

Percepciones y actitudes de la población de Colima, México, hacia los organismos genéticamente modificados

*Perceptions and attitudes of the Colima population, Mexico, towards
genetically modified organisms*

*Percepções e atitudes da população de Colima, no México, em relação aos
organismos geneticamente modificados*

Osva A. Montesinos-López

Facultad de Telemática, Universidad de Colima, México

oamontes2@hotmail.com

Emeterio Franco-Pérez

Escuela de Mercadotecnia, Universidad de Colima, México

francoperez@ucol.mx

Ignacio Licea-Panduro

Facultad de Contabilidad y Administración, Universidad de Colima, México

ignacio.licea@inegi.org.mx

Sofía Ramos-Pulido

Departamento de Matemáticas, Universidad de Guadalajara, México

sofi_rp1988@hotmail.com

Ignacio Luna- Espinoza

Universidad del Istmo-Campus Ixtotec, México

venus_luna77@hotmail.com

Sergio Felipe López-Jiménez

Facultad de Contabilidad y Administración, Universidad de Colima, México

sflopezj@ucol.mx



Autor para correspondencia: Emeterio Franco Pérez Escuela de Mercadotecnia Universidad de Colima. Av. Universidad 333, Col. Las Víboras, C.P. 28040, Colima, México. Email: francoperez@ucol.mx Teléfono celular 3121141265

Resumen

Actualmente existe un gran debate sobre la producción y el consumo de los organismos genéticamente modificados (OGMs) en México, ya sea para su uso alimenticio, en la agricultura o en aplicaciones médicas. Por ello se requiere obtener información sobre su viabilidad en el mercado. Por lo anterior, **el objetivo** del presente estudio fue medir las percepciones y actitudes de los consumidores sobre la producción y consumo de OGMs, en el estado de Colima, México, en 2015. Como **materiales y métodos** para obtener la información se estructuró un cuestionario con 60 preguntas que englobaron 11 factores latentes con un enfoque cuantitativo. El cuestionario se aplicó a 1 000 personas de la zona urbana del estado de Colima, México. **Los resultados** revelaron similitudes y diferencias importantes respecto a estudios realizados en otros países, mostrando, principalmente, que los encuestados no poseen la suficiente información sobre los OGMs, tienen desconfianza alta hacia los mismos y no perciben su valor social ni efectos positivos en la salud más allá de incrementar la productividad agrícola. **Se concluyó** que es necesario generar y proporcionar información científicamente correcta sobre los OGMs a los mexicanos para que estén mejor informados y puedan dar una opinión crítica sobre su consumo.

Palabras clave: organismos genéticamente modificados, percepciones y actitudes del consumidor, Colima.



Abstract

Nowdays, there is a great debate on the production and consumption of genetically modified organisms (GMOs) in Mexico. Whether as food for human consumption or for medical applications, for this reason it is required information about its viability in the marketplace. Therefore, **the objective** of this study was to measure the perceptions and attitudes about the production and consumption of consumers towards GMOs in the state of Colima, Mexico at 2015. As **materials and methods** to obtain information a questionnaire with 60 questions that encompassed in 11 latent factors was structured. The questionnaire was applied to 1 000 people of the urban localities of Colima, México. **The results** revealed important similarities and differences with studies in other countries, showing mainly that respondents did not have sufficient information on GMOs, have a high distrust toward GMOs, and not perceive their social value and positive health effects beyond increasing agricultural productivity. **We conclude** that it is necessary to generate and provide scientifically accurate information on GMOs to the people, so they are better informed and can give a critical opinion on the use of GMOs.

Keywords: genetically modified organisms, consumer perceptions and attitudes, Colima.

Resumo

Atualmente, há um grande debate sobre a produção e consumo de organismos geneticamente modificados (OGM) no México, seja para uso alimentar, agricultura ou aplicações médicas. Portanto, é necessário obter informações sobre sua viabilidade no mercado. Portanto, o objetivo deste estudo foi medir as percepções e atitudes dos consumidores sobre a produção eo consumo de OGM, no estado de Colima, no México, em 2015. Como materiais e métodos para obter a informação, um questionário foi estruturado com 60 questões que englobavam 11 fatores latentes com abordagem quantitativa. O questionário foi aplicado a 1.000 pessoas da área urbana de Colima, no México. Os resultados revelaram semelhanças e diferenças importantes em relação aos estudos realizados em outros países, mostrando, principalmente, que os entrevistados não possuem informações suficientes sobre os OGM, têm alta desconfiança em relação a eles e não percebem seu valor social ou efeitos positivos na saúde. além do aumento



da produtividade agrícola. Concluiu-se que é necessário gerar e fornecer informações cientificamente corretas sobre os OGM aos mexicanos para que eles estejam melhor informados e possam dar uma opinião crítica sobre seu consumo.

Palavras-chave: organismos geneticamente modificados, percepções e atitudes dos consumidores, Colima.

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Introduction

The production and consumption of genetically modified organisms (GMOs), also called "transgenic" organisms, is increasing around the world. In spite of the control carried out in Mexico on this type of biotechnology, it was not until 2001 when the greatest controversies and debates on this subject arose. The aforementioned, due to the national-level communication issued by the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), which reported the spread of genetically modified (GM) corn in the state of Oaxaca, in agreement with the Commission for Environmental Cooperation (CCA, 2004). Since then, this has been a controversial issue in economic, genetic, social, cultural, public health and ecology terms.

It is important to state that the above generated concerns in the national and international scientific community. Civil society mobilized in defense of corn, arguing the need to have sustainable agriculture (Cleveland, Soleri, Cuevas, Crossa and Gepts 2005, Landavazo, Calvillo, Espinosa, González, Aragón, Torres and Mora 2006).

