



## Revista Española de Nutrición Humana y Dietética

Spanish Journal of Human Nutrition and Dietetics

### INVESTIGACIÓN – **versión post-print**

**Esta es la versión aceptada. El artículo puede recibir modificaciones de estilo y de formato.**

## **Characterization of the opinion, knowledge and perception of the training needs of portuguese nutritionists in relation to genetically modified foods** **Caracterización de la opinión, el conocimiento y la percepción de las necesidades de capacitación de los nutricionistas portugueses en relación con los alimentos genéticamente modificados**

**Isabella Vieira<sup>a,b,\*</sup>, Teresa R.S. Brandão<sup>a</sup>, Elisabete Pinto<sup>a,c</sup>, Margarida Silva<sup>a</sup>.**

<sup>a</sup> Escola Superior de Biotecnologia, Centro de Biotecnologia e Química Fina, Universidade Católica Portuguesa. Porto, Portugal.

<sup>b</sup> Instituto Federal de Educação, Ciência e Tecnologia de Mato Grosso, Campus São Vicente. Cuiabá, Brasil.

<sup>c</sup> Unidade de Investigação em Epidemiologia (EPIUnit), Instituto de Saúde Pública, Universidade do Porto. Porto, Portugal.

\* ifvieira@porto.ucp.pt

Recibido: 19/02/2019; Aceptado: 05/12/2019; Publicado: 18/12/2019

**CITA:** Vieira I, Brandão TRS, Pinto E, Silva M. Characterization of the opinion, knowledge and perception of the training needs of portuguese nutritionists in relation to genetically modified foods. Rev Esp Nutr Hum Diet. 2019; 23(4). doi: 10.14306/renhyd.23.4.758 [ahead of print]

La Revista Española de Nutrición Humana y Dietética se esfuerza por mantener a un sistema de publicación continua, de modo que los artículos se publican antes de su formato final (antes de que el número al que pertenecen se haya cerrado y/o publicado). De este modo, intentamos poner los artículos a disposición de los lectores/usuarios lo antes posible.

*The Spanish Journal of Human Nutrition and Dietetics strives to maintain a continuous publication system, so that the articles are published before its final format (before the number to which they belong is closed and/or published). In this way, we try to put the articles available to readers/users as soon as possible.*

## ABSTRACT

**Introduction:** Genetically modified (GM) foods have been approved in the European Union. These foods have been questioned for their actual benefits and risks. This is especially relevant in the case of the nutritional dimension, where consumers are confronted with daily decisions about how to best feed their families. Within this complex framework, health professionals are called upon to intervene and respond to the questions on opinion, attitude and science their clients bring in. The objective of this study was to evaluate the knowledge and opinion of nutritionists on the subject of transgenic foods and their perception of training needs.

**Material and methods:** Quantitative research. A questionnaire was applied between March and July 2016, and 248 individuals participated. The variables studied were opinion, knowledge, and training. Descriptive calculations and multiple correspondence analysis were performed to obtain the respondents' profiles.

**Results:** With regard to opinion and knowledge results show that nutritionists are mostly unfavorable to genetically modified foods, even without knowing the technology in detail. They are aware of this illiteracy, which was confirmed by their answers to a number of objective questions about the national reality. Multiple correspondence analysis showed four different nutritionists' profiles are sufficient to group all participants. These profile types differ in interest and confidence levels relatively to the GM technology. Portuguese nutritionists do not have a unanimous position on GM foods but mostly agree that specific training in this area should take place at the university level.

**Conclusions:** This article highlights the different profiles of opinion, knowledge, and training needs of health professionals, nutritionists, in relation to genetically modified foods. Lifelong learning and interdisciplinary training supported by specific research, associations of health professionals and interference in public policies may strengthen attitudes towards the thematic.

**Keywords:** Food, Genetically Modified; Nutritionists; Knowledge; Education.

## RESUMEN

**Introducción:** Los alimentos modificados genéticamente (AGM) han sido aprobados en la Unión Europea. Estos alimentos, han sido cuestionados en cuanto a sus beneficios y riesgos reales. Esto es especialmente relevante en el caso de la dimensión nutricional, donde los consumidores se enfrentan a decisiones diarias sobre cómo alimentar mejor a sus familias. En este marco complejo, los profesionales de la salud deben intervenir y responder a las preguntas sobre opinión, actitud y ciencia que tienen sus clientes. El objetivo de este estudio fue evaluar el conocimiento y la opinión de los nutricionistas sobre el tema de los alimentos transgénicos y su percepción de las necesidades de capacitación.

**Materiales y métodos:** Investigación cuantitativa. Se aplicó un cuestionario entre marzo y julio de 2016, y participaron 248 personas. Las variables estudiadas fueron opinión, conocimiento y formación. Se realizaron cálculos descriptivos y análisis de correspondencia múltiple para obtener los perfiles de los encuestados.

