Consumers' Valuation for Lab Produced Meat:

An Investigation of Naming Effects

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Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association Annual Meeting, Washington, D.C., August 5-August 7.

ABSTRACT

"*In-vitro*" meat (IVM) technology could be seen as a solution that could overcome some of the concerns linked to conventional meat production, such as the expected demand increase, pressure on crop outputs, large greenhouse emission, high land, energy and water usage as well as consumers' concerns related to animal welfare. One of the main drawback of IVM is that consumers' might be reluctant to consume meat from this technology due to the perceived revulsion, lack of naturalness, taste, uncertainty about environmental benefits, and safety concerns. In this research, we aim to investigate consumers' perception and willingness to pay (WTP) for IVM chicken by testing whether the use of different names for the IVM technology (i.e. "cultured", "lab-grown" and "artificial") will lead to different consumers' preferences and WTP values. We conducted an online choice experiment (CE) in the United States with 625 participants to elicit consumers' WTP for IVM fresh skinless boneless chicken breast products. To test naming effects, we used a between-subjects approach by randomly assigning respondents to three treatments. The treatments differed only on the name used to describe IVM technology (i.e. "cultured", "lab-grown" and "artificial"). Results from Random Parameters Logit (RPL) models in WTP space shows that on average consumers prefer fresh skinless boneless chicken breast products produced with conventional meat technology with information about antibiotics free. Consumers tend to highly reject the IVM technology, with strong differences across the names. The term "cultured" is less disliked than the terms "artificial" and "lab-grown". Finally, implications and suggestions for policy makers and food operators are discussed along with future research avenues.

Key words: Consumers' willingness to pay (WTP); In-vitro meat; United States; Chicken products; Naming effects.

1. INTRODUCTION

Over time, cultural and nutritional necessities have constantly evolved and will continue to change in order to meet the needs of humankind (Hocquette, 2016; Mark Post, 2012). In this context, meat production has changed through time in several respects given population explosion, resource constraints, and new technologies (Bonny, Gardner, Pethick, & Hocquette, 2015; Datar & Betti, 2010; McCurry-Schmidt, 2012). For example, in the last decades, meat production and consumption have been characterized by several issues including expected demand increase (+73% going towards 2050), pressure on crop outputs and large greenhouse emissions (FAO, 2011), land, energy and water usage (Post 2014) necessary for conventional meat production. In addition, there are increasing societal concerns about intensified animal breeding and herding which is perceived to reduce animal welfare (Post and Hocquette 2017). For these reasons, consumers are expected to increasingly demand food products characterized by alternative protein sources (e.g. vegetables, in-vitro meat, algae, insects, etc.).

"*In-vitro*" meat (IVM) could be seen as one of the solutions that could overcome some of the concerns linked to meat conventional production method (Bonny, Gardner, Pethick, & Hocquette, 2017; Datar & Betti, 2010; Post & Hocquette, 2017). IVM production is a new technology that is derived from regenerative medicine where muscle-specific stem cells are taken from animal, and then grown in large numbers until they form muscle tissues that can then be considered as edible meat (Edelman, McFarland, Mironov, & Matheny, 2005; Post, 2012; Prosser & Trigwell, 1999; Roberts, Yuan, Genovese, & Ezashi, 2015; Yuan, 2018). Thus only animal muscle tissue is produced rather than the whole animal (Bhat & Bhat, 2011). The idea of IVM production for human consumption is not new since it was predicted long time ago by Winston Churchill (Churchill, 1932)[1]. During the 1950s Willem van Eelen theorised the idea of using IVM for producing meat products, but only during 1999 the IVM was patented (Bhat & Bhat, 2011). The production of IVM might have several advantages such as the production of meat in a more efficient, sustainable (i.e. reduction of water and land usage), and ethical (i.e. reduction of suffering animals and health-disease) way and improve public health (Hopkins & Dacey, 2008; Mattick, Landis, & Allenby, 2015; Post, 2012; Sun, Yu, & Han, 2015; Tuomisto & Teixeira de Mattos, 2011). During the last few years, several prototypical IVM products have been developed (BBC, 2013; The Telegraph, 2017). Although none yet has been made commercially available, several companies are aiming to sell IVM products in the near future. A number of new start-up businesses in different parts of the world, such as for example Memphis Meat, Mosa Meat, SuperMeat and Impossible Food as well as big companies like Tyson Foods, Inc. and Cargill are investing a large volume of financial resources into developing IVM products (Cosgrove, 2018; Garfield, 2018).