Likewise, there are different opinions on GMOs in which there is a lack of knowledge about their advantages and disadvantages. Therefore, in the face of such controversies, it is necessary to measure the perceptions and attitudes of consumers about the production and consumption of GMOs, which may vary according to sociodemographic conditions (Corti, 2010). For Nelson (2001), consumer skepticism can be attributed to the unknown consequences



on health and the environment, although such behavior is not always the same in human populations.

In this sense there is a need to perform a comprehensive analysis of the situation to make the best decision on the feasibility of using this type of biotech crops (Reséndiz-Ramírez, López-Santillán, Briones-Encinia, Mendoza-Castillo and Varela-Fuentes , 2014). Therefore, in order to create an instrument to measure perceptions and attitudes for the urban population of the state of Colima regarding the production and consumption of GMOs, it was decided to generate a questionnaire based on instruments developed in other parts of the country. world. This was done because, although there are instruments that allow the study of perceptions and attitudes towards GMOs, these were created for very specific populations, so there was no validated instrument to apply it in the population of the state of Colima.

The present work contributes to the study of the perceptions and attitudes of the urban population about the production and consumption of GMOs in the state of Colima, Mexico. A descriptive analysis of perceptions and attitudes by age groups is also presented. Finally, through a beta regression analysis, those sociodemographic aspects that could be significant to explain attitudes and perceptions about GMOs were identified.

Materials and methods

Participants

In order to achieve the proposed results, the objective of this research is the following: to know the perceptions and attitudes of the urban population of the state of Colima, Mexico on the production and consumption of genetically modified organisms, a study with quantitative approach, processing the data of the 1000 participants with the statistical technique of beta regression for this investigation. To obtain valid estimates for the state of Colima, Mexico, the corresponding literature was reviewed and experts in statistics were consulted, so it was proposed to estimate proportions close to 13%, with a maximum relative error of 17%, the reliability of 90% and a design effect of 1,516 for the estimates of this region. On the other hand, a response rate of 95% and an average of one selected person per household was established. The size of the regional sample was determined by applying the following formula Olaiz-



Fernández, Rivera-Dommarco, Shamah-Levy, Villalpando-Hernández, Hernández-Avila y Sepúlveda-Amor (2006):

$$n = \frac{Z_{\alpha}^2(1-p)DEFF}{r^2p(TR)h} = \frac{1.645^2(1-0.13)1.516}{0.17^2(0.13)(0.95)(1)} = 999.9665$$

Where n is the sample size (number of dwellings), p is the proportion to be estimated, Z_{α} is the quantile of the standard normal distribution associated with the desired confidence level, $(1-\alpha) = 0.90$, r is the maximum relative error of estimation, DEFF is the design effect (it is interpreted as the number of units collected with the instrument designed for this purpose, which are equivalent -for estimation purposes- to a unit collected through simple random sampling), TR is the expected response rate, and h is the average number of people per household. This resulted in the number of questionnaires to be made, which was 1,000, which were applied to men and women over 18 in the state of Colima, Mexico, considering only individuals in urban locations. These instruments were distributed in 6 locations, which are the following: Colima, Villa de Álvarez, Tecomán, Armería, El Colomo and Manzanillo. Table 1 shows the distribution of the surveys conducted in the entity by location:

Table 1. Distribución de la muestra por localidad, AGEBS, manzanas y personas

| No. | Entidad | Localidad | Total de AGEBS | Total de manzanas | Total de personas |
|-----|---------|-------------------|----------------|-------------------|-------------------|
| 1 | Colima | Villa de Álvarez | 10 | 50 | 200 |
| 2 | Colima | Ciudad de Armería | 5 | 25 | 100 |
| 3 | Colima | Colima | 15 | 75 | 300 |
| 4 | Colima | Manzanillo | 10 | 50 | 200 |
| 5 | Colima | El Colomo | 4 | 25 | 100 |
| 6 | Colima | Tecomán | 5 | 25 | 100 |
| | | | | Total: | 1000 |

Fuente: elaboración propia con datos del Censo de Población y Vivienda 2010.



From the survey of the 1,000 questionnaires, it was found that the female participation was 60.46%, while the masculine participation was 39.54%. Regarding the ages of the respondents, there was a greater participation of people between 30 and 40 years old (60.46%), followed by individuals under 30 years of age (25.1%), later those older than or equal to 55 years old. (18.1%) and, finally, the group between 45 and 54 years (16.1%). It is relevant to state that, with the previous information, a descriptive analysis of the perceptions and attitudes by age groups was carried out. Regarding the level of studies, the majority of the respondents expressed having only secondary (36.87%), followed by the primary level or less (22.55%), the baccalaureate level with 27.76% and, finally, only 12.82% of them said they had undergraduate level studies.

Measurement tools

The data collection instrument was constructed based on studies carried out worldwide, trying to characterize those factors that allow measuring the perceptions and attitudes towards the production and consumption of GMOs. In this sense, 11 factors were identified: knowledge, trust, perceived benefits, perceived risks, attitude toward technology, attitude toward genetic technology, religion, labeling, social values, attitude towards purchase and promotion. Additionally, questions were added that allowed capturing sociodemographic information (sector where [ST] works, level of completed studies [NET], age group in years [GE] and Sex) and a section to record georeferencing aspects. In this way, we arrived at the instrument shown in Table 2, which is made up of 11 factors and 60 variables (items) to measure the perceptions and attitudes of the urban population of the state of Colima on the production and consumption of genetically modified organisms (PAOGMs).