**Resultados:** Con respecto a la opinión y el conocimiento, los resultados muestran que los nutricionistas son en su mayoría desfavorables a los alimentos modificados genéticamente, incluso sin conocer la tecnología en detalle. Son conscientes de este desconocimiento, que fue confirmado por sus respuestas a una serie de preguntas objetivas sobre la realidad nacional. El análisis de correspondencia múltiple mostró que cuatro diferentes perfiles de los nutricionistas son suficientes para agrupar a todos los participantes. Estos tipos de perfil difieren en niveles de interés y niveles y confianza en relación con la tecnología de AGM. Los nutricionistas portugueses no tienen una posición unánime con respecto a los alimentos transgénicos pero en su mayoría están de acuerdo en que la capacitación específica en esta área debería realizarse a nivel universitario.

**Conclusión:** Este artículo destaca los diferentes perfiles de opinión, conocimiento y formación de profesionales, nutricionistas, en relación con los alimentos modificados genéticamente. El aprendizaje permanente y la formación interdisciplinaria apoyada por investigaciones específicas, asociaciones de profesionales de la salud e interferencia en las políticas públicas pueden fortalecer las actitudes hacia la temática.

**Palabras clave:** Alimentos Modificados Genéticamente; Nutricionistas; Conocimiento; Educación.

## KEY MESSAGES

Recognize the contribution of the issue of transgenic foods (emerging theme), in the academic and professional training of health professionals.

## INTRODUCTION

Genetically Modified foods (GM Foods) are in circulation in the European Union (and therefore also in the Portuguese market): mainly maize, soybeans and their derivatives [1]. The official position of the national government and the European Commission is that the authorized GM food is safe for human consumption [2].

Genetically modified organism is an organism that has had its genome modified in the laboratory without necessarily receiving genetic material (RNA or DNA) from another organism. Transgenic is an organism that has been subjected to the specific technique of inserting genetic material from an organism belonging to a different species. Therefore, it can be said that: every transgenic is a genetically modified organism, but not every genetically modified organism is a transgenic [1-2].

These foods obtained from new genetic technologies have been questioned as to the dimensions of their benefits and risks [3-5]. The controversy also extends to the social dimension [6] since innovations like this also have a direct impact on people's lives, often leading to conflicts with their own visions and values [7]. This is especially relevant in the case of food and nutrition, where consumers are confronted with daily decisions about how best to feed their families. In this context, health professionals are called upon to intervene, sooner or later, and respond in the context of their clinical contact to questions of opinion, attitude and science [8]. Nutritionists, by the nature of their professional skills, are potentially at the center of this educational challenge in relation to GM food.

A number of studies have been published on the positioning of consumers [9], farmers [10], adolescents [11], experts [12], professor [13], scientists [14] and even university students [15] in assessments covering the most diverse countries and cross-country comparisons. However, there are few studies that analyze the opinion and knowledge of health professionals regarding GM food. Their perception of the specific training required for this new food category is also unknown.

In short, it remains unknown whether health professionals - nutritionists in particular - are following the challenge of introducing GM food in human nutrition. Taking this into consideration, it is justified to explore the reality of nutritionists in relation to GM food in Portugal, particularly evaluating the possibility of including this theme in their university education. This case study in

Portugal could be extended to other countries because, as far as we are concerned, this professional group has been poorly studied in relation to this subject.

## **MATERIAL AND METHODS**

To obtain the nutritionists' profile in relation to GM foods, a questionnaire was elaborated with the following structure: (i) a brief introductory note - contextualization of the thematic, objectives, identification of the institution where the investigation takes place, clarification of the concepts (genetically modified organism, transgenic food and genetically modified food), a declaration of confidentiality and anonymity; (ii) seven questions of socio-demographic characteristics of the respondents (Table 1); (iii) twelve issues of opinion focusing on nutritional features, impacts on environment and on consumer's health (Figure 1); (iv) six knowledge issues related to cultivation, sale, and labeling of transgenic foods in Portugal (Figure 2); and (v) seventeen questions related to self-perception of training needs on GM foods. These last questions are related to usefulness of training during university education, type of training (Figure 3), topics to be covered (genetics, nutrition, health, labeling, legislation, ethics and environment), needs for deeper information on GM foods, and real applications (questions asked by patients on the topic).

