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by Gomez-Luciano, C.A., Vriesekoop, F. and Urbano, B.

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TOWARDS FOOD SECURITY OF ALTERNATIVE DIETARY PROTEINS: A COMPARISON BETWEEN SPAIN AND THE DOMINICAN REPUBLIC

Cristino A. Gómez-Luciano[1], Frank Vriesekoop[2] and Beatriz Urbano[3*]
[1)] *Instituto Especializado de Estudios Superiores Loyola, San Cristobal, Dominican Republic*
[2)] *Department of Food Science, Harper Adams University College, Newport, United Kingdom*
[3)] *Department of Agricultural and Forestry Engineering, University of Valladolid, Palencia, Spain*

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Abstract
Current environmental and health concerns encourage a shift towards more sustainable diets. A variety of options are currently being investigated to achieve the food security of alternative-to-meat dietary proteins. The food security of alternative to meat proteins will require attention to the availability, the access, the supply stability and the food safety and quality. The aim of this research is to get insight on consumers' food attitudes in order to achieve food security of four alternatives to meat proteins, namely, plant-based proteins, mycoproteins, cultured meat proteins and insect proteins in different development contexts in Spain and the Dominican Republic. In doing so, the research analyses meat consumption, reduces consumers' attitudes using a principal component analysis, predicts first adopters of alternative dietary proteins using a Chi-square test and ranks preferred alternative dietary proteins using a multicriteria decision-making method. The results show that plant-based proteins are the best positioned alternative, while insects are the worst positioned in the Dominican Republic. Gender and education in the Dominican Republic and gender, education and age in Spain are significant factors for the adoption of alternative to meat proteins. Health and convenience attitudes may determine the adoption of alternative dietary proteins in Spain and the Dominican Republic. This research contributes to identifying the consumers' attitudes to encourage the dietary shift to alternative to meat proteins. It can help industry to market alternative-to-meat proteins in different development contexts to achieve food security.

Keywords: consumers' attitudes; alternative-to-meat proteins; preferences; multicriteria decision making (MCDM); principal component analysis (PCA); Spain; Dominican Republic.

JEL Classification: O13, Q18.

* Corresponding author, **Beatriz Urbano** – beaturb@iaf.uva.es

Introduction

The food security is the condition in which all people have access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2006). Food security considers, among other factors the availability, the access to food, the supply stability and the food safety and quality. In this line, the global environmental pressure generated by livestock production and the link with meat consumption, particularly red and processed meat, and detrimental health outcomes suggests that it is beneficial to substitute meat in the diet (De Boer, Schösler and Aiking, 2014; Sabaté and Soret, 2014; Schösler, de Boer and Boersema, 2012; Tilman and Clark, 2014). The substitution of meat in the diet, either with meat raised in a more sustainable manner (De Boer, Schösler and Aiking, 2014) or with alternative dietary sources of proteins (Tilman and Clark, 2014), requires mechanisms to ensure the availability, access and preference of alternative-to-meat dietary proteins.

The United Nation Food and Agriculture Organization (FAO, 2019) reports meat consumption is highest across high-income countries. Nevertheless, changes in consumption in high-income countries have been much slower - with most stagnating or even decreasing over the last 50 years (FAO, 2019). In this sense, Spain reached a meat consumption of 113.25 kg in 2000, from 21.78 kg in 1961, and it has decreased to 94.04 kg in 2014. Moreover, the report marks that growth in per capita meat consumption has been most marked in countries which have undergone an economic transition. In this sense, the Dominican Republic has tripled per capita meat consumption from 15.34 kg in 1961 to 47.2 kg in 2014. For this reason it is of interest to compare both different development countries in the transition to low meat diets. To the best of the authors' knowledge, no previous comparisons have been made to achieve the food security of alternative to meat proteins according to population-specific preferences comparing different development contexts. Although consumer perception and reaction remain largely unknown (Verbeke, Sans and Van Loo, 2015), taking them into consideration can help the food industry, policymakers and managers to ensure the food security of alternative to meat proteins in different development contexts.

This paper aims to get insight on consumers' food attitudes and preferences in order to achieve food security of four alternatives to meat proteins, namely, plant-based proteins, mycoproteins, cultured meat proteins and insect proteins in different development contexts of Spain and the Dominican Republic.