Table 2. Factores e ítems para medir las percepciones y actitudes de la población urbana de Colima sobre la producción y consumo de los OGMs

| Factor latente | Indicador | Ítem |
|----------------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conocimiento (CN) | CN1 | ¿Has escuchado hablar del término “genéticamente modificado o transgénico”, en productos para el consumo humano en México? |
| | CN2 | ¿Conoces cuáles son los productos transgénicos para el consumo humano? |
| | CN3 | ¿Conoces qué productos transgénicos para el consumo humano están presentes en nuestro país? |
| | CN4 | ¿Conoces algún producto transgénico para el consumo humano que se importe a México? |
| | CN5 | ¿Has consumido algún producto transgénico? |
| | CN6 | ¿Sabes que algunos cultivos agrícolas pueden hacerse resistentes a ciertas plagas mediante la modificación genética? |
| | CN7 | ¿Sabes si en México existen leyes o reglamentos que regulen la producción y el consumo de productos transgénicos? |
| Confianza (CF) | CF1 | ¿Tienes confianza en el trabajo de los científicos que están modificando genéticamente plantas y animales con el fin de elaborar productos para el consumo humano? |
| | CF2 | ¿Tienes confianza en los científicos de las universidades mexicanas y del mundo, que modifican genéticamente plantas y animales para el consumo humano? |
| | CF3 | ¿Tienes confianza en las empresas que están modificando genéticamente algunas plantas y animales para el consumo humano? |
| | CF4 | ¿Tienes confianza en las compañías farmacéuticas que utilizan plantas y animales transgénicos para fabricar medicamentos? |
| | CF5 | ¿Tienes confianza en los agricultores que utilizan semillas modificadas genéticamente para incrementar la elaboración de productos alimenticios? |
| | CF6 | ¿Tienes confianza en las empresas que fabrican productos con ingredientes transgénicos para el consumo humano? |
| Beneficios percibidos (BP) | BP1 | ¿Consideras que los cultivos transgénicos traerán beneficios al medio ambiente de nuestro país? |
| | BP2 | ¿Consideras que la producción de productos transgénicos traerá beneficios para ti y tu familia? |
| | BP3 | ¿Consideras que los cultivos con semillas transgénicas incrementarán la producción agrícola en México? |
| | BP4 | ¿Consideras benéfico que las empresas fabriquen medicamentos para el consumo humano con plantas y animales genéticamente modificados, en México? |
| | BP5 | ¿Consideras que los productos transgénicos ayudarán a mejorar la nutrición de los mexicanos? |
| | BP6 | ¿Consideras que el consumo de productos transgénicos mejorará la economía de los mexicanos? |
| | BP7 | ¿Consideras que con los productos transgénicos mejorará el valor nutricional de los alimentos de los mexicanos? |
| Riesgos percibidos (RP) | RP1 | ¿Consideras que el consumo de productos transgénicos es un riesgo para la salud de los mexicanos? |
| | RP2 | ¿Consideras que el cultivo de productos transgénicos provocará severos daños al medio ambiente en México? |
| | RP3 | ¿Consideras que los productos transgénicos afectarán considerablemente la calidad de vida de tu familia? |



| Factor latente | Indicador | Ítem |
|--------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|
| | RP4 | ¿Crees que el consumo de productos transgénicos pueda generar efectos negativos en tus descendientes? |
| | RP5 | ¿Crees que la producción y el consumo de productos transgénicos amenazan la naturaleza humana? |
| | RP6 | ¿Crees que los productos transgénicos pueden causar enfermedades en tu familia? |
| Actitud hacia la tecnología (AAT) | AAT1 | ¿Consideras que la ciencia y la tecnología son importantes para el desarrollo social? |
| | AAT2 | ¿Consideras que la ciencia y la tecnología son fundamentales para el desarrollo de la sociedad mexicana? |
| | AAT3 | ¿Consideras que la ciencia y tecnología son vitales en la producción y elaboración de productos saludables para los mexicanos? |
| | AAT4 | ¿Consideras que los nuevos desarrollos tecnológicos afectarán el equilibrio ecológico de nuestro país? |
| | AAT5 | ¿Consideras que la ciencia y la tecnología pueden contribuir en la mejora de la economía de los mexicanos? |
| Actitud hacia la tecnología genética (ATG) | ATG1 | ¿Consideras que es indispensable la producción de productos transgénicos para incrementar la producción de alimentos entre los mexicanos? |
| | ATG2 | ¿Consideras moralmente aceptable la producción de productos transgénicos para el consumo de los mexicanos? |
| | ATG3 | ¿Estás de acuerdo con la producción y el consumo de productos transgénicos para la población mexicana? |
| | ATG4 | ¿Consideras que los productos transgénicos tienen mayor contenido nutricional que los productos convencionales? |
| | ATG5 | ¿Consideras que el consumo de productos transgénicos incrementará la esperanza de vida de la sociedad mexicana? |
| | ATG6 | ¿Estás de acuerdo en promover en tu familia el consumo de productos transgénicos? |
| Religión (REL) | REL1 | ¿La religión que profesas está a favor de la producción de los productos transgénicos para el consumo humano? |
| | REL2 | ¿La religión que profesas prohíbe el consumo de productos transgénicos? |
| | REL3 | ¿Tu religión considera, por razones morales, que no deberías comer productos transgénicos? |
| | REL4 | ¿Tu religión considera moralmente incorrectos la producción de productos transgénicos? |
| | REL5 | Para tu religión, ¿es correcto que los científicos modifiquen plantas y animales, para el consumo humano? |
| Etiquetado (ET) | ET1 | ¿Tienes el hábito de leer las etiquetas de los productos que consume tu familia, en la dieta alimentaria, antes de comprarlos? |
| | ET2 | ¿Consideras que los productos transgénicos deben mostrar, en su etiqueta, la información correspondiente? |
| | ET3 | ¿Consideras que en la publicidad de los productos transgénicos es vital que se informe al consumidor sobre su contenido? |
| | ET4 | ¿Consideras que el gobierno mexicano debe generar leyes para regular el etiquetado de los productos transgénicos? |
| Valores sociales (VS) | VS1 | ¿Estás dispuesto a consumir productos transgénicos junto con tu familia? |
| | VS2 | ¿Estás de acuerdo en que se utilice la tecnología genética, en la producción de productos transgénicos, para el consumo humano? |