**Table 1.** Characterization of study participants (n = 248).

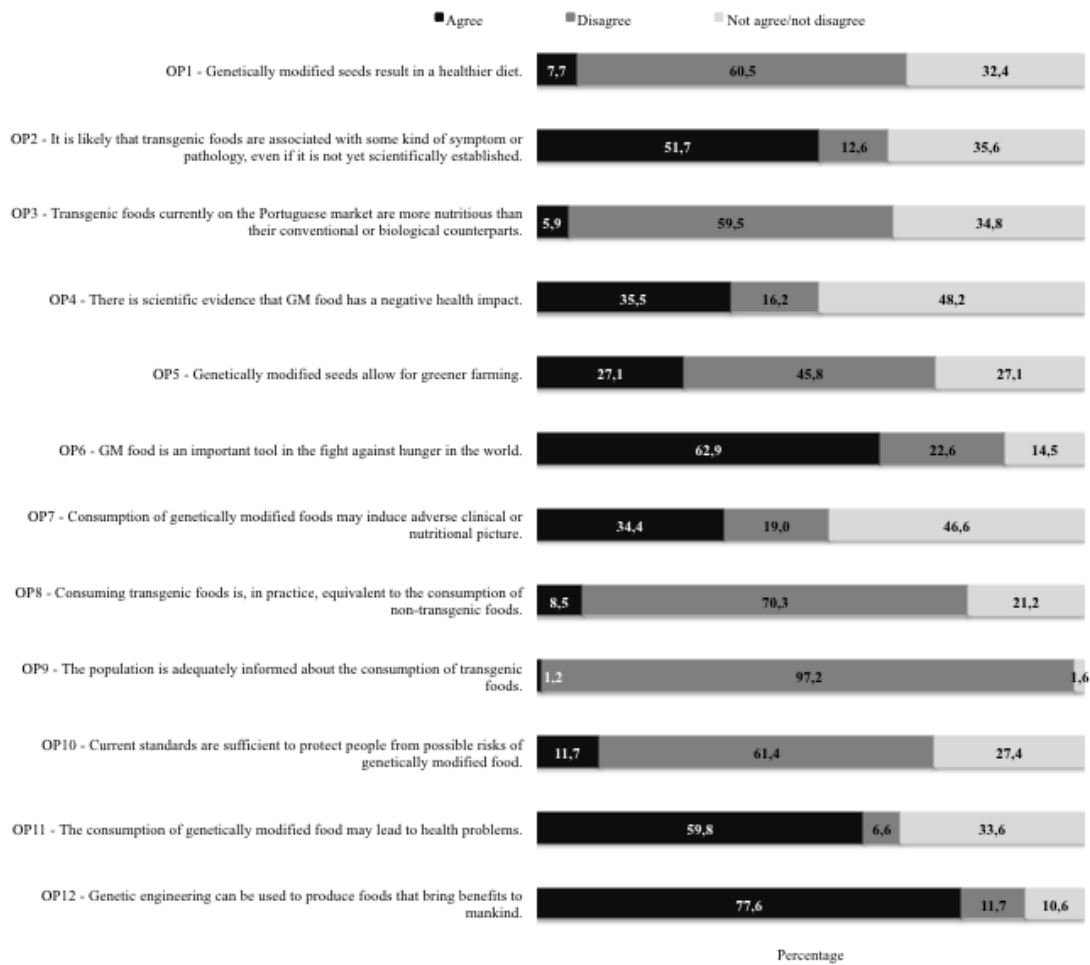
<b>Variables</b>	<b>n*</b>	<b>%</b>
<b>Gender</b>		
Male	38	15,4
Female	209	84,6
<b>Age (years)</b>		
22-25`	83	35,3
26-30	66	28,1
31-35	34	14,5
above of 35	52	22,1
<b>Level of training</b>		
Graduation	129	52,2
Masters	42	17
Ph.D.	17	6,8
Post-graduate	59	23,8
<b>Region of residence (NUTS II**)</b>		
North	156	64,2
Center	39	16
Lisbon	44	18,1
Alentejo	1	0,4
Algarve	1	0,4
Madeira	2	0,8
<b>Frequency of contact with patients</b>		
Diary	133	53,8
Weekly	37	15
Monthly	21	8,5
Irregularly	20	8,1
Never or almost never	36	14,6
<b>Institution of university graduation (graduation)</b>		
School of Biotechnology of the Portuguese Catholic University	40	16,5
Faculty of Nutrition and Food Sciences of the University of Porto	125	51,4
Higher Institute of Health Sciences Egas Moniz	21	8,6
University Institute of Health Sciences-North (CESPU)	18	7,4
Others	39	16
<b>Conclusion year</b>		
< 2004	52	21,4
2005 - 2010	55	22,6
2011 - 2016	136	56

\* n do not always total sample size due to incomplete surveys.

\*\* NUTS II - Nomenclature of Territorial Units for statistical purposes, level 2.