The paper is structured as follows. First, the theoretical background is discussed, followed by a research methodology and results discussion. Marketing implications, limitations of the research and suggestions for future research are presented at the end of paper.

1. Review of the scientific literature

Current environmental and health concerns encourage a shift towards more sustainable diets (De Boer, Schösler and Aiking, 2014; Schösler, de Boer and Boersema, 2012; Tilman and Clark, 2014). This scenario encourages a shift towards diets that reduce the overall consumption of intensively reared meat proteins and partially substitute it with another protein source (De Boer, Schösler and Aiking, 2014; Sabaté and Soret, 2014). In this context a variety of options are currently being investigated to achieve the food security of

alternative to meat dietary proteins. This is caused by the future requirements for high quantity and quality healthy proteins to mitigate the environmental pressure (Gerber et al., 2013). Plant-based substitutes have been available as an alternative for some time now. Plant-based diet which contains the bulk of calories from plant resources, is sustainable (De Boer and Aiking, 2011) and healthy (Sabaté, 2003) and prevents animal suffering (Foer, 2010). On the other hand, cultured meat grown from skeletal muscle satellite stem cells using tissue-engineering techniques has also been developed as a potential alternative resource (Post, 2014). This research also considers insects as a potential substitute for animal-derived proteins (Vogel, 2010). Insects have historically been used as a part of the daily diet for large numbers of ethnic groups (Ramos-Elorduy, 1997; Zhi-Yi, 1997) due to their high nutritive value and protein-rich nature (30% in wood worms to 81% in *Polybia* wasps). They are now gaining popularity in modern societies (Verbeke, 2014) and being eaten by high-status urban dwellers in different countries where they are seen as a gourmet dish or delicacy. The implementation of alternative dietary proteins is a global challenge for the diet, environment and health (De Boer, Schösler and Aiking, 2014; Tilman and Clark, 2014). By 2050 the current dietary trends, if unchecked, would be a major contributor to an estimated 80 per cent increase in global agricultural greenhouse gas emissions from food production and to global land clearing (Gerber et al., 2013; Tilman and Clark, 2014). Moreover, the current diet is greatly increasing the incidence of type II diabetes, coronary heart disease and other chronic non-communicable diseases. Alternative dietary proteins, if widely adopted, can reduce global agricultural greenhouse gas emissions, reduce land clearing and resultant species extinctions, and help prevent such diet-related chronic non-communicable diseases (Kearney, 2010; Tilman and Clark, 2014).

Most authors have researched the meat substitution in developed countries (De Boer, Schösler and Aiking, 2014; Graça, Oliveira and Cardoso, 2015; Sabaté and Soret, 2014; Schösler, de Boer and Boersema, 2012); however, little research has been performed in developing countries (Tilman and Clark, 2014) where rising incomes and urbanisation are driving a global dietary transition in which traditional diets are being replaced by diets high in refined sugars, refined fats, oils and meat. Furthermore, Sabaté and Soret (2014) reported that meat consumption in developing countries has increased by 300% since 1963, while the worldwide consumption increased by 62% in the same period. Little research has focused on food security of alternative dietary proteins in developing countries. While some Europeans envisage meat substitutes as a solution to reduce food insecurity in developing countries, no research has compared the consumers' perceptions of alternative to meat proteins in developed-developing countries (Verbeke, Sans and Van Loo, 2015). In addition, Goodwin and Shoulder (2013) analysed the media coverage of cultured meat and found an asymmetry of sources in America and Europe. More research should be developed in order to identify the alternative to meat protein preferences in developed and developing countries. This paper develops a comparison in two of those target countries, Spain and the Dominican Republic. Moreover, alternatives to meat are scarcely considered by consumers and the food industry in developing countries. Tilman and Clark (2014) demonstrated that as annual incomes increase there were concomitant increases in per capita daily demand for total protein, meat protein demand and 'empty calories' consumption, defined as calories from refined fats, refined sugars, alcohols and oils. This consumption trends are associated with urbanization, industrial food production (Tilman and Clark, 2014), trade liberalization, transnational food corporations, retailing growth, food industry marketing and consumer attitudes and behaviours (Aiking, 2014).

