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Faculty Members' Perspectives on Genetically Modified Foods: The Mediating Role of Food Integrity

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ABSTRACT

Food security in developing countries faces new challenges these days. Scientific developments and biotechnological applications such as transgenic products are of particular importance due to their principal impact on key contexts such as food production. If transgenic products are a potential solution to the world's challenges, authorities need to know and understand the core of society's responses to scientific innovations and their products. This paper expands the body of knowledge by examining the predictors of transgenic product consumption by mediating the role of food integrity. The study population included 681 faculty members of Shiraz University in Iran. The sample size was estimated at 140 faculties using the stratified random sampling method, based on the Cochran formula. The results of applying path analysis showed a good fit of the variables entered in the conceptual model (RMSEA= 0.068). The explaining power of variables in the model respectively include attitude to transgenic product, environmental concerns, trust, and ethical norms. Results of this investigation could be effective in providing practical solutions in social issues such as enhanced attitude to the transgenic product with cultural mechanisms, emphasis on ethical norms, and trust-building in the academic community. These factors, based on public awareness of human involvement in food systems, can be improved by planning and presentation by researchers from relevant business and executive organizations. Based on these findings, providing factors that ensure the health of people could reduce the level of concern about the issues of food integrity and lead to the ideal level of acceptance and consumption of transgenic products.

Keywords: Biotechnology, Food security, Psychological factors, Transgenic products.

INTRODUCTION

Ensuring food security in developing countries, faces new challenges as climate change (Aghaee *et al*., 2015; Shew *et al*., 2018), and population growth (Aghaee *et al*., 2015; Gurau and Ranchhod, 2016; Shew *et al*., 2018). In addition to the food shortages, the evolution of the global climate patterns, increased global demand for agricultural productivity and the simultaneous reduction in environmental conditions, changes in land-use policies, and regional production problems exacerbate the demand for food and threaten food security (National Academy of Washington DC, 2001; Gurau and Ranchhod, 2016; Dayani and Sabzalian, 2018; Shew *et al*., 2018).

In response to food security threats, new technologies have been improved through animal cloning, nutrigenomics, food irradiation, nanotechnology, High-Pressure Processing (HPP), Pulsed Electric field Processing (PEF), and transgenic products to increase accessibility, quality, and health of food, in order to meet human nutritional needs (Frewer *et al*., 2011). Whereas it seems unlikely that a single technological advance could be a solution to these challenges, it is important to critically evaluate new technologies to determine their role in challenges (Baltes *et al.*, 2017). Therefore, new scientific developments, such as biotech

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Table 1. Variables in the literature of transgenic crop utilization research.

Variables	Researcher (s)
Knowledge	Wilcock *et al*., 2004; Pezeshki Rad and Naeemi, 2010; Pezeshki Rad and Naeemi, 2011; Ghasemi *et al*., 2013; Ghiasvand *et al*., 2015; Agaviezor, 2018; Goddard *et al*., 2018; Safi Sis *et al*., 2019; Hakim *et al*., 2020; Ardebili and Rickertsen, 2020
Attitude	Burgess *et al*., 1998; Vermeir and Verbeke, 2006, Ellen *et al*., 2006; Chen and Li, 2007; Costa Font *et al*., 2009 ; Ghasemi Tazangni, 2008; Christoph *et al*., 2008; Arvola *et al*., 2008; Azmi *et al*., 2008; Naeemi *et al*., 2009; Klockner and Blobaum, 2010; Hume, 2010; Pezeshki Rad and Naimi, 2010; Naeemi *et al*., 2011; Braun, 2012, Liu *et al*., 2012; Ghiasvand *et al*., 2015; Yazdanpanah *et al*., 2016 ; Mehrab Ghouchani *et al*., 2016; Pino *et al*., 2016; Nourizadeh *et al*., 2017; Safi Sis *et al*., 2019
Trust	Ghasemi *et al*., 2013; Yang, 2013; Marques *et al*., 2015; Yazdanpanah *et al*., 2016; Goddard *et al*., 2018
Environmental concern	Spence and Townsend, 2006; Snelgar, 2006; Naeemi *et al*., 2009; Kim, 2014; Yazdanpanah *et al*., 2016; Mohr and Golley, 2016; Shin *et al*., 2017; Goddard *et al*., 2018; Safi Sis *et al*., 2020
Ethical norms	Chen and Li, 2007; Rahnama, 2008; Ghasemi Tazangni, 2008; Weale, 2010; Pezeshki Rad and Naeemi, 2010; Meyer *et al*., 2012; Manatizadeh *et al*., 2015; Yazdanpanah *et al*., 2016, Safi Sis *et al*., 2020
Culture	Pahlavan, 2008; Jafari, 2016; Baca, 2017; Sreen *et al*., 2018; Alonso *et al*., 2017
Food Integrity	Hoorfar and Prugger, 2011; Elliott, 2012; Mohr and Golley, 2016; Goddard *et al*., 2018; Ali and Suleiman, 2018
Health concern	Mohr and Golley, 2016; Goddard *et al*., 2018; Safi Sis *et al*., 2019; Safi Sis *et al*., 2020