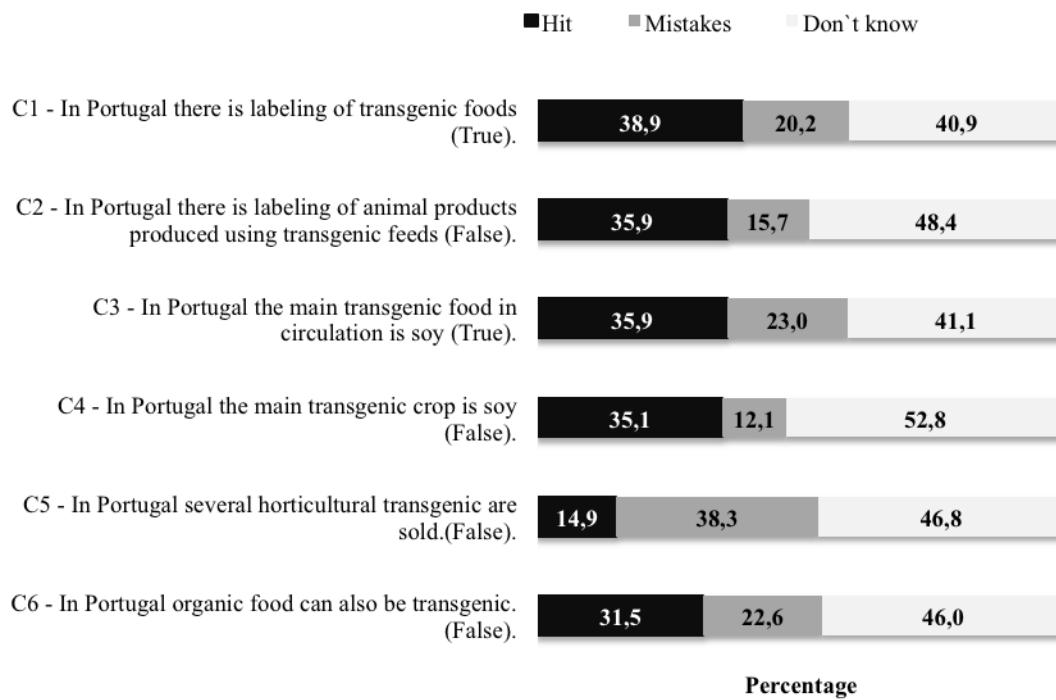


**Figure 1.** Distribution of the responses related to the opinion on GM food.



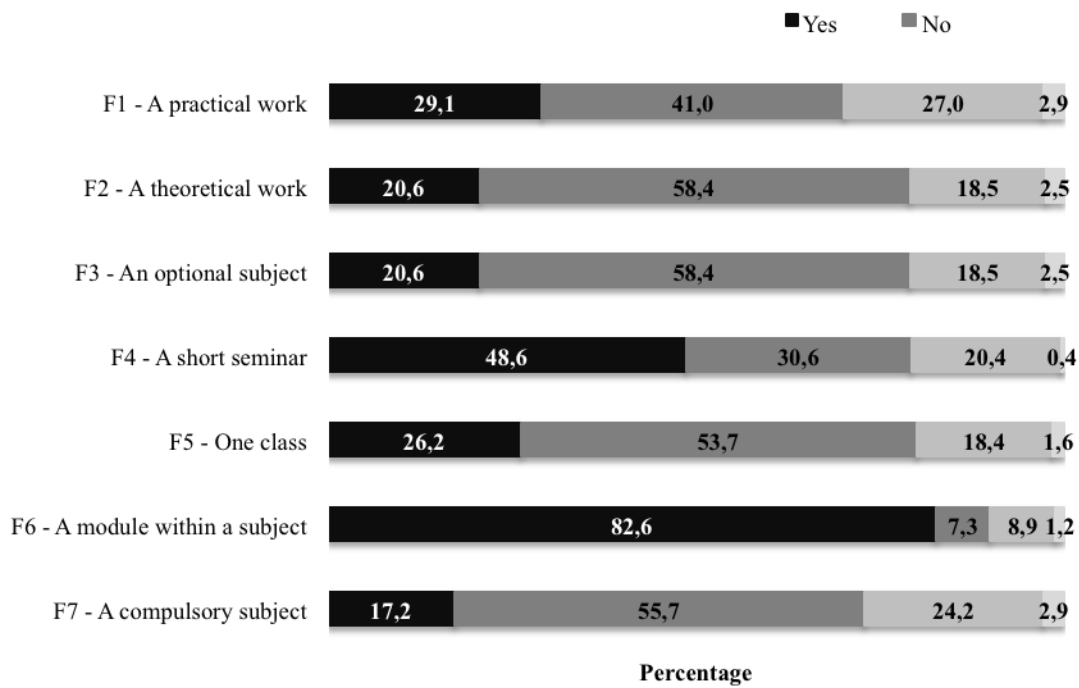
OP# refers to a question about opinion.

**Figure 2.** Distribution of answers related to GM food knowledge.



C# refers to a question about knowledge.

**Figure 3.** Distribution of responses related to the type of training on GM foods.



F# refers to a question about training.