The food security of alternative-to-meat dietary proteins requires a quantitative and qualitative analysis including the availability, the access to food, the supply stability and the food safety and quality. In this sense, Wansink (2002) noted that the adoption of alternative-to-meat dietary proteins will depend on availability, good taste, familiarity, appearance and expected feel. Acceptability concerning the product attributes ranges from its intrinsic sensory quality, healthiness, safety and sustainability to its price and availability (Verbeke, Sans and Van Loo, 2015). In this sense, one negative aspect that could endanger the acceptance of alternative to meat proteins may be the price when compared with the value perceived in tasty and nutritious meat (Goodwin and Shoulders, 2013; Verbeke, Sans and Van Loo, 2015). Understanding consumers' food attitudes and preferences towards alternative-to-meat dietary proteins is crucial to achieve food security (Cox and Evans, 2008). Consumer insight is indispensable to encourage alternative to meat proteins (Verbeke, Sans and Van Loo, 2015). Therefore, the society should develop more research to identify the preferences to encourage the dietary shift to alternative to meat proteins (Köster, 2009).

2. Research methodology

A sample of 401 residents, 201 from the Dominican Republic (DR) and 200 from Spain (SP), was utilised to perform the study. The socio-demographic characteristics of the participants are presented in table no. 1.

Table no. 1: Socio-demographic profile in Spanish and Dominican sample expressed in percentage of each sub-sample

Variable	Cases	SP (N=200)	DR (N=201)
Gender	Male	50.50	67.00
	Female	47.00	31.50
	Prefer no answer	2.50	1.50
Year of birth	1934-1968	20.00	3.19
	1969-1980	19.00	6.91
	1981-1991	25.00	27.13
	1992-2001	36.00	62.77
Studies	Primary/Secondary	10.50	36.50
	University	89.50	63.50
Location	Rural	35.00	77.23
	Urban	65.00	22.28
Food allergies	Yes	12.00	17.17
	No	88.00	82.83

The average age in the Spanish sample was 35.5 years (range: 16-83; 50.5% male; 47% female and 2.5% preferred not to answer). In this cohort, 10.5% had completed primary or secondary school and 89.5% were undergraduates or had completed tertiary studies. The average age in the DR cohort was 25 years (range: 16-70; 67.0% male; 31.5% females and

1.5% preferred not answered). A total of 15.0% had completed primary school, 21.5% secondary school, 63.5% had a graduate degree, master or PhD.

The participants responded to a combination of a digital survey and a face-to-face survey. The process started in February 2017 and finished in October 2017. The questions were presented in the form of option questions or statements in which the respondents expressed their opinion using a five-point Likert scale (strongly disagree = 1 to strongly agree = 5). The first item block in the questionnaire contained three statements related to the healthiness of food, four statements related to convenience orientation towards food and five statements related to the consumer's environmental orientation towards food. The next block contained ten option questions asking about the consumer's beliefs regarding the health and nutritional benefits of meat, their views on the sensory experience of meat and their meat consumption. In addition, they were also asked about their intention to maintain, increase or decrease their meat consumption by the same time next year. The questionnaire also included the descriptions of the four alternative dietary proteins that formed the basis of this study, namely, plant-based proteins, mycoproteins, cultured-meat proteins and insect proteins. For each alternative, six questions were asked regarding the consumer's perception of their healthiness, safety, nutritious content, sustainability, taste and price with respect to meat. After this, consumers were also asked about their willingness to consider and try the alternative dietary proteins. Finally, four options about the realistic nature of each alternative in the short term (2030) and long term (2050) were given. The questionnaire also registered the socio-demographic characteristics of the respondents including their gender, age, education and origin.

In the first stage of the data analysis, we analysed the consumption and their intention to maintain, increase or decrease their meat consumption by the same time next year within their beliefs regarding the health and nutritional benefits of meat and their views on the sensory experience of meat. A principal component analysis (PCA) reduced the dimensions of the healthiness, convenience and environmental attitudes towards foods to predict the possible acceptance of alternative-to-meat dietary proteins. Four new principal components were obtained in the DR and SP. The factorial coefficients determined the correlations between variables and principal components. The matrix had four columns of principal components and twelve rows of standardised variables calculated by the formulae:

$$X_{ij} = a_{il} \text{ x } Z_{\text{lj}} + \ldots + a_{ik} \text{ x } Z_{\text{ik}} = \Sigma^{k}_{s=1}\, a_{is} \text{ x } Z_{sk} \quad (1)$$

where a is the coefficient and Z is the standardised healthiness, convenience and environmental attitudes towards food for each respondent.