applications, due to their significant impacts on key areas such as food production, have particular importance (Costa Font and Gil, 2009). Nowadays, the Green Revolution has emerged as a "gene revolution" and has led to the production of transgenic products (Bazuin *et al.,* 2011). But mostly, when technology applications is used in the food industry, it would be a controversial issue globally (Yang, 2013; Gurau and Ranchhod, 2016; Goddard *et al*., 2018; Palmieri *et al*., 2020). Unfortunately, this can affect the future of transgenic products and, therefore, the production and consumption of food (Gurau and Ranchhod, 2016).

On the other hand, sometimes public concerns about technology applied to food may impede the ability of the food system to actually enhance its integrity through innovation (Goddard *et al*., 2018). Consequently, cultivation of transgenic products as new applied technology has become a highly controversial issue, causing huge gap in public as well as in the scientific community, as clearly seen in both the media and the literature. Often incompatible data and observations about some of these products have formed the basis of this gap (Jin *et al*., 2014; Ahmad and Mukhtar, 2017). Environmental impacts, food safety and security, ethical considerations, legal patents, etc. prolong these debates (Palmieri *et al*., 2020).

According to above-mentioned reasons, areas for numerous studies on transgenic products have been taken into consideration. More recent researches have addressed the influences of other factors, such as higher-order attitudes (Magnusson Hursti, 2002; Saher *et al*., 2006; Akbari and Asadi, 2008; Kikulwe *et al.*, 2011; Aleksejeva, 2014; Pino *et al*., 2016) or worldviews about science and technology, the environment and nature, or health (Bawa and Anilakumar, 2013). Studies of how individuals evaluate risk or process information about the issue of transgenic products have also been identified (Hudson *et al*., 2015; Malyska *et al*., 2016).

Recent food integrity scandals in Europe have shaken public confidence in food

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consumption. In the past, public concern typically focused on high-quality products and safer foods. Recent scandals in some food products have raised consumer concerns about food integrity (Ali and Suleiman, 2018). Therefore, currently, food integrity is a public and global issue (Liu *et al.,* 2018). Weaknesses in management, supervision, processing, and other factors along the food supply chain lead to heterogeneity in the above-mentioned comprehensiveness (Ali and Suleiman, 2018).

The term integrity in the literal sense typically refers to being whole, entire, or undiminished. A definition of integrity for the food supply chain might be the requirement that the system performs its intended function in a unique way, without deliberate or unwanted abuse. This description is borrowed from computer networks such as the World Wide Web (Hoorfar and Prugger, 2011). The food integrity has been defined by Elliott (2014, p.84) as "Food integrity can be seen as ensuring that food which is offered for sale or sold is not only safe and natural, but also has the material and quality expected by the buyer and includes the other aspects of food production, such as how to present, procure, and distribute it, and being honest with consumers about these elements" (Goddard *et al.,* 2018; Ali and Suleiman, 2018; Liu *et al.,* 2018).

Many researchers have studied some aspects of food integrity in recent years, including food safety and quality assurance (Elliott, 2012; Liu *et al*., 2018) and supply chain management (Ali and Suleiman, 2018, Kleboth *et al*., 2016). Other studies have addressed the issue of nutritional integrity in conventional fods. However, there have been few studies evaluating the relationship between food integrity concerns and concerns about the use of biotechnology in foods such as transgenic products (Mohr and Golley, 2016; Goddard *et al*., 2018).

Mohr and Golly's results show that there is a strong relationship between concern for food integrity and concern about the content of transgenic products in food. Concerns about food integrity, in turn, are predicted by environmental concerns and health engagement (Mohr and Golley, 2016). Also, Goddard *et al*. (2018) stated that variables that have the potential to predict food integrity concerns are generally identified with concerns about food technology applications that involve direct and conscious human involvement in food products (Goddard *et al*., 2018). From the perspective of these researchers, positive scientific attitudes are a major determinant of reduced concerns about food integrity and two technologies including transgenic and nanotechnology (Goddard *et al*., 2018). Considering these points, as well as numerous worldwide studies that have been conducted on psychological, social, and ethical responses to the use of transgenic products, several variables have been used in this study. Table 1 refers to these variables. Based on the previous studies, there are some limitations such as: many opponents and supporters, statistical community constraints and limitations of experimental studies.