These 35 questions were closed in qualitative scales, Likert type, with 5 levels that later were grouped into 3 levels (disagree, neither disagree nor agree, agree) and multiple choice with a single possibility of response.

The questionnaire was developed by the authors, based on Hill & Hill (2008) guidelines [17]. It had been previously validated by 24 individuals (13 physicians and 11 nutritionists) in terms of clarity, structure, presentation, relevance, efficacy, and interactivity. Additionally, the questionnaire was evaluated by two specialists with experience in the elaboration of these instruments, also having relevant scientific production related to transgenic foods and nutrition.

The questionnaire was implemented in the online platform of LimeSurvey (version 1.91+) and released from March to July 2016 through the Portuguese Association of Nutritionists, in scientific meetings and in social and professional networks. The dissemination potentially covered a population of 2,347 nutritionists, the number of nutritionists enrolled in the Association at the time of this work. The study was approved by the Scientific Council of the Biotechnology School, *Universidade Católica Portuguesa* and evaluated ethics committee. The professionals who participated in the survey had informed consent. Survey respondent data was exported from LimeSurvey to Microsoft® Excel® (Microsoft Corporation, version 14.5.7) and subsequently analyzed in the IBM SPSS Statistics 23 for Windows® program (SPSS Inc., Chicago, USA).

In addition to the descriptive calculations, a multiple correspondence analysis (MCA) was also performed aiming at obtaining associations of the nominal and ordinal qualitative variables so that they could be represented in a few dimensions through the most discriminative variables. The number of dimensions was based on inertia, discrimination measures and higher internal consistencies [16]. The internal consistency was evaluated based on the Cronbach's Alpha value [17], which was 0.83 and 0.77 for dimensions 1 and 2, respectively.

## RESULTS

### Characterization of participants

The study included 248 nutritionists, 209 (84.6%) being women. The participants' age ranged between 22 and 59 years of age, with 64.2% of those living in the northern region of the country. It was found that a considerable proportion of the professionals had other training beyond the degree: 23.8% had a postgraduate degree, 17% had a master's degree and 6.8% a Ph.D. degree. Regarding the place where they completed their academic training, 51.4% referred to *Faculdade de Ciências da Nutrição e Alimentação* of University of Porto, with *Universidade Católica Portuguesa* emerging as the second most cited institution (16.5%) and *Instituto Superior de Ciências Médicas Egas Moniz* in third place (8.6%). Regarding the years of completion of the course, 56.0% concluded between 2011 and 2016. When asked how often they contacted patients, 53.8% of the professionals reported doing it daily (Table 1).

### Identification of nutritionists' opinions regarding GM Food

Results of nutritionists' opinions regarding GM foods are in Figure 1. Most participants (77.6%) agree that genetic engineering can be used in the production of foods that bring benefits to mankind (Question OP12). However, 59.8% agree that consumption of GM food may lead to health problems (Question OP11). In addition, 70.3% answer that consuming GM food is not equivalent to consuming non-transgenic foods (Question OP8).

When asked whether the consumption of GM food can induce an adverse clinical or nutritional picture (Question OP7) and if there is scientific evidence that GM food has negative health impacts (Question OP4), most participants did not have a clear position: the majority reported not agreeing or disagreeing (46.6% and 48.2% for OP7 and OP4, respectively).

When asked whether GM food is likely to be associated with some kind of symptom or pathology, even if it is not yet scientifically established (Question OP2), 51.7% agree, opposing 35.6% who "neither agree nor disagree". Relatively to the sentence which states that current standards are sufficient to protect people from possible risks of GM food (Question OP10), it is found that a large proportion (61.4%) of respondents disagree with it.

Almost unanimity appeared in Question OP9, where 97.2% of participants understood that the population was not adequately informed about GM food consumption. Concerning the usefulness

of GM food in the fight against hunger in the world (Question OP6), 62.9% of the respondents agree with it although they also think (45,8%) that genetically modified seeds do not allow a greener agriculture (Question OP5).

Finally, the vast majority (59.5% and 60.5% respectively) disagree that GM food currently in the Portuguese market is more nutritious than their conventional or biological counterparts (Question OP3) and that GM seeds result in healthier food (Question OP1).

### **Identification of the nutritionists' knowledge in relation to GM food**

Figure 2 presents the results regarding the knowledge revealed by nutritionists about GM food. On average, only 32.0% of the respondents hit the six issues and 22.0% failed the answers. A considerable number of nutritionists assumed their illiteracy about the reality of GM foods in Portugal, averaging 46% of the respondents. Among the participants, 38.9% got a correct answer to the question of whether transgenic foods were being labeled in Portugal (Question C1, which is true). The highest mistake was related to Question C5; 38.3% failed the answer to the question of whether in Portugal several horticultural transgenic are sold, which is actually false.