In the second stage of the analysis, the two-way dependence between the willingness to try, the realistic nature of the alternative dietary protein both in the short-term (2030) and long-term (2050) and the explanatory socio-demographic characteristics of the respondents was calculated using a Pearson's Chi-square ($\chi^2_{.95}$) test. To accept or reject the null hypothesis (H_0, which implies no relationship between the variables), the value of the χ^2 statistic and the respective P values were considered, and dependence was determined in light of the frequencies expected and obtained and the corresponding corrected typified residues (c.t.r.). For variables with $P < 0.05$, the null hypothesis was rejected.

In the third stage of the data analysis, the alternative dietary proteins were outranked according to the healthiness, nutrition, environmental concerns and the price criteria using the Electre I method (Hatami-Marbini and Tavana, 2011). The Electre method was chosen

to characterise the alternative dietary proteins due to Electre's relevance when facing decision situations. The weight vector was calculated as the average in the DR and SP measured as the contribution to the total decision (table no. 2).

Table no. 2: Main criteria that influence Spanish and Dominican Republican consumers' with regards to food choices

Criteria/statement	%SP	%DR	Mean	Weight
HEALTHY I am very particular about the healthiness of the food I eat	78.1	84.0	81.1	30.3
NUTRITIOUS The nutritional benefits of meat can easily be matched by alternative protein sources	52.7	43.5	48.1	18.0
ENVIRONMENT When I buy foods I try to consider how my use of them will affect the environment	42.3	48.5	45.4	17.0
PRICE Would you personally not be willing to pay more for alternative dietary proteins than for meat?	91.9	93.5	92.7	35.0

The weight vector result was: W = ($W_{HEALTHY}$ = 0.3, $W_{NUTRITIOUS}$ = 0.18, $W_{ENVIRONMENT}$ = 0.17 and W_{PRICE} = 0.35).

From the decisional matrix, the concordance matrix was calculated considering that an alternative protein 'a outranked b', denoted by aSb, only when the following two conditions were true. Table no. 3 shows the decisional matrix.

Table no. 3: Decisional matrix normalised and standardised from participants means scores for the alternatives and the four criteria in Spain and Dominican Republic

Alternatives	Healthy	Nutritious	Sustainability	Price
Plant-based SP	0.58	0.48	0.43	1.56
Plant-based DR	0.59	0.50	0.50	1.68
Mycoproteins SP	0.51	0.43	0.43	1.44
Mycoproteins DR	0.50	0.42	0.41	1.45
Cultured-meat SP	0.38	0.36	0.39	1.25
Cultured-meat DR	0.47	0.36	0.37	1.37
Insect-based SP	0.45	0.40	0.42	1.49
Insect-based DR	0.29	0.32	0.33	1.33

On the one hand, the strength of the concordant coalition (the sum of the weights associated with the criteria forming that coalition) was powerful enough to support the above assertion. It can be defined by the following concordance index (assuming, for the sake of formulae simplicity, that $\sum_{j\in J} w$j = 1, where J is the set of the indices of the criteria):

$$c\ (aSb) = \sum_{\{j:gj(a)\geq gj(b)\}} wj \qquad (2)$$

where $\{j:g_j(a) \geq g_j(b)\}$ is the set of indices for all the criteria belonging to the concordant coalition with the outranking relation aSb.

3. Results and discussion

3.1. Meat consumption and substitution

A total of 30% of Spanish and 29.18% of Dominican subjects considered that they consumed a lot of meat. One-quarter of Spanish participants revealed their intent to decrease (25.0%) their meat consumption during the next year, while in the DR, one-third expected to reduce their meat consumption. Conversely, in the DR, 12.63% expected to increase their meat consumption within this timeframe (table no. 4). In the DR, rising incomes and urbanisation (Sabaté and Soret, 2014) are the reasons behind the substitution of high carbohydrate and starch diets with meat protein-based diets (Popking and Ng, 2007). Individuals in developing countries have increased their meat consumption due to economic growth (e.g. a 7.1% increase was reported in the DR in 2014-16) (One, 2010); however, this subsequently poses a greater challenge for sustainable diets. In SP, meat consumption decreased by 2.8 kg/person in the past 5 years (Mapama, 2018).