The production of IVM, however, faces some key challenges that can affect its development such as consumers' acceptance, high costs of production, difficulty scaling-up, and taste not yet being satisfactory (Post, 2012). Some researchers have claimed that consumer acceptance is the biggest barrier of IVM production (Sharma, Thind, & Kaur, 2015). Bryant and Barnett (2018) provided a systematic review of the 14 studies that investigated consumers' acceptance for IVM. They found that consumers' preferences for IVM are driven by the same factors affecting consumers'

[1] *"fifty years hence, we shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium*" (Churchill, 1932).

acceptance for other new food technologies (e.g. GMO). Socio-demographics characteristics, such as age, gender, education and familiarity with the technology affect consumers' acceptance of IVM. Specifically, young and higher educated men might be the early adopters of cultured meat (Bryant & Barnett, 2018b). Some studies revealed that consumers' acceptance of IVM meat depends on the country; for example North Americans seems to be more favourable towards IVM than Europeans (Eurobarometer, 2005; Surveygoo, 2018). In addition, healthiness, safety, taste and price are likely to be the most important consumers' concerns about IVM (The Grocer 2017; Wilks and Phillips 2017). The latter view is corroborated by Lusk and Briggeman (2009). On the other hand, animal welfare, environment and food security are perceived to be the most relevant IVM benefits. There are also individual benefits related to health and safety, but these have not been discussed as much yet (Bryant & Barnett, 2018b). According to Bruhn (2007) it is possible that these personal benefits are the most important ones that will motivate consumers to buy IVM products.

Bryant and Barnett (2018) pointed out that there is a lack of scientific research that investigate the relative value of health, environmental and animal welfare benefits of IVM. Other studies show that consumers might be reluctant to buy IVM products due to a variety of reasons, including perceived disgust, lack of naturalness, taste, uncertainty about environmental benefits, and safety concerns (Verbeke et al., 2015; Wilks & Phillips, 2017). In this regard, Frewer et al. (2011) observed that the way the information about the production method is conveyed to consumers could significantly affect consumer acceptance of new food technologies. Indeed, the name of the production method of IVM reported on the label could also potentially impact acceptance (Bryant & Barnett, 2018b). Commonly used names for IVM are "cultured", "lab-grown or factory-grown" and "artificial" (Verbeke et al., 2015). To the best of our knowledge, only a few studies have investigated consumers' acceptance for IVM products and these studies tend to be qualitative and exploratory in nature (Verbeke et al. 2015; Hocquette et al. 2015; Bekker, Tobi, and Fischer 2017; Wilks and Phillips 2017). No other known study has investigated consumers' willingness to pay (WTP) using more realistic elicitation methods (i.e. choice experiments) and no other study has examined how the naming of the production method would affect WTP values for IVM products. This topic is very important given current controversy and questions related to whether food products created from animal cells should be labelled differently from conventional food products. In fact, several farm groups have affirmed their allegiance to traditional way of producing meat by loudly voicing their opposition to the so called "fake meat" or by demanding that they not be called "meat" [2].

To fill this void, this study uses an online choice experiment (CE) to investigate consumers' stated preferences and willingness to pay (WTP) for hypothetical IVM fresh skinless boneless chicken breast products, hereafter called "chicken products". We chose fresh skinless boneless chicken breast because it is one of the most consumed meat products in United States as well as because US chicken industry is the largest in the world (National Chicken Council, 2018a, 2018b). Specifically, we explore how sensitive consumers' WTP for the products are to different names associated with IVM technology.

2. MATERIALS AND METHODS

2.1 Experimental design

The data used in this study are drawn from an online choice experiment (CE), conducted during

[2] This issue is now one of the US National Cattlemen's Beef Association's top policy priorities, with the goal of protecting people from what they called misleading labels.

Fall 2017 involving 625 consumers in the United States using the online platform Qualtrics LLC (Provo, US). Consumers where randomly recruited by Qualtrics using sampling quotas in terms of age, gender and income based on official statistics (United States Census Bureau, 2015). Consumers were informed about the opportunity to participate in a survey on consumers' valuation of chicken products. Consumers that were at least 18 years old and that stated to provide the best answer were included in the survey. In case of negative response, Qualtrics continued to randomly select other consumers and ask the screening questions until eligible consumers were found.