MATERIALS AND METHODS

Conceptual Model

After literature review, two conceptual models of Mohr and Golley (2016) and Godard *et al*. (2018) were considered, due to comprehensiveness and newness of some variables. Then, by determining the relationships between the variables, a hypothesis and conceptual model were formulated**.** Mohr and Golley (2016) presented a hypothetical structural model of factors that could predict response to food transgenic content in the context of food integrity (Mohr *et al*., 2007). They stated that this structural model was developed to predict concerns about food integrity and concerns about the content of transgenic in foods. In general, Mohr and Golley (2016) model used two predictor variables of intuitive thinking and health engagement. Other variables such as science benefits attitude, science risk attitude, food integrity, and environmental concern were included in the model, too. After that, Godard *et al*. (2018) utilized the same structural model and were able to examine the influences on a broad class of general concerns about food integrity and the direct and indirect effects of those concerns on specific concerns about GM foods and nanotechnology applications in food products and introduced a new structural model in this field (Goddard *et al.,* 2018). Their findings included variables such as trust (general and institutional) and knowledge as key predictors of response to food content that influences the adoption of food technologies (Goddard *et al*., 2018).

In this study, the structural paradigm of environmental concerns and health engagement, as discussed in both Mohr and Golley (2016) and Goddard *et al*. (2018), was used as the main predictor of response to food transgenic content in the context of food integrity. A survey of nanotechnology and transgenic technologies in Canada showed that socio-demographic variables, trust, and knowledge in food integrity concerns, and concerns of using nanotechnology and transgenic technology in food, are related together, directly and indirectly. In addition, other studies have acknowledged the direct and indirect impact of these variables on the acceptance or consumption of transgene products. Therefore, in this model, these variables were used, as well. Both Mohr and Golley (2016) and Goddard *et al*. (2018) noted that attitudes to the benefits of science and technology can change people's perceptions toward the use of new technologies in food. Attitude has been selected because of the important and predictive ability of attitude on intention and behavior (Burgess *et al*., 1998; Klockner and Blobaum, 2010; Braun, 2012; Freyer *et al*, 2005; Vermeir and Verbeke, 2006; Arvola *et al*., 2008; Liu *et al*., 2012; Hume, 2010). In this study, attitude toward science and technology was not generally measured, because it seems that the expansion of different fields of science increases the probability of different interpretations and thus increases the error in the measurement of research variables. Therefore, the attitude toward one type of science and technology, which is genetic science and, more specifically, the transgenic products, has been measured. In this study, in addition to the above-mentioned predictive factors, two predictors of culture and ethical norms have been added to the model, based on the importance of these predictors in the literature. The variables used in the conceptual model of this study are outlined into three categories: social, psychological, and ethical. Figure 1 illustrates the conceptual model including factors influencing the consumption of transgenic products.

This study aimed to investigate the predictors of concern for food integrity and transgenic products based on researches on nutritional integrity and the application of specific technologies such as transgenic products. Also, an assessment of the relationship between food integrity concerns and transgenic crop technology in a more informed scientific group, including faculty members, has been considered, since they are usually more prepared than ordinary people to criticize the pros and cons of different issues. Also, they have the ability and capacity to influence the market by choosing to use a product or not (Valente and Chaves, 2017). They can think critically about the subject that has been given to them and see different dimensions of a subject. Therefore, they may have a better understanding of the transgenic food discussion (Folkerth, 2015).

Method

This research is a kind of applied quantitative research that used a survey technique to collect needed data and information. The statistical population of the study consisted of 681 faculty members of Shiraz University who carry out educational and research activities in different faculties of this university (15 faculties and 63 educational departments) as coach, assistant professor, associate professor, and professor (Shiraz University, 2019). The sample size was estimated at 140 according to Equation (1).