| Factor latente | Indicador | Ítem |
|------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | VS3 | ¿Consideras que los productos transgénicos pueden ayudar en la lucha contra el hambre, de los mexicanos? |
| | VS4 | ¿Crees que la tecnología genética resuelva la falta de productos alimenticios para la sociedad mexicana? |
| Actitud hacia la compra (AC) | AC1 | ¿Compraría productos transgénicos si éstos tuvieran menos grasa que los productos convencionales? |
| | AC2 | ¿Compraría productos transgénicos si éstos fueran más baratos que los productos convencionales? |
| | AC3 | ¿Compraría productos transgénicos si éstos fueran cultivados en ambientes más amigables que los productos convencionales? |
| | AC4 | ¿Adquiriría productos transgénicos si el precio fuera igual? |
| | AC5 | ¿Compraría un kilo de tortilla elaborado con maíz transgénico si el precio fuera igual a un kilo elaborado con maíz convencional? |
| | AC6 | ¿Compraría un kilo de frijol transgénico si el kilo de frijol convencional costara lo mismo? |
| Promoción (PR) | PR1 | ¿Estás de acuerdo en que el gobierno mexicano permita la producción y el consumo de productos transgénicos? |
| | PR2 | ¿Estás de acuerdo en que el gobierno mexicano otorgue financiamiento a las empresas para producir productos transgénicos? |
| | PR3 | ¿Estás de acuerdo en que el gobierno mexicano otorgue financiamiento para efectuar investigaciones con el fin de crear más medicamentos usando transgénicos? |
| | PR4 | ¿Estaría de acuerdo en que el gobierno abriera las puertas a la producción de cultivos e importación de los productos transgénicos para el consumo de los mexicanos? |

Fuente: elaboración propia.

For each of the 11 factors listed in Table 2, 11 variables were created that describe the observed average, which was determined with the items of each factor. Such variables are described as: CNpro, CFpro, BPpro, RPpro, AATpro, ATGpro, RELpro, ETpro, VSpro, ACpro and PRpro for the factors knowledge, trust, perceived benefits, perceived risks, attitude toward technology, attitude toward genetic technology, religion, labeling, social values, attitude toward purchase and promotion, respectively. Given that the response of each item of the proposed instrument is binary (1 = Yes, 0 = No), the average of the items that make up each of the latent factors is a continuous variable in the range of 0 to 1. Therefore, In the regression analysis that is implemented, the beta regression was used, which is appropriate when the response variable is continuous in the zero to one interval. In addition, in this regression the explanatory variables used were ST, NET, GE y Sexo.



Results and discussions

The results of the perceptions and attitudes for each of the 11 latent factors are presented below. Its association with age groups is contemplated and a regression process is carried out to identify the significant sociodemographic factors.

Latent factors

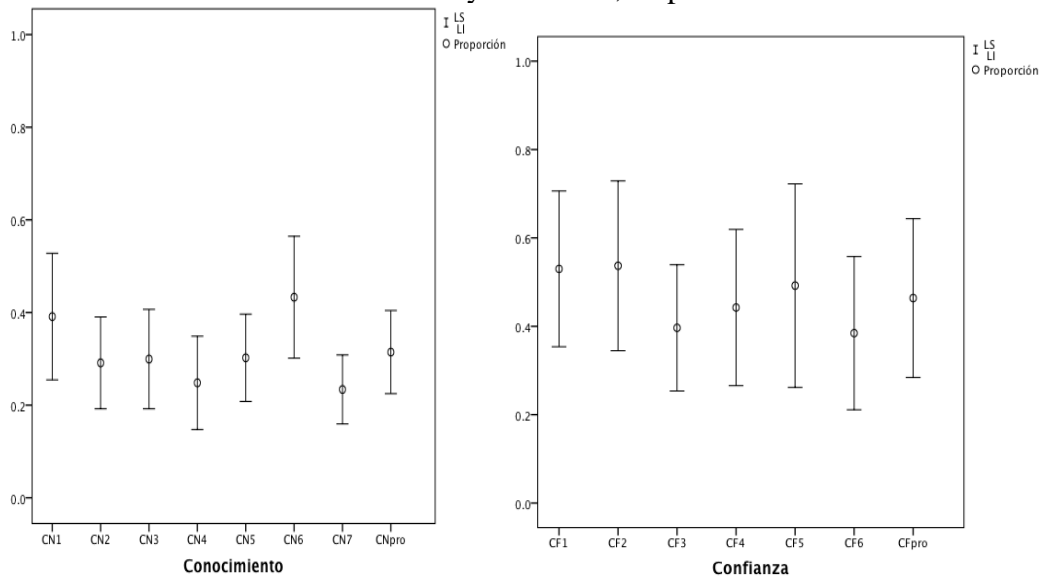
Knowledge and trust

In general, the knowledge indicators do not exceed 50% (Figure 1, first panel), which indicates that the respondents do not know which GMOs are present in the market (CN2, CN3 and CN4; 32%, 32.3% and 27%, respectively) and if there are any regulations in this regard (CN7, 25.6%). These values suggest a relatively low level of knowledge on the subject of GMOs by the surveyed population (CNpro, 33.25%). The above agrees with what was reported by Vanderschuren, Heinzmann, Faso, Stupak, Yalc, Hoerzer and Slimkova (2010) in a study conducted in Europe in which they found a significant lack of knowledge about biotechnological issues.