Four attributes were used to describe the different types of chicken products, such as production method, carbon trust label, antibiotic use and price (Table 1). Two-levels of production method were specified either "*Conventional*" or IVM. As previously mentioned, we randomly assigned respondents to three treatments to test the effect of different IVM "names". Specifically, IVM was named: "*Cultured*" for treatment one, "*Lab-grown*" for treatment two, and "*Artificial*" for treatment three. The two-levels of Carbon Trust Label were specified by the presence "*Carbon Trust Label*" or the no label reported. The two levels of antibiotic use were specified by the sentence "*No antibiotics ever*" or no information about this was reported. Lastly, four price levels were specified to approximately reflect the current market prices for fresh skinless boneless chicken breast products in stores United States ($2.50/lb, $5.50/lb, $8.50/lb and $11.50/lb)[3].

Accordingly, the selected attributes and their levels were first used to determine an orthogonal

[3] The prices for fresh skinless boneless chicken breast products were based on prices recorded in different US stores including grocery stores, farmers' markets, specialty stores, organic stores and supercentres.

fractional factorial design that resulted in the creation of 24 choice sets[4]. We finally used 24 choice sets that were divided in two blocks of 12 choice sets. Each choice set was composed of two product alternatives (options A and B) and an "opt-out" option (option C)[5]. The resulting choice sets are described in Appendix A. The randomization was conducted both within each block of 12 choice sets and within each choice set (options A and B).

Table 1 – Attributes and attribute levels

ATTRIBUTES	LEVELS		
	Treatment 1	**Treatment 2**	**Treatment 3**
Production method	0 – "Conventional". 1 - "Cultured"	0 – "Conventional". 1 - "Lab-Grown"	0 – "Conventional". 1 - "Artificial"
Carbon Trust Label	0 - No label reported. 1 - Carbon Trust Label. reducing with the Carbon Trust CO2	0 - No label reported. 1 - Carbon Trust Label. reducing with the Carbon Trust CO2	0 - No label reported. 1 - Carbon Trust Label. reducing with the Carbon Trust CO2
Antibiotic use	0 - No information reported. 1 - "No antibiotics ever".	0 - No information reported. 1-"No antibiotics ever".	0 - No information reported. 1- "No antibiotics ever".
Price	2.5$/lb 5.5$/lb 8.5$/lb 11.5$/lb.	2.5$/lb 5.5$/lb 8.5$/lb 11.5$/lb.	2.5$/lb 5.5$/lb 8.5$/lb 11.5$/lb.

[4] The suitability of the adoption in this study of an orthogonal design approach with no prior information is given by the use of treatments differing in terms of the naming frame, i.e. production method. As we expected, the use of different naming frames might have affected consumers' evaluation of the products attributes. As such, the use of an experimental design based on prior information might have more efficiently worked in the case of one treatment (i.e. the treatment where the same naming frame was specified), but not for all them (Bliemer & Collins, 2016; Caputo, Lusk, & Nayga, 2018).

[5]An example of a choice set presented to consumers is reported in the Appendix B.

The survey started with the introduction of the study with the explanation and description of the attributes and attributes levels. Then, before starting the choice tasks, respondents were introduced to a cheap talk (CT) which aims to mitigate the hypothetical bias that typically affect WTP estimates in stated preference studies (Cummings & Taylor, 1999). Upon completion of the twelve choice tasks, the respondent were then asked to fill out a questionnaire concerning habits, attitudes and socio-demographics characteristics.

A pre-test with 50 consumers was performed during spring 2017 to test the final survey.

2.2 Experimental treatments and research hypothesis

As mentioned above, we used three CE treatments with a between-subjects design. Hence, each consumer was randomly assigned to only one of the CE treatments. The three treatments only differed in terms of name given to the IVM (i.e., "cultured", "lab-grown" and "artificial"). In the first treatment, named "*cultured treatment*" (CULT), 210 consumers were exposed to chicken products with the IVM product using the name "Cultured". In the second treatment, named "*lab-grown treatment*" (LABT), 208 respondents were exposed to chicken products with the IVM product using the name "Lab-grown". In the third treatment, named "*artificial treatment*" (ARTT), 207 respondents were exposed to chicken products with the IVM using the name "Artificial".