$$n_h = n\frac{N_h}{N} \qquad (1)$$

Where,

n: The number of samples selected from the study population

N_h: Number of people in the h class

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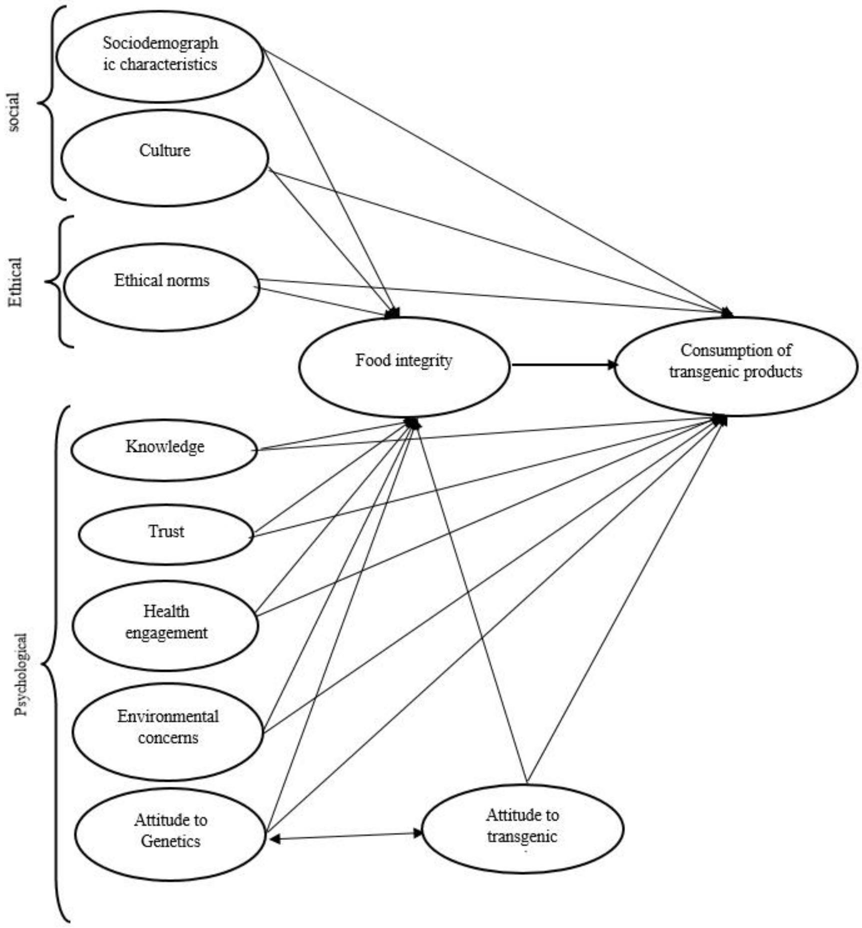

Figure 1. Hypothesized model: factors influencing the consumption of transgenic products.

n_h: Selected sample from class h

N: The total number of people in the community

h= 1, 2,…, k ($N_1 + N_2 + \ldots + N_h + \ldots + N_K = N$)

The stratified random method with proportional volume assignment was used for sampling. To determine the sample size of classes, all Shiraz University faculty members were divided into five categories based on their college and major field of study including literature and humanities, engineering, basic sciences, agriculture and natural resources, and veterinary medicine. In the next step, according to the sample size, the number of samples was divided into five classes.

To design research tools, we first tried to study the existing and published research literature and articles. This stage provided the basis for the design of the research instrument. The research instrument was a researcher administrated with closed-ended questions whose validity was confirmed by Shiraz

Table 2. Alpha coefficients of variables' scales.

Variable	Alpha coefficient
Knowledge of Transgenic	0.79
Attitude to Genetics	0.97
Attitude to transgenic products	0.80
Trust	0.79
Consumption of transgenic products	0.82
Food Integrity Concerns	0.64
Environmental concern	0.73
Health engagement	0.65
Ethical norms	0.80
Cultural factors	0.83

Table 3. Comparison of means for gender and consumption of transgenic products and food integrity.

Comparable variable	Gender	Mean	SD	t	level of significance
Consumption of transgenic products[a]	female	18.15	0.49	-1.39	0.117
	male	19.14	0.40	-1.54	
Food integrity[b]	female	25.02	0.64	-1.18	0.006
	male	25.79	0.31	-1.07	

[a] Consumption range of transgenic products 9-26, [b] Food Integrity range 17-30.

University experts' opinions. The reliability of the questionnaire was calculated using Cronbach's Alpha for the variables that were measured using the Likert scale in an area outside of the study sample. The results confirmed the questionnaire (Table 2). The data were analyzed using SPSS 22 and AMOS 22 software.

RESULTS

Descriptive analysis of data showed that the age of the respondents ranged from 31 to 70 years old, and their mean age was approximately 43 years [Standard Deviation (SD)= 12.88]. Also, 100 respondents (71.4%) were men and the other 40 (28.6%) were women. The distribution of the respondents in the field of the study showed that the highest frequency was related to agricultural engineering with 31.4% (n= 44) and the lowest frequency was related to engineering and veterinary engineering with 12.2% (n= 17). Individuals with specialized disciplines of basic sciences and humanities each participated in about 22%. About 98% (138 persons) of respondents had PhD degree and less than 2 percent had postgraduate degree. Considering the scientific rank of the individuals, data analysis showed that 58% (n= 81) of the responders were assistant professors, 28% (n= 39) were associate professors and about 13% (n= 18 member) were professors.

Comparison of Means about Gender and Consumption of Transgenic Products and Food Integrity

According to the results in Table 3, there were no significant differences in the consumption of transgenic products between the two groups of males and females. However, there was a significant difference between the two groups of males and females regarding the level of food integrity concern. The average concern for food integrity among men was higher than women, so, men were more concerned about food integrity than women.

Test Results between Age and Consumption of Transgenic Products

The results of Table 4 show that the mean consumption of transgenic products was significantly ($P< 0.05$) different between the faculty members in different ages. This finding indicates that age level can affect consumption of transgenic products.