As shown in the second panel of Figure 1, slightly more than half of respondents have confidence in Mexican and world public universities about their work in the genetic modification of plants and animals for human consumption (CF2, 53.2%), a proportion that barely surpasses the one that measures confidence in the work of scientists in general (CF1, 52%). This leaves farmers at lower levels of confidence (CF5, 49%), pharmaceutical (CF4, 44.8%), companies in general (CF3, 38.8%) and, finally, companies specialized in the use of transgenic ingredients (CF6). , 38.7%). In summary, it can be inferred that more than half of the respondents do not have confidence in the institutions and companies that manufacture or develop GMOs (CFpro, 46%), which is consistent with the results of Barrena-Figueroa and Sánchez (2004).) and Lang and Hallman (2005), which place scientists, health professionals and universities as the most credible sources of information, followed by the media, and finally, leave politicians and industries at the lowest level of credibility.



Figure 1. Proporciones muestrales (con intervalos de confianza al 95%) de los indicadores del factor conocimiento y confianza, respectivamente.



Fuente: elaboración propia con la base de datos de las mil encuestas aplicadas en el estado de Colima, México

Benefits and perceived risks

The majority of respondents believe that the use of GMOs will increase Mexican agricultural production (BP3, 60.4%), although they do not fully consider that its use positively affects the Mexican economy (BP6, 48.9%) and that its pharmaceutical use is beneficial (BP4, 45%). In general, respondents do not consider that the use of GMOs entails any benefit for the country and for families (BP1 and BP2 with 41.1%), for example, increasing in nutritional value (BP5 and BP7, 40.1% and 36.7%) , that is, a low attitude toward the perceived benefits is perceived (BPpro, 45.13%).

The results coincide with what was reported by the European Commission in the Eurobarometer (2010), which shows the level of mistrust regarding the safety of GMOs by the European population, since they do not perceive any benefit. Similarly, a study conducted by the European Commission (2010) found that respondents consider agriculture a key factor for the future and approve the fact that farmers take advantage of biotechnological advances to be more competitive and able to fight against the effects of climate change.

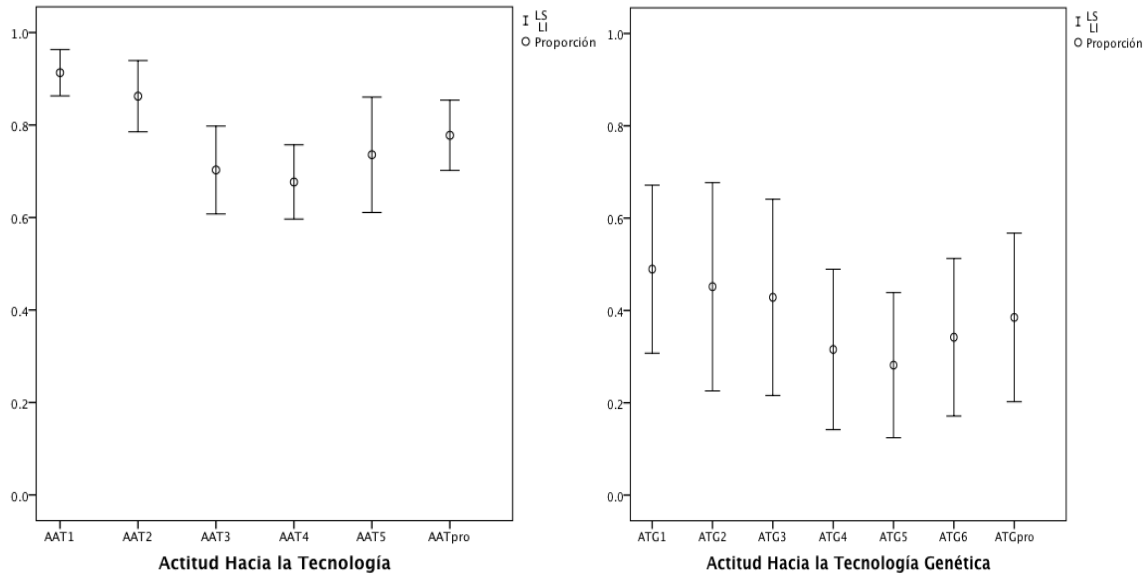


Respondents perceived that GMOs are a high risk to health (RP1, 66%), considering that GMOs could cause diseases to their descendants (RP6 and RP4, 64.6% and 59.2%) and affect the quality of family life (RP3, 59.3%). They also consider that their use will affect the environment (RP2, 59%) and assume it as a threat to humanity (RP5, 55.4%). The concern about the environment is consistent with that reported by Reynolds and Beatty (2000) and Abbott (2003), who claim that consumers are increasingly concerned about the consequences of agricultural globalization, mainly on the environment. On the other hand, Lusk, Jamal, Kurlander, Roucan and Taulman (2005) reported that the perceptions and attitudes of the European community are negative towards GMOs and that such skepticism is attributed mainly to its environmental consequences and health impacts. unknown.

Attitude towards genetic technology and technology

In the first panel of Figure 2, it is observed that a high percentage (91.09%, AAT1) of respondents consider science and technology as an important factor for human development and, in particular, for Mexican society (AAT2, 86.89 %). In addition, they consider that science and technology contribute to improving the Mexican economy and is important for the production and production of healthier products (AAT3 and AAT5, 71.47% and 73.87%). While it is true that, in general, the sample surveyed shows a positive attitude towards technology, it notes its concern about its effect on the national environment (AAT4, 68.87%).

Figure 2. Proporciones muestrales (con intervalos de confianza al 95%) de los indicadores de actitud hacia la tecnología y actitud hacia la tecnología genética, respectivamente.



Fuente: elaboración propia con la base de datos de las mil encuestas aplicadas en el estado de Colima, México

In the second panel of Figure 2, it is observed that less than half of the population under study considered essential the use of GMOs to increase Mexican agricultural production (ATG1, 48.35%), although it morally refutes its consumption and is not at all according to its production and consumption in Mexico (ATG2 and ATG3, 46.45% and 44.14%). It is also noted that respondents do not believe that transgenic products provide better nutrition that increases life expectancy, so, in general, they do not agree to promote their family consumption (ATG4, ATG5 and ATG6, 33.53%, 31.23% and 36.44%).