### **Self-perception of training needs of nutritionists, in relation to GM food**

Almost all of the respondents (95.6%) consider it useful to have some type of training on genetically modified foods during university education. When questioned about what type of training they considered more appropriate to receive, the vast majority (82.6%) preferred a module within a subject during the degree, which is clearly more than one class but leaves open the exact number of hours devoted to the theme (Figure 3).

Regarding the type of topics they would like to see covered in this training, all aspects suggested in the survey, genetics, nutrition, health, labeling, legislation, were considered very important (chosen by more than 80% of the participants) except for topics related to ethics and environment (chosen by 76.1 and 69.2% of nutritionists, respectively).

The need for more information is also evident in the 70.2% who stated that they had already researched some kind of information about GM food. In addition, 89.1% also affirmed to be useful throughout the professional life the existence of continuous training to update on GM food. The knowledge to be acquired will have real application: in the previous year, 21% of clients had asked nutritionists questions about GM food.

## Identification of nutritionists' profiles

The multiple correspondence analysis (MCA) allowed the identification of two dimensions with high internal consistency. Dimension 1 included 17 questions and dimension 2 included 10 questions, which allowed each dimension to be characterized. The dimensions resulted as follows:

(i) The first dimension integrates in the 1A profile people with the opinion that consuming GM food is not equivalent to consuming non-transgenic foods and that these are no longer more nutritious nor healthier than their conventional or biological counterparts. They consider that genetic engineering does not allow greener agriculture, that it is not an important tool in the fight against hunger in the world and it does not bring benefits to humanity. They also believe that the consumption of GM food may imply health problems and induce an adverse clinical or nutritional picture. They also admit that these foods are associated with some type of symptom or pathology with negative health impacts and that this is scientifically proven. They consider that the population is not adequately informed about the consumption of GM food and that the standards are not sufficient to protect people from possible risks. These nutritionists consider it important to receive health and nutrition training on GM food in the form of a module within a subject during the degree. In terms of knowledge, they agreed that in Portugal there is no labeling of products coming from animals fed with transgenic feeds.

By contrast, there is profile 1B, with nutritionists who consider that genetic engineering allows for a more ecological agriculture, being an important tool in the fight against hunger in the world and bringing benefits to humanity. These individuals consider that the current standards are sufficient to protect people from possible risks. They also reveal indifference about training during the degree and do not consider it important to include topics in GM food-related to health and nutrition in training. This indifference is transversal to the other aspects of opinion, training, and knowledge mentioned for the first profile (1A).

(ii) The second dimension includes, in profile 2A, the individuals who consider that the population is not properly informed about the consumption of GM food but agree that these foods allow a more ecological agriculture. These nutritionists are interested in training which addresses the topics of health, nutrition, genetics, environment, labeling, legislation, and ethics.

Profile 2B includes a group of nutritionists who neither agree nor disagree on the level of information of the population and who disagree that these foods allow a greener agriculture. Their interest in GM food is minimal, not seeing any advantage in specialized training.

Although most nutritionists are suspicious of GM food, the method of multiple correspondence analysis has allowed the identification of other relevant profiles that represent subsets of the professionals studied. The two primary characteristics in the differentiation of the large nutritionists' profiles found are confidence / non-confidence versus usefulness / non-usefulness of GM food training. Table 2 presents these four sets and classifies them according to the respective variables meeting. Those who trust in they may have more interest (and in this case the specific formation is) or a more distant relationship (and there does not recognize usefulness to the study of the subject). The same is true of those who regard GM food with suspicion.



**Table 2.** Synthesis of the profiles obtained in the MCA based on the differentiating variables and matching with the nomenclature of Roberts et al. (2006) and Wilkins et al. (2008).

	<b>WANTS TRAINING</b>	<b>DOES NOT WANT TRAINING</b>
<b>TRUSTS GM FOOD</b>	Profile 2A FAVORABLE AND INTERESTED	Profile 1B FAVORABLE AND UNINTERESTED
	<i>(Discerning supporter) *</i>	<i>Promoting</i>
<b>DOES NOT TRUST GM FOOD</b>	Profile 1A SUSPICIOUS AND INTERESTED	Profile 2B SUSPICIOUS AND UNINTERESTED
	<i>Precautionary</i>	<i>Precautionary</i>

\* Wilkins et al. (2008) used the expression "Cautiously supportive" instead of "Discerning supporter"

## DISCUSSION

As far as the authors are concerned, this study is the first to evaluate the opinion, knowledge, and training of nutritionists in relation to GM food, particularly in the professional environment, in Portugal. The tested hypotheses that (i) nutritionists do not have sufficient knowledge about GM food, (ii) that there is no unanimity of opinions, and (iii) that there is a need for university education were largely supported by results.