The descending order of mean consumption of transgenic products was seen in age groups of 41-50, 51-60, 40 and less, and 61 and more, respectively. The results of LSD test showed that there was a significant difference between the age groups of 40-50 and the age group of 40 and less in consuming the products of transgenic products, but age groups of 51-60 and 61 years and more had no significant differences.

Test Results of Field of Faculty Members with Transgenic Products Consumption and Food Integrity

Table 5 shows that the mean consumption of transgenic products was significantly ($P< 0.05$) different between faculty members with different fields. The average consumption among agricultural faculty members was higher than in other groups. Results of Fisher's LSD test showed that the agricultural group had significant differences with humanities and engineering in terms of the use of transgenic products, but there was no significant difference with veterinary and basic science groups. In

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other words, people who were more relevant in the field and, probably, had more information about transgenic products reported greater product consumption than other faculty members.

Also, ANOVA results showed that the mean score of food integrity concern among faculties with different fields of the study showed that food integrity concern among faculty members was different. A comparison of these findings indicated that people who were educated in agriculture and veterinary had less concern about food integrity and consumed more transgenic products. In other words, people who are educated in humanities and technical engineering are more concerned about food integrity and consume less transgenic products (Table 5).

Path Analysis Results

Pearson correlation test was used to investigate the relationship between the consumption of transgenic products and independent research variables. The results of this test showed that the various variables used in the model with the consumption of transgenic products had significant correlations as follows: Food integrity (P= -0.400**, Sig= 0.0001); Knowledge (P= 0.300**, Sig= 0.0001); Culture factors (P= 0.448**, Sig= 0.0001); Attitude genetic (P= 0.529**, Sig= 0.0001); Attitude transgenic (P= 0.528**, Sig= 0.0001); Trust (P= 0.539**, Sig= 0.0001); Health engagement (P= -0.54, Sig= 0.05); Ethical norms (P= 0.465**, Sig= 0.0001); Environmental concern (P= 0.247**, Sig= 0.003).

Factors affecting the level of technological applications of transgenic products were estimated by path analysis technique in Amos24 Software. Path analysis allows to test a set of regression equations concurrently and to examine simultaneously the relationships between different variables (Anderson and Gerbing, 1988; Hooman, 2009).

The tested model is shown in Figure 2. In the first step, the fit indices of the initial model showed that the model did not fit. Then, the path variables of the model were modified, including deletions (including culture to food integrity, ethical norms to food integrity, environmental concerns to food integrity, and knowledge to food integrity), adding new double sided paths

Table 4. Comparison of the mean of the four age groups of the faculty members regarding the consumption of transgenic products.

Variable	40 and less 1			41-50[A] 2			51-60 3			More than 61 4			ANOVA	
Consumption of GM	Mean	SD	F_i	Mean	SD	F_i	Mean	SD	F_i	Mean	SD	F_i	F	Sig[B]
	18.22[b]	3.62	67	20.20[a]	4.27	29	48.19[ab]	3.45	35	20.17[ab]	2.94	9	2.41	0.05

[a-b] The different Latin letters in each column represent a significantly different meaning.[A] The age group 41-50 has the highest average.[b] Significant difference at the 0.05 level.

Table 5. Comparison of the mean consumption of transgenic products of faculty members by different field of study.

Variable	Humanities[a] 1		Veterinary Medicine 2		Agriculture and Natural Resources[b] 3		Basic Sciences 4		Engineering 5		ANOVA	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	F	Sig
Consumption of GM	17.67[b]	3.58	18.82[ab]	2.34	20.11[a]	4.31	18.68[ab]	3.55	17.26[b]	3.01	2.99	0.02
Food Integrity Concerns	27.09[a]	3.12	24.17[b]	3.67	24.55[b]	2.97	26.20[ab]	3.59	26.46[ab]	3.81	4.13	0.003

[a] The Humanities Department has the highest average concern. [b] Faculties of the Department of Agriculture and Natural Resources have the highest average consumption. (a-b) The different Latin letters in each column represent a significantly different meaning.