These results contrast with what was reported by the European Commission (2005), which states that most Europeans are in favor of biotechnology applied to medicine, although their opinion is less favorable if it is applied in agriculture or food. Mucci, Hough and Ziliani (2004) report that there is a difference in consumer acceptance depending on the purpose of genetic modification: nutritional, sensory and increased productivity, among others.



Religion and labeling

The religion of the respondents is not in favor of the genetic modification of plants and animals for human consumption (REL1 and REL5, 29.53% and 31.63%), although this does not totally prohibit its consumption or production, because it does not completely classify it as morally incorrect (REL2, REL3, REL4 and RELpro, 7.11%, 12.41%, 15.22% and 19.04%).

In the first panel of Figure 3, it is observed that most of the individuals read the labels of the products consumed (ET1, 67.7%) and believe that the labels and advertising of the GMOs must show all the necessary information (ET2 and ET3, 91.9% and 92.7%). In addition, they consider it important that the Mexican government legislate on the labeling of GMOs (ET4, 91.6%). These results agree with the reports in the study carried out by Tas, Balci, Yüksel and Sahin-Yesilçubuk (2015) and Demir and Pala (2007), which states that consumers are in favor of mandatory labeling of transgenic products. Similar results were found in the study conducted by Basaran, Kilic, Soyyigit y Según (2004).

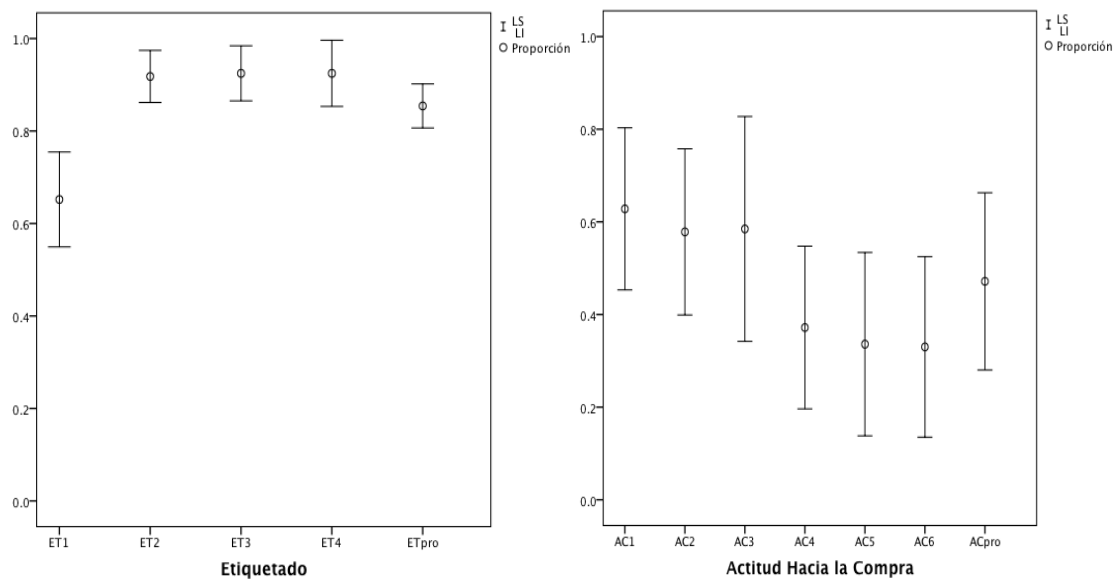
Attitude towards purchase, social value and promotion

In the second panel of Figure 3, it is observed that, of the total of respondents, more than half have a positive attitude towards the consumption of GMOs that have the characteristics of containing less fat, being cultivated in friendlier environments and being cheaper, in that order (AC1, AC2 and AC3; 61.3%, 57% and 59.3%). However, they would choose to buy organic foods, such as corn and beans, if their price equals that of transgenics (AC4, AC5 and AC6, 38.3%, 34.4% and 33.9%). The results are not entirely consistent with what was obtained by Sebastian-Ponce, Sanz-Valero and Wanden-BergheI (2014) who report that the consumer expresses a preference for organic products and claims to be willing to pay a little more for them, although I would buy the best price product. Similarly, Yang, Ames and Berning (2015) found that the Taiwanese would spend a little more to avoid buying transgenics. On the other hand, O'Brien, Stewart-Knox, McKinley, Almeida and Gibney (2012) highlight that the respondents are not totally satisfied with the consumption of GMOs that have been modified in some way in their fat content (35%), that contrasts with our results, in which the interviewees would opt for GMO foods with less fat.



More than half of the surveyed population believes that the use of genetically modified products can help combat the shortage of food products in Mexico and, therefore, help fight hunger (VS3 and VS4, 56% and 50.2%). On the other hand, less than half of them agree with the use of genetic technology to produce food for human consumption (VS2, 47.6%). In general, slightly less than half of these people perceive some social value in the use of GMOs (VSpro, 49.63%), which may be due to low knowledge about biotechnological issues, as Critchley (2008) states, and that, in lack of knowledge about biotechnology, people rely on social trust, which is crucial to understanding attitudes towards GMOs (Marques, Critchley y Walshe, 2014).

Figure 3. Proporciones muestrales (con intervalos de confianza al 95%) de los indicadores de etiquetado y actitud hacia la compra, respectivamente.



Fuente: elaboración propia con la base de datos de las mil encuestas aplicadas en el estado de Colima, México

Finally, about half of the sample studied agrees that the government grants support for the research of new drugs from transgenic products, as well as allowing their production and consumption (PR3 and PR1, 50.1% and 49.7%). However, they do not agree that the doors to the production and import of transgenic products for consumption in Mexico are opened (PR2 and PR4, 46.9% and 43.3%). On average, less than half of respondents agree with the promotion of GMOs by the Mexican government (PRpro, 47.51%). This behavior can be explained by



James (1997), who states that the general concept towards companies that use biotechnology is that they have a utilitarian view of nature, being indifferent to the consequences for human beings.