A total of 69.65% and 66% of Dominican and Spanish respondents, respectively, considered meat to be an important part of a healthy diet (Graça, Oliveira and Cardoso, 2015). Moreover, they also declared themselves to be meat lovers, with 88% of Spanish and 86.5% of Dominican respondents liking the taste of meat, 87% and 83.52% liking the texture of meat and 87% and 84.5% liking the smell of meat. Therefore the alternatives must mimic the taste, texture and smell of real meat (Graça, Oliveira and Cardoso, 2015; Hoek et al., 2013).

A total of 27.86% of DR respondents and 15.5% of Spanish participants thought that eating meat was necessary to obtain beneficial nutrients. More than half of respondents in the DR (52.74%) and a large number in SP (43.5%) believed that the nutritional benefits of meat could easily be matched by alternative protein sources, thus suggesting a possible meat substitution rate lower than the 72% reported by Verbeke, Sans and Van Loo (2015).

In this substitution, 86% of Spanish respondents and 88.42% of Dominican respondents would consider plant-based proteins as a source of dietary proteins, which is higher than the 80% reported by Verbeke, Sans and Van Loo (2015). In addition, 69.5% and 62.25% of respondents from the DR and SP, respectively, would consider mycoproteins as dietary proteins, and 37% and 43.37% would consider cultured meat. Most of the DR respondents (82.72%) considered all insects to be disgusting, and only 4.19% did not mind insects. Of the Spanish respondents, 25% did not mind insects and 37.5% disliked some insects.

Regulations that consider insects as food in EU (European Commission, 2018) may explain this result. In contrast, a 'yuck' attitude was found in the DR (Ramos-Elorduy, 1997).

Table no. 4: Meat consumption, perceptions of meat and future consumption in Spanish and Dominican sample expressed in percentage of each sub-sample

Variable	Cases	SP (N=200)	DR (N=201)
Meat consumption	High	30.00	29.18
	Moderate	64.00	68.22
	No meat	6.00	2.60
Future meat consumption	Increase	3.00	12.63
	Decrease	25.00	33.33
	Maintain	72.00	54.04
Meat is necessary for obtaining beneficial nutrients	Strongly +agree	15.50	27.86
Meat is an important part of a healthy and balanced diet	Strongly +agree	66.00	69.65
The nutritional benefits of meat can easily be matched by alternative protein sources	Strongly +agree	43.50	52.74
The taste of meat is important to me	Strongly +agree	88.00	86.10
The texture of meat is important to me	Strongly +agree	87.00	83.50
The smell of meat is important to me	Strongly +agree	87.00	84.50

3.2. Healthiness, environmental and convenience attitudes towards food

With regards to participants attention to the environmental impact of their food choices, 70.5% of Spanish participants (worried = 48%; strongly worried = 22.5%) and 66.17% of Dominican participants (worried = 40.8%; strongly worried = 25.37%) reported that they were worried about man's ability to provide the nutritional needs of all people living on Earth. The main difference between country samples and intra-group was regarding the statement that global warming is a fad that is dreamt up by a bunch of hippies. A total of 80.5% of Spanish respondents (disagree = 65%; strongly disagree = 15.5%) and 72.64% of Dominican participants (disagree = 22.39%; strongly disagree = 50.25%) disagreed with this statement.

The convenience orientation in relation to food showed that even though participants were living busy lives, 68.16% of Dominican (agree = 33.83%; strongly agree = 34.33%) and 64.5% of Spanish (agree = 39.5%; strongly agree = 25.0%) respondents loved to cook and bake whenever possible (table no. 5). Although this result confirms the preference for traditional slow-cooked food in both countries (Mapama, 2018; ProChile, 2013), this trend was found to be combined with fast food to adapt to current participants lifestyles. In this sense, 48.5% of Spanish participants declared that they preferred food that required less preparation, while 55.72% of Dominican participants preferred food that was easy to prepare at home.