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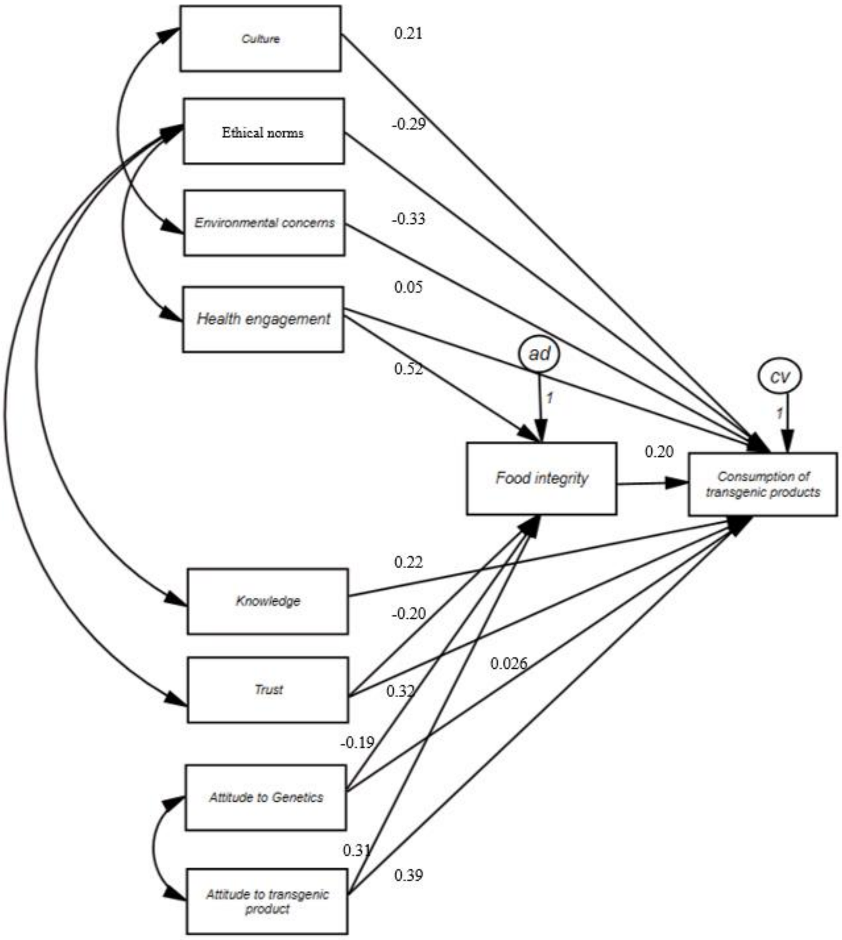

Figure 2. Structural model: Psychological, social, and ethical factors affecting responses to consuming transgenic products.

Table 6. Goodness of fit indices before and after model modification. [a]

Index				Equivalent of index	
		Research model	Reasoning model	Perfect fit	Good or acceptance
X^2/DF	Chi Square/DF	10.59	1.64	$X^2/df \leq 2$	$X^2/df \leq 3$
CMIN	Minimum discrepancy function *C*	296.629	44.403	----	----
DF	Degrees of freedom	28	27	----	----
P	Significance level	0.0001	0.01	----	----
RMSEA	Root Mean Squared Error Estimated	0.26	0.068	*RMSEA*≤ 0.05	*RMSEA*≤ 0.08
NFI	Normed Fit Index	0.31	0.89	*NFI*≥ 0.95	*NFI*≥ 0.90
IFI	Incremental Fit Iindex	0.33	0.95	*IFI*≥ 0.95	*IFI*≥ 0.90
TLI	Tucker-Lewis Index	-0.12	0.92	*TLI*≥ 0.95	*TLI*≥ 0.90
CFI	Comparative Fit Index	0.302	0.95	*CFI*≥ 0.95	*CFI*≥ 0.90

[a] Reference equivalent of index: Byrne, 2010, Reference Research model: Researcher

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between some variables (including attitude to the transgenic product with attitude to genetics, culture with environmental concerns, ethical norms with trust, knowledge and health engagement), indicating that there were correlation between variables utilized in the conceptual model. All of the modifications improved the theoretical reliability of the model, significantly reduced the RMSEA statistic, and increased NFI, CFI, IFI, TLI, hence, improved the model. In terms of goodness of fit indices of the structural model after correction (RMSEA, NFI, CFI, IFI, TLI), the model had acceptable level (Table 6). Results of research hypotheses tests are shown in Table 7.

DISCUSSION

The biotech market in the world is expanding in several areas, the first of which is in the field of genetic engineering and production of transgenic products. Globally, technology applications remain contentious in the food industry; also, food technologies remain largely unexplored across time and countries (Goddard *et al.*, 2018).

Research in this area could inform food industry decision-makers about appropriate methods to enhance food concern and about how much to focus on food integrity implications when introducing new technology applications (Goddard *et al.*, 2018). In general, it can be said that the results of path analysis show that the consumption of transgenic products is related to food integration concerns as two main and mediating variables. These two variables are also explained by variables such as ethical norms, environmental concerns, health concerns, attitudes toward genetics, and attitudes toward consumption. These findings are explained in details in Figure 2.

The results of the path analysis showed that variables used in the conceptual model, explain the consumption of transgenic products and showed a significant correlation. These

Table 7. Results of research hypotheses tests.