Association of indicators and latent factors with age groups

This section contemplates the sample proportions obtained by age groups (categories: less than 30 years, between 30 and 44 years, between 45 and 54 years, and 55 years or more) in each of the observed factors.

Knowledge, attitudes towards technology and genetic technology

Although the trends are not entirely clear, observing the averages we realize that the level of knowledge seems to decrease slightly with increasing age, which could denote the recent emergence of GMOs (CNpro averages were located at 37.11% for the categories of less than 30 years, in 32.52% for 30-44 years, in 33.55% for 45-54 years and in 29.40% for 55 years or more).

Such behavior is repeated in the case of attitude toward technology. The group of children under 30 has a slightly higher proportion considering that science and technology are important for human development (AAT1) and its contribution to the Mexican economy (AAT5), decreasing slightly in groups where age is higher. For the under 30 category we have variable AAT1 with 94.02% (AAT5 with 78.49%), 30-44 years old has AAT1 with 91.38% (AAT5 with 73.40%), 45 - 54 years old has AAT1 with 91.30 % (AAT5 with 73.29%). And, finally, for the group of 55 years or more, it has AAT1 with 86.19% (AAT5 with 69.06%). Particularly, for genetic technology it is observed that it is morally more acceptable in the age group under 30 years (ATG2, 49.8%), such acceptability declining until the group of 55 years or more (ATG2, 43.09%). This pattern is repeated in the case of the promotion of GMOs for family consumption (ATG6), since their acceptance is higher in ages under 44 years (39.44% for children under 30 years and 37.68% for 30-44 years), remaining in low acceptance for the groups in which the age is higher (32.3% for 45-54 years and 33.15% for 55 years and more). Finally, the group of 55 and over, with a ratio of 34.81%, perceives that GM foods could increase life expectancy in Mexico.

**Risks and perceived benefits**

In general, regardless of the age group, the population under study agrees that GMOs will help increase agricultural production in Mexico (BP3 above 50%), even though they also consider that they will not improve the nutritional value of the crops. food in Mexico (BP7 less than 40%). In the case of the age group under 44, there is a lower risk of health and less negative effects on their descendants; risk that is slightly higher in the age group over 45 years. This may be due to the level of knowledge about GMOs, which is slightly higher in young groups. It has been reported that a higher level of knowledge about GMOs has a positive effect on their acceptance (Hallman, Hebden, Cuite, Aquino y Lang 2004).

Social values and promotion

Groups under 44 years agree with the use of technologies in the production of transgenic products (VS2> 46%) and their usefulness to reduce hunger in Mexico, in addition to showing a greater willingness to consume GMOs as a family (greater than 44%), situations that occur less commonly in age groups over 45 years (around 40%). Regarding the promotion of transgenics, it was observed that the age groups under 30 have a more positive attitude (PRpro with 50.68%), which decreases as the age of the group increases. Thus, for category 30-44 there is a PRpro of 48.14%, followed by PRpro with 45.35% for the category 45-54 years and, finally, the group of 55 years or more registered a PRpro of 43.33%. This pattern is repeated in factors such as knowledge and attitude toward genetic technology.

Attitude towards purchase and labeling

The age group under 30 years has the highest proportions in terms of their willingness to eat low-fat transgenic foods, which are cheap and have been grown in friendly environments (AC1 with 66.93%, AC2 with 62.55% and AC3 with 65.34%). Regarding the labeling by age group, it was observed that the proportion of individuals who read the labels of the food they consume (ET1) is higher in the age groups between 30 and 54 years (around 70%), following the age group of 55 years or more (66.85%), and, finally, the group of children under 30 years (60.96%). The latter contrasts with the attitude toward the purchase, because although those under 30 are



more willing to consume GMO products with less fat, they generally do not read the labels, basing their choice only on advertising.

Beta regression

A regression process was performed to identify if the explanatory variables ST, NET GE and Sex have any significant relationship with the study variables. Having variable response in the interval (0,1), we proceeded to perform the beta regression with the observed averages of the indicators of each latent factor.

Table 3 summarizes the results on the statistical significance of the explanatory variables put to the test. In general, it was found that the explanatory variable NET was significant in explaining most of the response variables. Subsequently, ST and GE stand out as significant in explaining the response variables Labeling and Social Values, respectively.

Table 3. Estimación de coeficientes beta (Betas) y valores-p asociados de las variables explicativas ST, NET, GE y Sexo, producto de la regresión beta con los factores latentes para medir las percepciones y actitudes de la población urbana del estado Colima sobre la producción y consumo de los OGMs.