Regarding opinion and knowledge, the figures obtained show that nutritionists are mostly unfavorable to transgenic foods, even without knowing the technology in detail. Lack of knowledge is felt by themselves and it became evident in the answers to objective questions about national reality. These results paralleled those of Vogliano [18], who identified a lack of knowledge and varied perceptions in American dietitians. In this study, most respondents also revealed a cautious attitude towards genetically modified organisms. Schmidt *et al.* [19] have reached similar conclusions about the knowledge and attitude of American health professionals, including dieticians, showing that in this survey knowledge about applications of food biotechnology and genetic engineering is equally inadequate.

Nutritionists agree that consumers are not properly informed about the consumption of transgenic foods. This is also due to the fact that 21% have already been questioned by their clients on this subject, which points at the same time to the search for information from credible sources by attentive consumers. It should be noted that in the most recent Eurobarometer [20] Portugal is the second most uninformed country in the European Union, with 44% of respondents seeking information about it at least once. The literature shows that, in fact, consumers trust and seek health professionals for health and food responses [19, 21, 22], which effectively attributes to nutritionists the responsibility of interface between GM food and society. However, they do not feel and are not prepared to respond and to mediate the construction of this knowledge.

The curricular inclusion of GM food requires not only a scientific-technological approach but also a social and environmental one, as this is a complex theme. Some contributions to the pedagogical approach can be found in the literature, but there is scarce scientific material that includes pluridimensionality, with the dominant tendency being the refuge in the essentially technical description [23, 24]. Perhaps as a result of this limitation, both consumers in general and health professionals, in particular, are ultimately dependent on the media, social networks and other informal channels whose rigor is far from being guaranteed [25, 26]. The GM food

theme is not the only one requiring such treatment, but it is one of the most recent. The space chosen by the respondents - a module within a subject - can create a model of an open methodology, of reflection and production of knowledge about GM food, which serves interested nutritionists well beyond the validity period of the knowledge itself.

The result of nutritionists' profiles classification took the aggregations already published relative to dietitians [27] and teachers [28] even farther. These two studies have identified three main groups: (i) the Discerning Supporter, (ii) the Promoting and Prompt, and (iii) the Precautionary. Table 2 matches this nomenclature with Portuguese nutritionists' profile classified in our study. The level of correspondence found is interesting, especially considering that the mentioned works did not use the MCA method. The set of cautious people is, in the present work, unfolded in two distinct profiles depending on the proximity and interest in the subject (and respective training).

The variances of perspective characterized in each sample can be attributed to differences in professional experiences/assignments as well as personal perceptions of a more ethical nature. Overall, these results demonstrate the need for a GM food approach that is inclusive, multidisciplinary and sensitive to changers that transcend mere biomaterial reading.

#### Limitations

The present study employed a convenience sample, so caution is needed in any generalization. Still, the data presented represent the best portrait available in the literature and leave no doubt as to the value of relevant university education.

## CONCLUSIONS

This exploratory and indicative study aimed to contribute to the understanding of the actual training needs of nutritionists in relation to transgenic foods. The identified lack of knowledge is a mirror of what is happening in society in general but, if reversed, can trigger a chain reaction that benefits all citizens thanks to the key role of nutritionists. It is concluded and recommended the insertion in the curriculum of the subject of GM food, in an inclusive and multidimensional logic that takes into account both what is known and what is still to be discovered. This can be supported by associations of health professionals, lifelong learning and interdisciplinary training supported by specific research, and interference in public policies.

## **AUTHORSHIP**

Study design: Isabella Vieira, Elisabete Pinto and Margarida Silva; data acquisition: Isabella Vieira and Margarida Silva; analysis and interpretation: Isabella Vieira, Teresa Brandão, Elisabete Pinto and Margarida Silva.

## **ACKNOWLEDGMENTS**

Participants of this research.

## **FUNDING**

This work was supported by National Funds from FCT - Fundação para a Ciência e a Tecnologia through project UID/Multi/50016/2019.

## **CONFLICT OF INTEREST**

Authors state that there are no conflicts of interest in preparing the manuscript.