In order to avoid providing information that could positively or negatively affect consumers' responses, we provided the same definition of IVM across all the treatments: *"in cultured/lab-grown/artificial the product is produced by taking a number of cells from a live chicken. These cells are then transported to a food industry lab where the cells will proliferate in a nutrient-rich medium until a fresh boneless skinless chicken breast product is formed and then it will be packaged. No chicken is slaughtered".*

With these CE treatments, we were able to test a series of hypotheses aimed at testing if the name of IVM affects consumers' preferences and WTP for a new food technology. In order to determine the effect of names on individuals' WTP, the estimates from the three treatments were compared. Accordingly, we conducted three comparisons:

- Treatment 1 vs. Treatment 2. In order to test if consumers are willing to pay higher or lower price for "cultured" or "lab-grown" meat, we tested the following hypothesis:

  $$H_{01}: (WTP^{LABT} - WTP^{CULT}) = 0$$

  $$H_{11}: (WTP^{LABT} - WTP^{CULT}) \neq 0$$

  If H_{01} is rejected we might confirm that if IVM is named "cultured" or "lab-grown" consumers are willing to pay different prices to buy IVM chicken products.

- Treatment 1 vs. Treatment 3. To test if consumers are willing to pay higher or lower price for "cultured" or "artificial" meat, we tested the following hypothesis:

  $$H_{02}: (WTP^{ARTT} - WTP^{CULT}) = 0$$

  $$H_{12}: (WTP^{ARTT} - WTP^{CULT}) \neq 0$$

  If H_{02} is rejected we might confirm that if IVM is named "cultured" or "artificial" consumers are willing to pay different prices to buy IVM chicken products.

- Treatment 2 vs. Treatment 3. To test if consumers are willing to pay higher or lower price for "lab-grown" or "artificial" meat, we tested the following hypothesis:

  $$H_{03}: (WTP^{ARTT} - WTP^{LABT}) = 0$$

  $$H_{13}: (WTP^{ARTT} - WTP^{LABT}) \neq 0$$

  If H_{03} is rejected we might confirm that if IVM is named "artificial" or "lab-grown" consumers are willing to pay different prices to buy IVM chicken products.

3. ECONOMETRIC ANALYSIS

To test the research hypothesis, we estimated the effect of the treatments on WTP estimates. First, the derivation of WTP measures across the treatments requires the selection of the econometric model to conduct the data analysis. We performed an exploratory approach using different discrete choice models (DCMs), such as the multinomial logit (MNL) model, the random parameter logit (RPL) model and the RPL with error component (RPL-EC) (Hensher, Rose, & Green, 2015). Given the goodness of fit measures of the models, we decided to use the RPL model. RPL models are largely used in food consumer studies (Aprile, Caputo, & Nayga Jr, 2012; Asioli, Næs, Øvrum, & Almli, 2016; Ortega, Wang, Wu, & Olynk, 2011; Van Loo, Caputo, Nayga, Meullenet, & Ricke, 2011).

The following step in the model estimation was the choice of how to specify the utility function. Basically, there are two types of utility specifications: preference space and WTP space (Hensher et al., 2015). WTP space has been deemed more practical in the derivation of welfare estimates in comparison with preference space utility specification. For example, indeed, past studies indicated that estimating models in WTP space have several advantages, including: 1) accounting for interpersonal scale variations (Scarpa & Willis, 2010), 2) more stable WTP estimates (Balcombe, Chalak, & Fraser, 2009) and 3) more reasonable WTP distribution (Train & Weeks, 2005). Hence, we opted for the specification of the utility function in WTP space.

The specification of the utility (*U*) function in our study can be defined as follows (Hensher et al., 2015):

$$U_{njt} = \alpha(\theta_1 ASC - PRICE_{njt} + \theta n_2 PRODUCT_{njt} + \theta n_3 CARBON_{njt} + \theta n_4 ANTIBIOTIC_{njt}) + \varepsilon_{njt} \qquad (1)$$

where n refers to each individual, j denotes each of the three options available in the choice set, and t is the number of choice occasions. θ are the WTP estimates. α is the price scale parameter that is assumed to follow a log-normal distribution. The ASC is a dummy variable indicating the selection of the opt-out option. The price (*PRICE*) attribute is a continuous variable represented by the four price levels (i.e. 2.5$/lb, 5.5$/lb, 8.5$/lb and 11.5$/lb). *PRODUCT* is a dummy variable representing the production method taking the value of 0 if the production method is "Conventional" and 1 if it "Cultured" for treatment one, "Lab-grown" for treatment two, "Artificial" for treatment three. *CARBON* is a dummy variable representing the carbon trust label taking the value of 0 if the no label is reported and 1 with Carbon Trust Label reported. Finally, *ANTIBIOTIC* is a dummy variable for information about antibiotic use taking the value of 0 if no information is reported and 1 if it is reported "No antibiotics ever". Finally, ε_{njt} is an unobserved random term that is distributed following an extreme value type I (Gumbel) distribution, i.i.d. over alternatives. Consumers are assumed to choose the alternative in the choice set which provides the highest utility level from those available.