| Factor latente | Estimación | Variable explicativa | | | | Observación |
|--------------------------------------|------------|----------------------|-------------|-------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------|
| | | ST | NET | GE | Sexo | |
| Conocimiento | Betas | 0.0242 | -0.5869 | 0.0199 | 0.1318 | Solamente el NET resulta ser significativa (valor-p < 0.05) con relación a la CNpro (conocimiento promedio). |
| | Valor-p | 0.2133 | < 0.0001 | 0.8913 | 0.1259 | |
| Confianza | Betas | 0.0217 | 0.3648 | 0.0924 | -0.0167 | Solamente el NET tiene una relación significativa (valor-p < 0.05) con la CFpro (confianza promedio). |
| | Valor-p | 0.2863 | 0.0131 | 0.5428 | 0.8522 | |
| Beneficios percibidos | Betas | 0.0136 | 0.2352 | 0.0111 | -0.0845 | Ninguna variable explicativa resulta ser significativa (valor-p > 0.05) con relación a BPro (beneficios percibidos promedio). |
| | Valor-p | 0.4914 | < 0.1071 | 0.9402 | 0.333 | |
| Riesgos percibidos | Betas | -0.0058 | -0.2022 | 0.0448 | -0.0947 | Ninguna variable explicativa resulta ser significativa (valor-p > 0.05) con relación a la RPro (riesgos percibidos promedio). |
| | Valor-p | 0.7712 | 0.2290 | 0.7681 | 0.2892 | |
| Actitud hacia la tecnología | Betas | 0.0138 | 0.0093 | 0.0134 | -0.0486 | Ninguna variable explicativa resulta ser significativa (valor-p > 0.05) con relación a AATpro (actitud hacia la tecnología promedio). |
| | Valor-p | 0.4415 | 0.9441 | 0.9233 | 0.5488 | |
| Actitud hacia la tecnología genética | Betas | 0.0056 | 0.4033 | -0.0079 | 0.0792 | Solamente el NET tiene una relación significativa (valor-p < 0.05) con relación a ATGpro (actitud hacia la tecnología genética promedio). |
| | Valor-p | 0.7706 | 0.0016 | 0.958 | 0.3694 | |
| Religión | Betas | 0.0081 | 0.1531 | 0.0094 | 0.0906 | Ninguna variable explicativa resulta ser significativa (valor-p < 0.05) con relación a RELpro (religión promedio). |
| | Valor-p | 0.6396 | 0.2318 | 0.9425 | 0.2452 | |
| Etiquetado | Betas | 0.0368 | -0.1926 | 0.0113 | -0.1361 | Solamente ST es marginalmente significativo (valor-p < 0.05) con relación a ETpro (etiquetado promedio). |
| | Valor-p | 0.0428 | < 0.1164 | 0.9309 | 0.0828 | |
| Valores sociales | Betas | 0.0027 | 0.2045 | 0.1692 | 0.1204 | Ninguna variable explicativa resulta ser significativo (valor-p < 0.05) con relación a VSpro (valor social promedio). |
| | Valor-p | 0.8923 | < 0.1703 | < 0.2659 | 0.1771 | |
| Actitud hacia la compra | Betas | 0.0243 | 0.3575 | 0.0059 | -0.0617 | Solamente el NET tiene una relación significativa (valor-p < 0.05) respecto a ACpro (actitud hacia la compra promedio). |
| | Valor-p | 0.2243 | 0.0163 | 0.9685 | 0.4856 | |



| | | | | | | |
|-----------|---------|--------|--------|--------|--------|---------------------------------------------------------------------------------------------------------------|
| Promoción | Betas | 0.0233 | 0.3401 | 0.1191 | 0.0304 | Solamente el NET tiene una relación significativa (valor-p < 0.05) con relación a PRpro (Promoción promedio). |
| | Valor-p | 0.2535 | 0.0236 | 0.4435 | 0.7369 | |

Nota: En el caso de las variables (NET, GE y Sexo) se reporta el máximo valor-p de los distintos niveles.

Fuente: elaboración propia con la base de datos de las mil encuestas aplicadas en el estado de Colima, México.

Conclusions

The ignorance of the respondents regarding the GMOs can explain the distrust of their benefits and those who produce them, so that a social value for GMOs in general is not clearly perceived. Even with this situation, it is important to note that there is a positive attitude towards technological development, and, although it is not particularly for genetic technology, it is for sectors such as the production of new biotechnological medicines and the promotion of agricultural development. in the country; although some resistance is perceived by the opening to the production and importation of GMOs for national consumption.

Regarding the consumption of transgenics, individuals prefer to be informed and want to legislate on the labeling of foods that contain GMOs (although a high percentage do not read the labels). People look for lower prices and not as much origin, without giving evidence about paying a bit more for organic foods, although they would prefer the consumption of organic foods if they had the same price as GMOs.

With the results of the regression process, it was observed that the level of studies completed (NET) is statistically significant to explain the latent factors such as knowledge, confidence, perceived benefits, attitude toward genetic technology, labeling, social values and attitude toward purchase of GMOs. Also highlight the sector where he works (ST) and the age group (GE), to be significant in explaining labeling and social values, respectively, leaving the gender factor as not significant.

From this study, it is deduced the important need to carry out more studies of national coverage to understand the perceptions and attitudes of the Mexican population about the production and consumption of GMOs, besides the need to educate and provide scientific information is imperative and urgent. correct about GMOs to the Mexican population.



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| Rol de Contribución | Autor (es) |
|---------------------|-----------------------------------------------------------------------------------------------|
| Conceptualización | Dr. Osval Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |



| | |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Metodología | Dr. Osva Antonio Montesinos López Desarrollo , Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |
| Software | Dr. Osva Antonio Montesinos López, Maestro Ignacio Licea Panduro y Maestra Sofía Ramos Pulido |
| Validación | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez, Maestro Ignacio Licea Panduro y Dr. Sergio Felipe López Jiménez |
| Análisis Formal | Dr. Osva Antonio Montesinos López, Maestro Ignacio Licea-Panduro y Maestra Sofía Ramos Pulido |
| Investigación | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |
| Recursos | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |
| Curación de datos | Dr. Osva Antonio Montesinos López, Maestro Ignacio Licea Panduro, Maestra Sofía Ramos Pulido, Maestro Ignacio Luna Espinoza y Dr. Sergio Felipe López Jiménez |
| Escritura - Preparación del borrador original | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez, Maestro Ignacio Licea Panduro y Dr. Sergio Felipe López Jiménez |
| Escritura - Revisión y edición | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |
| Visualización | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |
| Supervisión | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez, Maestro Ignacio Licea Panduro y Dr. Sergio Felipe López Jiménez |
| Administración de Proyectos | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Licea Panduro |
| Adquisición de fondos | Dr. Osva Antonio Montesinos López, Dr. Emeterio Franco Pérez y Maestro Ignacio Luna Espinoza |

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