Table no. 5: Attitudes towards food. Percentage of participants agreed or strongly agreed, Mean±Standard Deviation

Statement	SP		DR	
	%	M±SD	%	M±SD
Attitudes towards the health character of food				
The healthiness has little impact on food choices	83.0	4.16±0.96	26.87	2.48±1.33
I am very particular the healthiness of food I eat	84.0	4.18±0.91	78.11	4.09±0.96
I eat what I like and I do not worry much healthiness	63.0	3.74±0.98	32.16	2.83±1.26
Convenience orientation in relation to food				
The less I have to do to prepare a meal - the better!	48.5	3.29±1.07	38.31	3.09±1.23
I love cooking and will spend a lot of time and effort to prepare foods on a daily basis	51.0	3.38±1.13	62.69	3.68±1.20
At home. I preferably eat meals that can be prepared quickly	34.0	3.08±1.04	55.72	3.57±1.10
Even though I live a busy life. whenever possible I love to cook and bake	64.5	3.67±1.15	68.16	3.73±1.28
Food choice environmental impact				
When I buy foods I try to consider how my use of them will affect the environment	48.5	3.26±1.16	42.29	3.15±1.14
I am worried about humankind's ability to provide the nutritional needs for all people living on earth now	70.5	3.8±0.95	66.17	3.75±1.04
Something drastic has to change in order to feed all the people on earth by 2050	71.5	3.98±0.93	79.11	4.13±0.92
The world can easily sustain the food demands of a growing population in one or two generations time	22.5	2.75±1.00	30.35	3.00±1.07
Global warming is a fad, dreamt up by a bunch of hippies	12.5	1.74±1.29	17.91	2.05±1.36

The PCA reduced the environmental, convenience and healthiness attitudes towards food in four components in SP and the DR. In SP and the DR, no difference was found between the countries and intergroup for the environmental statements; however, the health and convenience consumption attitudes did vary between the countries. A similar attitude beyond environmental issues was identified, thus confirming the results of Verbeke, Sans and Van Loo (2015) who reported that participants were unwilling to compromise on environmental of food. Many participants express environmental concerns regarding meat; however, their behaviour is often not in accordance with their concerns (De Boer, Hoogland and Boersema, 2007; Graça, Oliveira and Cardoso, 2015). This is called the 'meat paradox', where people enjoy eating meat but disapprove of harming animals (Loughnan, Bastian and Haslam, 2014).

The consideration of healthiness was similar amongst Spanish participants, while the Dominican respondents were clearly divided. In contrast, Dominican respondents presented similar attitudes towards convenience while Spanish participants presented a differentiated behaviour (table no. 6). The difference between SP and the DR was the attitude towards the convenience of reduced-preparation foods. These results confirm participants differentiated attitudes in the demand of trends of modernity of convenience and health foods.

Table no. 6: Rotated component matrix of the PCA

	Components DR				Components SP			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
The healthiness has little impact on food choices	0.73	-0.12	0.32	0.02	0.03	0.83	-0.05	-0.03
I am very particular the healthiness of food I eat	-0.76	0.31	0.10	0.11	0.15	0.78	-0.08	0.25
I eat what I like and I do not worry much healthiness	0.82	-0.01	-0.03	0.02	0.08	0.71	0.01	0.15
The less I have to do to prepare a meal - the better!	0.15	-0.44	0.60	0.05	0.78	0.23	-0.10	-0.05
I love cooking and will spend a lot of time and effort to prepare foods on a daily basis	-0.06	0.88	0.02	0.06	0.82	0.01	-0.05	0.25
At home. I preferably eat meals that can be prepared quickly	0.21	-0.15	0.52	0.26	0.76	0.13	0.08	-0.13
Even though I live a busy life. whenever possible I love to cook and bake	-0.16	0.80	-0.01	0.07	0.81	-0.03	0.03	0.28
When I buy foods I try to consider how my use of them will affect the environment	-0.17	0.12	0.31	0.47	0.16	0.13	0.08	0.78
I am worried about humankind's ability to provide the nutritional needs for all people living on earth now	0.08	0.08	0.03	0.79	0.02	0.24	-0.25	0.74
Something drastic has to change in order to feed all the people on earth by 2050	-0.03	-0.06	-0.16	0.72	0.01	0.01	-0.75	0.29
The world can easily sustain the food demands of a growing population in one or two generations time	-0.14	0.12	0.68	-0.09	-0.03	0.02	0.78	-0.07
Global warming is a fad, dreamt up by a bunch of hippies	0.13	0.41	0.52	-0.21	0.01	-0.15	0.57	0.28