The differences in WTPs among the three treatments involved in our hypothesis (i.e. H_{01}, H_{02} and H_{03}) can be tested by conducting pairwise tests using data from the two respective treatments involved in the particular hypothesis. A similar approach has been used by Bazzani et al. (2017) and De-Magistris, Gracia, & Nayga (2013). In these pairwise tests, we created a dummy variable to differentiate one treatment over the other treatment (*dtreat*). Accordingly, the model can be specified as follows:

$$U_{njt} = \alpha(\theta_1 ASC - PRICE_{njt} + \theta n_2 PRODUCT_{njt} + \theta n_3 CARBON_{njt} + \theta n_4 ANTIBIOTIC_{njt} + \eth_1 (PRODUCT_{nj} * dtreat) + \eth_2 (CARBON_{nj} * dtreat) + \eth_3 (ANTIBIOTIC_{nj} * dtreat) + \varepsilon_{njt} \qquad (2)$$

where *dtreat* is coded as 1 for the first treatment in the analysed hypothesis, and 0 otherwise. The significance of the estimated ð coefficients and their signs indicate the effect of the treatment on marginal WTPs for the attributes of interest.

In the questionnaire, we asked respondents whether they have heard about the IVM production method before they participated in the current study (i.e. variable name HEARING). Given the potential for heterogeneity in results in each treatment for those who have heard vs those who have not heard about the IVM production method, we added from our baseline specification in equation (1) an interaction term between PRODUCT and HEARING, where HEARING is a dummy variable taking the value of 1 if the respondent had heard about the production method prior to the current study, 0 otherwise[6]. Accordingly, the model can be specified as follows:

$$U_{njt} = \alpha(\theta_1 ASC - PRICE_{njt} + \theta n_2 PRODUCT_{njt} + \theta n_3 CARBON_{njt} + \theta n_4 ANTIBIOTIC_{njt} + ðn_1 (PRODUCT_{nj} * HEARING) + \varepsilon_{njt} \qquad (3)$$

The significance and sign of the ð coefficient indicate whether the marginal WTP for the IVM production method in each treatment differs between those who heard and those who have not heard of the IVM technology prior to the current study.

All the models were estimated using NLOGIT 6.0 (Plainview, USA) software.

[6] For treatment one the question was: “Have you ever heard of the term "cultured" meat before?”.
For treatment two the question was: “Have you ever heard of the term "lab-grown" meat before?”.
For treatment three the question was: “Have you ever heard of the term "artificial" meat before?”.

4. RESULTS

4.1 Socio-demographics information

Table 3 reports the summary statistics of the socio-demographics characteristics investigated (i.e. age, household size, education, income, race, presence of child, area of growing up, area of living, employment and gender) across the three treatments. To check for significant differences across the treatments, for the ordinal variables (i.e. age, income, household size, education and income) we used the non-parametric Kruskall-Wallis test, while for the categorical variables (i.e. race, presence of child, area of growing up, area of living, employment and gender) we used the chi-square test. The results show that the hypotheses of equality of means between socio-demographics characteristics across treatments failed to be rejected at the 5% significance level. Hence, we can confirm that the random assignment of respondents to the treatments was able to provide a balanced sample in terms of the socio-demographics characteristics across the three treatments.

Table 3 – Socio-demographic characteristics of the sample

SOCIO-DEMOGRAPHICS	Treatment 1 CULT (N=210)	Treatment 2 LABT (N=208)	Treatment 3 ARTT (N=207)	Pooled (N=625)
Age				
18-35	33.33%	34.62%	34.30%	34.08%
36-53	29.52%	28.85%	28.02%	28.80%
54-71	32.38%	30.77%	30.92%	31.36%
>71	4.76%	5.77%	6.76%	5.76%
Chi-squared = 0.05 with 2 d.f.				
Probability = 0.98				
Household size (n° member)				
1-5	97.14%	95.67%	96.14%	96.32%
6-10	2.86%	4.33%	3.38%	3.52%
11-15			0.00%	0.00%
6-20			0.00%	0.00%
>20			0.48%	0.16%
Chi-squared = 0.07 with 2 d.f.				
Probability = 0.97				
Education				
Elementary/some high school	2.38%	0.96%	0.97%	1.44%
High school diploma	20.95%	21.15%	21.74%	21.28%
Some college	17.14%	22.12%	17.39%	18.88%
Technical school diploma	3.33%	2.88%	3.86%	3.36%
Associate's degree	9.52%	11.06%	9.18%	9.92%
Bachelor's degree	31.43%	28.37%	28.50%	29.44%