## REFERENCES

- (1) ISAAA, Global status of commercialized biotech/GM Crops in 2017: Biotech crop adoption surges as economic benefits accumulate in 22 Years. Ithaca, NY. 2017;53.
- (2) Europa.eu. EU Register of Authorised GMOs. 2017.
- (3) Zhang C, Wohlhueter R, Zhang H. Genetically modified foods: A critical review of their promise and problems. Food Science and Human Wellness. 2016; 5:116-123.
- (4) Santis BS, Stock N, Wal JM, Weesendorp E, Lalles, JP, Dijk JV, Kok E, Giacomo M, Einspanier R, Onori R, Brera C, Bikker P, Meulen JVD, Kleter G. Case studies in genetically modified organism (GMOs): Potential risk scenarios and associated health indicators. Food and Chemical Toxicology. 2018; 36-65.
- (5) Sanchez MA and Parrott WA. Characterization of scientific studies usually cited as evidence of adverse effects of GM food/feed. Plant Biotechnology Journal. 2017; 15(10): 1227-1234.
- (6) Lucht JM. Public acceptance of plant biotechnology and GM Crops. Viruses. 2015; 7:4254-4281.
- (7) Popek S, Halagarda M. Genetically modified foods – consumer awareness, opinions and attitudes in selected EU countries. Irregularly Journal of Consumer Studies. 2017; 41(3): 325-332.
- (8) Edge MS, Kunkel E, Schmidt J. Evidence analysis library systematic review on advanced technology in food production. Journal of the Academy of Nutrition and Dietetics. 2015;118(6):1106-1127.
- (9) Boccia F, Sarnacchiaro, P. Genetically modified foods and consumer perspective. Recent Patents on Food, Nutrition & Agriculture. 2015; 7(1): 28-34.
- (10) Almeida C, Massarani, L. Farmers prevailing perception profiles regarding GM crops: A classification proposal. Public Understanding of Science. 2018; 1-15.
- (11) Lachowski S, Jurkiwicz A, Choina, P, Florek-Luszcki M, Buczaj A, Gozdziwska M. Readiness of adolescents to use genetically modified organisms according to their knowledge and emotional attitude towards GMOs. Annals of Agricultural and Environmental Medicine, 2017; 24(2): 194-200.
- (12) Aleksejeva, I. EU Experts` attitude towards use GMO in food and feed and other industries. Procedia – Social and Behavioral Sciences. 2014; 110:494-501.
- (13) Gardner GE, Jones MG. Science instructors' perceptions of the risks of biotechnology: Implications for science education. Research in Science Education. 2011; 41: 711-738.

- (14) Aleksejeva I. EU experts' attitude towards use of GMO in food and feed and other industries. *Procedia - Social and Behavioral Sciences*. 2014; 110: 494-501.
- (15) Velickovic V, Jovic M, Nalic E, Visnjic A, Radulovic O, Cedomir S, Ciric M. Knowledge, attitudes toward, and acceptability of genetic modification among Western Balkan University students of life sciences (AGREE Study). *Journal of the American college of Nutrition*. 2016; 35(2): 1-14.
- (16) Carvalho H. Análise multivariada de dados qualitativos - utilização da ACM com o SPSS. Vol. 2. 2017, Lisboa: Edições Sílabo.
- (17) Hill MM, Hill A, *Investigação por questionário*, ed. Sílabo. 2008: Lisboa.
- (18) Vogliano CT, Knowledge base and perception registers dietitians hold on the genetic modification of foods, in *School of Health Sciences*. 2012, Kent State University College. p. 70.
- (19) Schmidt JL, Vickery CE, Cotugna NA, Snider OS. Health professionals hold positive attitudes toward biotechnology and genetically engineered foods. *Journal of Environmental Health*. 2005; 67(10): 44-49.
- (20) Commission, E., *Europeans and Biotechnology in 2010*, ed. E. Commission. Vol. EUR 24537. 2010, Brussels.
- (21) Brown JL, Consumer perception of risk associated with eating genetically engineered soybeans is less in the presence of a perceived consumer benefit. *American Dietetic Association*. 2003; 103(2): 208-214.
- (22) Heffernan JW, Hillers VN. Attitudes of consumers living in Washington regarding food biotechnology. *Journal of the American Dietetic Association*. 2002; 102(1): 85-87.
- (23) Hilimire K, Gillon S, McLaughlin B, Dowd-Urbe B, Monsen KL. Food for thought: Developing curricula for sustainable food systems education programs. *Agroecology and Sustainable Food Systems*. 2014; 38(6): 722-743.
- (24) Rayner G, Barling D, Lang T. Sustainable food systems in Europe: Policies, realities and futures. *Journal of Hunger & Environmental*. 2008; 3(2-3): 145-168.
- (25) Quesada JCB, Lembo T. Percepção dos estudantes da área da saúde sobre biotecnologia e alimentos transgênicos. *Journal of the Health Sciences Institute*. 2014; 32(3): 229-234.
- (26) Wunderlich S, Gatto KA. Consumer perception of genetically modified organisms and source of information. *Advances in Nutrition*. 2015; 6:842-851.
- (27) Roberts KS, Struble MB, McCullum-Gomes C, Wilkins L. Use of a risk communication model to evaluate dietetics professionals viewpoints on genetically engineered foods and crops. *American Dietetic Association*. 2006; 106: 719-727.

- (28) Wilkins JL, Kraak V, Pelletier D, McCullum C, Uusitalo U. Moving from debate to dialogue about genetically engineered foods and crops: Insights from a land grant University. *Journal of Sustainable Agriculture*, 2008. 18: p. 167 - 201.