Relationships between variables			Direct effects of standard coefficients	
			Path coefficients	level of significance
Knowledge	→	Consumption of transgenic products	0.22	0.001
Trust	→	Consumption of transgenic products	0.32	***
Attitude to Genetics	→	Consumption of transgenic products	0.026	***
Attitude to transgenic product	→	Consumption of transgenic products	0.39	0.01
Environmental concerns	→	Consumption of transgenic products	-0.33	***
Health engagement	→	Consumption of transgenic products	0.05	***
Ethical norms	→	Consumption of transgenic products	-0.29	***
Culture	→	Consumption of transgenic products	0.21	***
Trust	→	Food integrity	-0.20	0.003
Attitude to Genetics	→	Food integrity	-0.19	***
Attitude to transgenic product	→	Food integrity	0.31	0.04
Health engagement	→	Food integrity	0.52	***
Consumption of transgenic products	→	Food integrity	0.20	***

explaining power respectively include attitude to transgenic product, environmental concerns, trust, and ethical norms. Health engagement, attitude to transgenic products, and trust were the most powerful variables to explain food integrity concern. The importance of these variables was confirmed by previous studies (Mohr and Golley, 2016; Goddard *et al*., 2018; Safi Sis *et al*., 2019).

Based on the results, path coefficients of food integrity as a mediating variable in the model were acceptable. These results were relevant to the findings of Goddard *et al*. (2018), which included research on transgenic and nanotechnology products in the context of food integrity among Canadian citizens; and the Mohr and Golley (2016) survey among Australian citizens. In these studies, factors include environmental concerns, health engagement and attitude related to the GM food consumption by the mediating role of food integrity. On the other hand, the results showed that among all variables utilized in the conceptual model, five factors were affected by food integrity concern as a mediating variable, including trust, attitude to genetics, attitude to transgenic product, and health engagement.

Also, the structural equation of research showed that the attitude towards genetics and attitude towards transgenic products, respectively, affect the consumption of these products and both types of attitudes have positive correlations. As illustrated in the model, attitude toward the transgenic product is the most important variable in explaining the transgenic product consumption among the faculty members. This could be expected based on the previous studies about the predictive ability of attitude on intention and behavior (Vermeir and Verbeke, 2006; Arvola *et al*., 2008, Liu *et al*., 2012). According to TRA (Fishbein and Ajzen, 1980), individual behavior is determined by two main factors including individual attitude.

According to this model, the faculty members' positive attitude would lead to transgenic products consumption if they have the ability and the opportunity to use these products.

Findings also indicate trust as a good predictor of the consumption behavior of transgenic products and food integrity concern, which could be an important step in reducing concerns about the use of these products. As Chen and Li (2007) pointed out, trusting the institutions and scientists has a positive impact on understanding the benefits of these products. Also, Ghiasvand *et al*. (2015) identified trust in biotechnology institutions as the most important variable that affects the attitude of the study subjects to food products. It can also be recalled that a lack of consumer confidence in food has detrimental effects on food integrity and leads vulnerable consumers to misinformation and poor diet (Meyer *et al*., 2012).

The results also showed that the culture variable explains the consumption of transgenic products and showed a positive correlation. It can be stated that people who express collectivistic beliefs mostly intend to consume transgenic products. Individuals in collectivist societies sacrifice their individual goals for group goals and thus try to make the decisions that society makes. This dimension of culture in the statistical population of the research can be interpreted based on the family-based structure of the studied community, which often has the characteristics of the collectivist culture. In this regard, it seems that policymakers and planners can be more effective in encouraging the consumption of transgenic products by focusing on collective beliefs in different social groups.

Besides, the results showed a negative correlation between the consumption of transgenic products and environmental concerns and also ethical norms, among faculty members. Higher environmental concerns and ethical norms could lead to less use of transgenic products. It can be stated that a person who has more concerns about environmental issues, has severe ethical norms, and considers the probability of dangers of consuming transgenic products for environment and other people, would use lower amounts of these products. Based on these finding and considering the details of the high level of concern of the subjects, it can be concluded that by reducing the environmental concern of the people about the problem of food integrity and using information strategies, it could be expected that the level of concern of the people would be reduced or it would be closer to the ideal level. In fact, concerns about the use of Genetically Modified (GM) products could prevent of food industry capability, and lead to the food insecurity of communities.

Health engagement also is one of the most important variables that strongly affect the consumption of transgenic products through food integrity. Ethical norm is one of the variables that affect the consumption of transgenic products, but it has a negative relation. This finding is confirmed by Devos *et al*. (2008).

The present model has shown two-way and significant correlational paths from environmental concern to culture; attitude toward transgenic products to attitude towards genetic science; and from trust, knowledge and health engagement to ethical norms that indicate the relevance of these variables. In other words, the independent variables evaluated in the present study, in addition to being one of the determinants of consumption of transgenic products, have significant relationships with each other. In order to promote the consumption of transgenic products in the community, planning can be done based on the variables under consideration.

The model suggests that personal factors such as knowledge, attitude, trust, and ethical norms along with sociocultural factors could affect transgenic product consumption. It is thus clear from the above discussion that consumer behavior is strongly affected by attitude and various personal and situational factors. Further, these factors can affect the attitude-behavior relationship.