3.3. First adopters of alternative to meat proteins

Dominican men were significant more likely to try alternative dietary proteins, such as mycoproteins and cultured meat proteins ($P = 0.009$; corrected typified residue c.t.r. = 2.9). Conversely, DR men were found to dislike food preparation ($P = 0.000$; c.t.r. = −2.9), while women from the DR loved cooking ($P = 0.002$; c.t.r. = 2.2) and spent a lot of time and effort preparing foods on a daily basis even when they were busy ($P = 0.000$; c.t.r. = 3.2). A strong cultural link was found with the gender role in the DR, with women preparing the food while the men were open to trying alternative proteins. This may be linked to education levels. The percentage of educated women is higher than the percentage of

educated men in the DR (One, 2010; Roos, Prättälä and Koski, 2001). In this context, tertiary-educated respondents significantly were willing to pay more for mycoproteins (P = 0.008; c.t.r. = 2.4) and cultured meat (P = 0.011; c.t.r. = 2.5) proteins, while secondary-educated respondents were likely not to pay more for mycoproteins (P = 0.008; c.t.r. = −2.4) or cultured meat (P = 0.011; c.t.r.=−2.5) proteins. Therefore education may play a significant role in the substitution of meat proteins. Highly-educated respondents were also likely to be concerned with the health attributes of their purchases (P = 0.002; c.t.r. = 2.2).

In the case of SP, gender played an important role (Graça, Oliveira and Cardoso, 2015). Spanish women were significantly more willing to try plant-based diets (P = 0.032; c.t.r. = 2.0) than Spanish men, who are significantly unwilling to try plant-based proteins (P = 0.032; c.t.r. = −2.7). Spanish women considered plant-based diets to be realistic in the short term (P = 0.016; c.t.r. = 2.9) and were willing to try mycoproteins (P = 0.035; c.t.r. = 2.4), while the mycoproteins alternative was more preferable among Dominican men than women. Similar to Dominican men, Spanish men were also likely to consider cultured meat (P = 0.016; c.t.r. = 2.8). Those with a Spanish university education were also more willing to try (P = 0.001; c.t.r. = 2.6) plant-based protein alternatives. The level of education in SP (MAPAMA, 2018) meant that different attitudes to alternative proteins may be observed. For example, respondents aged 16-27 years old were more likely to consider a plant-based alternative protein diet as a realistic long-term achievement (P = 0.003; c.t.r. = 2.3) and not consider mycoproteins (P = 0.016; c.t.r. = 3.2) as a realistic protein alternative (P = 0.000; c.t.r. = 4.0). Moreover, they were also more likely to be unwilling to try cultured meat (P = 0.027; c.t.r. = −2.7). In conclusion, gender and education were significant factors in the adoption of alternative dietary proteins in the DR and gender, education and age in SP (table no. 7).

Table no. 7: Contingency between alternative dietary proteins and variables in percentage of respondents. Chi-square test ($\chi^2_{.95}$) with age, studies and gender

Alternatives		Willing to try	Realistic of the alternative			
			Realistic	Short-term (2030)	Long-term (2050)	No realistic
Plant-based	**SP**	75.5**	35.5	29.5**	17.0	18.0
	DR	59.8	41.6	37.4	12.6	8.4
Mycoprotein	**SP**	69.5*	19.0**	26.5	24.5	30.0
	DR	47.5*	31.3	29.7	20.0	18.9
Cultured	**SP**	25.0*	6.0	23.0	38.0	33.0
	DR	35.7**	24.7	19.9	33.9	21.5
Insects	**SP**	34.5	20.0	24.0	26.5	29.5
	DR	18.0	12.8	15.0	25.5	46.7

Note: *P<0.05; **P<0.01; ***P=0.000

3.4. Ranking alternative dietary proteins in SP and the DR

Table no. 8 scores alternative dietary proteins in SP and the DR.

