaviour of South African urban and rural consumers regarding non-staple food products for everyday use and luxury food products. However, the research results presented in this paper provided some insight in the behaviour and acceptance of South African urban white maize consumers towards GM white maize and contributed towards improved knowledge regarding South African consumers' knowledge, attitudes and perceptions regarding GM food products.

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