We can finally conclude that introducing transgenic products to food markets should be accompanied by appropriate policies to reassure consumers about safety. These procedures will help the consumer to experience a low level of risk when using transgenic products and increase their consumption. The findings also suggest that efforts to demonstrate the safety of using genetic science in food technologies have not been effective and people are still concerned about the use of transgenic food products. This finding is also confirmed by Goddard *et al*. (2018). In a study by Christoph *et al*. (2008) in Germany on transgenic products, they stated that health concerns have strong explanatory power for the attitude and consumption of these products. The evidence suggests that concerns about specific technologies are similar to concerns about issues of food integrity. The results of this study show that there is a correlation between environmental concern and the consumption of transgenic products.

CONCLUSIONS

Based on the results obtained from explaining the power of variables, attitude to transgenic products, environmental concerns, trust, and ethical norms, respectively, were the most important determinants of consumption of transgenic products among the studied faculty members. The faculties' attitude towards transgenic products and trust were the most important issues.

Cultural mechanisms, such as holding influential presentations in universities, improving the training and public's information by conducting specialized symposiums, conferences, and meetings could be used to provide the details of technical and operational processes for the production of transgenic products.

According to the results of this study, procedures that reduce food integrity standards and deprive consumers of these standards can affect the acceptance of these technologies. Therefore, development program measures of the country in future has essential need for a more precise targeting of national macro policies to gain the trust and acceptance of consumers for biotech and transgenic products. Reviewing and enacting more effective consumer protection laws and more appropriate for producers in order to produce more substantial and ethical practices, as well as creating a suitable context for private sector activities such as biotechnology cooperation makes the field more responsive.

Based on the results and because of the important role of trust in the consumption of transgenic products, establishing a link between the country's scientific researchers and the mass media can build trust in the public level. The need for well-planned programming in educational and promotional films, important news and information on biotechnology achievements, and the use of knowledgeable and experienced professionals in the field of transgenic products by these media are requisites of transgenic science development. This should be done to increase the level of public knowledge and awareness in this field and; also, ambiguities and concerns among different sections of society at different levels, from educated members to the general public, need to be clarified and resolved.

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دیدگاه اعضای هیات علمی در مورد مواد غذایی تراریخته: نقش میانجی‌گری یکپارچگی مواد غذایی

ف. بادگان، و ر. نامداری

چکیده

امروزه، امنیت غذایی در کشورهای در حال توسعه با چالش‌های جدیدی رو به رو است. پیشرفت‌های علمی و کاربردهای زیست‌فناوری مانند محصولات تراریخته به دلیل تأثیر به سزای آن‌ها در زمینه های کلیدی مانند تولید مواد غذایی از اهمیت ویژه‌ای برخوردار است. اگر محصولات تراریخته، یک راه حل بالقوه برای چالش‌های جهان باشد، شناختن و درک مسئولان از محورهای اصلی پاسخ‌های جامعه نسبت به نوآوری‌های علمی و محصولات آن‌ها بسیار حائز اهمیت است. این مقاله با بررسی پیش بینی‌های مصرف محصولات تراریخته با میانجی‌گری، یکپارچگی مواد غذایی، سطح دانش را گسترش می‌دهد. جامعه مورد مطالعه شامل ۶۸۱ عضو هیئت علمی دانشگاه شیراز در ایران بود. حجم نمونه بر اساس فرمول کوکران ۱۴۰ نفر با استفاده از روش نمونه گیری تصادفی طبقه ای برآورد شد. نتایج حاصل از استفاده از تجزیه و تحلیل مسیر، مناسب بودن متغیرهای وارد شده در مدل مفهومی را نشان داد (RMSEA = 0/068). قدرت توضیح متغیرها در مدل به ترتیب شامل نگرش به محصول تراریخته، نگرانی‌های زیست‌محیطی، اعتماد و هنجارهای اخلاقی است. نتایج این تحقیق می‌تواند در ارائه راه حل‌های عملی در مسائل اجتماعی مانند افزایش نگرش به محصولات تراریخته با ساز و کارهای فرهنگی، تأکید بر هنجارهای اخلاقی و اعتماد سازی در جامعه دانشگاهی موثر باشد. این عوامل، مبتنی بر آگاهی عمومی از دخالت انسان در سیستم‌های غذایی، می‌تواند با برنامه ریزی و ارائه توسط محققان از سازمان‌های تجاری و اجرایی مرتبط بهبود یابد. بر اساس این یافته‌ها، عواملی را که سلامت افراد را تضمین می‌کند، می‌تواند سطح نگرانی در مورد مسائل یکپارچگی مواد غذایی را کاهش داده و منجر به سطح ایده آل پذیرش و مصرف محصولات تراریخته شود.

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