Table no. 8: Scores for four meat-alternative proteins in SP and DR. Means±Standard Deviation

	Plant-based		Mycoproteins	
	SP	**DR**	**SP**	**DR**
Healthy	4.36±0.69	4.41±0.75	3.80±0.81	3.72±0.87
Safe to eat	4.15±0.80	4.18±0.84	3.50±0.90	3.52±0.92
Nutritious	4.21±0.77	4.31±0.73	3.74±0.83	3.69±0.83
More sustainable	3.30±1.00	3.78±1.07	3.30±0.95	3.10±1.02
More tastier	2.52±1.06	2.96±1.13	2.63±0.95	2.75±1.09
Cheaper	3.31±1.14	3.55±1.11	3.05±0.95	3.07±1.00
	Cultured meat		**Insects**	
	SP	**DR**	**SP**	**DR**
Healthy	2.81±0.96	3.19±0.98	3.34±0.97	2.73±1.14
Safe to eat	2.81±0.95	2.88±0.97	3.09±0.99	2.47±1.07
Nutritious	3.16±0.94	3.17±0.96	3.49±0.98	2.75±1.15
More sustainable	2.99±1.08	2.83±0.99	3.23±1.05	2.49±1.19
More tastier	2.36±0.84	2.70±1.01	2.30±0.93	2.12±1.06
Cheaper	2.65±1.00	2.89±1.07	3.16±1.02	2.81±1.16

The concordance – discordance matrix (table no. 9) revealed that plant-based was the preferred alternative to meat protein in the DR, while the plant-based and mycoproteins were preferable in SP. It could be interesting to promote mycoproteins in the DR and insect-based proteins in SP. In a final step, it would be interesting to develop cultured meat in the DR then in SP. Foods based on insects would need to be promoted to gain popular interest (Zhi-Yi, 1997).

Table no. 9: Concordance-discordance matrix multi-criteria analysis

	Plant SP	**Plant DR**	**Myco SP**	**Myco DR**	**Cultur SP**	**Cultur DR**	**Insect SP**	**Insect DR**	**N**
PlantSP		0	1	1	1	1	1	1	6
PlantDR	1		1	1	1	1	1	1	7
MycoSP	0	0		1	1	1	1	1	5
MycoDR	0	0	0		1	1	0	1	3
CulturedSP	0	0	0	0		0	0	1	1
CulturedDR	0	0	0	0	1		0	1	2
InsectsSP	0	0	0	0	1	1		1	3
InsectsDR	0	0	0	0	0	0	0		0

Conclusions

The transition to alternative-to-meat dietary proteins varies from alternative-to-alternative and country-to-country. Despite this, some trends of interest could be concluded. The preferred alternatives were the plant-based proteins in both countries. This was followed by mycoproteins, cultured meat and insects in Spain, while an intense 'yuck' response to eating insects was found in the Dominican Republic.

Gender and education in the Dominican Republic and gender, education and age in Spain were significant factors for the acceptance of alternative to meat proteins. Dominican men were significant more likely to try alternative dietary proteins, such as mycoproteins and cultured meat proteins, while educated Dominican significantly were willing to pay more for mycoproteins and cultured meat. Spanish women considered plant-based diets and were willing to try mycoproteins. Spanish university educated were also more willing to try plant-based protein alternatives, while Spanish aged 16-27 years old were more likely to consider a plant-based alternative protein diet.

With regards to environmental, convenience and healthiness attitudes towards food, a differentiated attitude of the health benefits within a general slow cook convenience was found in the Dominican Republic, while in Spain, a differentiated attitude towards convenience of preparation within a common message of healthiness may achieve the food security of alternative to meat proteins.

In order to achieve low meat diets in different development contexts, it should be taken in account that some subjects in developing countries could increase their meat consumption as their income increase. Alternative dietary proteins first adopters' may vary from developing-developed countries according to gender and age. While in developing countries, traditional slow cook convenience may achieve some alternative to meat proteins, in developed countries convenience of preparation could be crucial for the adoption of alternative to meat diets.

The research limitations come about through the selective bias and the ambiguity of the inferred hypotheses which limited the scope of generalization of the findings of this study. Furthermore, the reported consumers' attitudes could vary according to the product and situations and must not be assumed to an actual or future adoption of alternative to meat dietary proteins.

This research contributes to identifying the consumers' attitudes to encourage the dietary shift to alternative to meat proteins in developed-developing contexts. It can help industry to market alternative-to-meat proteins in different development contexts to achieve food security.

There is scope for further research regarding the generalization of the findings with respect to the majority of countries. The development of other new food preparations and processes for alternative-to-meat dietary proteins is another future line of research that could increase acceptance of alternative proteins. Although further research needs to be conducted before some alternative dietary proteins are ready for large-scale distribution and consumption this research gets insight how to achieve the food security of alternative-to-meat dietary proteins.

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