Master's degree	9.52%	9.62%	13.04%	10.72%
Doctorate	5.24%	3.37%	4.33%	4.48%
Other	0.48%	0.48%	0.48%	0.48%
Chi-squared = 0.89 with 2 d.f.				
Probability = 0.64				
Income				
Less than $19,999	11.91%	11.06%	14.01%	12.32%
$20,000-$39,999	19.05%	23.07%	16.43%	19.52%
$40,000-$59,999	18.57%	16.34%	18.36%	17.76%
$60,000-$79,999	16.19%	18.27%	16.91%	17.12%
$80,000-$99,999	8.1%	7.21%	6.28%	7.2%
$100,000-$149,999	15.24%	13.94%	14.98%	14.72%
More than $150,000	10.95%	10.1%	13.04%	11.36%
Chi-squared = 0.44 with 2 d.f.				
Probability = 0.80				
Race				
White	82.38%	80.77%	80.19%	81.12%
Hispanic	6.19%	4.81%	5.31%	5.44%
Native american	0.48%	0.96%	0.48%	0.64%
African american	5.24%	5.77%	8.70%	6.56%
Asian/pacific islander	4.29%	6.73%	2.90%	4.64%
Other	1.43%	0.96%	2.42%	1.60%
Pearson chi2(10) = 7.94				
Pr = 0.64				
Presence of child under 18 y				
Child	33.81%	39.90%	37.68%	37.12%
No child	66.19%	60.10%	62.32%	62.88%
Pearson chi2(2) =1.70				
Pr = 0.43				
Area of growing up				
Rural area	19.52%	19.71%	24.64%	21.28%
Urbanized cluster	46.67%	42.31%	36.23%	41.76%
Urban area	33.81%	37.98%	39.13%	36.96%
Pearson chi2(4) = 5.27				
Pr = 0.26				
Area of living				
Rural area	18.57%	18.75%	17.87%	18.40%
Urbanized cluster	49.52%	38.94%	41.55%	43.36%
Urban area	31.90%	42.31%	40.58%	38.24%
Pearson chi2(4) = 6.38				
Pr = 0.17				
Employment				
Student	4.29%	3.85%	4.83%	4.32%
Independent worker	7.14%	4.81%	11.11%	7.68%
Private sector worker	33.33%	28.85%	30.92%	31.04%
Public sector worker	13.33%	17.79%	14.49%	15.20%
Retired	24.29%	20.19%	23.19%	22.56%
Unemployed seeking work	8.57%	5.77%	4.83%	6.40%
Not in paid employ not seeking work	3.81%	11.06%	5.80%	6.88%
Other	5.24%	7.69%	4.83%	5.92%
Pearson chi2(14) = 21.36				
Pr = 0.09				
Gender				
Male	52.86%	53.37%	53.620%	53.28%
Female	47.14%	46.73%	46.38%	47.62%
Pearson chi2(2) = 0.03				
Pr = 0.99				

4.2 Estimation of willingness to pay (WTP) space and hypothesis tests

The results from the estimation of the RPL models in WTP space for the three treatments are exhibited in table 4. All the estimations were conducted using 500 Halton draws. The parameters corresponding to the three non-price attributes (i.e. production method, carbon trust label and antibiotic use) were modelled as random parameters while the opt-out parameter was modelled as a fixed parameter.

Table 4 – Estimated WTP space from RPL models for the three treatments.

ATTRIBUTE	Treatment 1 CULT (N=210)		Treatment 2 LABT (N=208)		Treatment 3 ARTT (N=207)	
	WTP($/lb)	SD	WTP($/lb)	SD	WTP($/lb)	SD
Production method	-2.47***	5.06***	-11.02***	8.45***	-7.10***	6.56***
Carbon Trust Label	1.06***	2.98***	0.36	2.43***	0.37	2.93***
Antibiotic use	1.78***	1.95***	1.71***	2.23***	1.20***	2.58***
Opt-out	-3.75***		-3.24***		-3.83***	

Note: ***, **, * significance respectively at 1%, 5%, 10% level.

The mean estimate of opt-out is negative and highly significant suggesting that consumers in the CE tended to highly prefer one of the two product alternatives as opposed to the "opt-out" option. On average, consumers prefer chicken products produced with conventional production method, and labelled "No antibiotics ever" and depending on the IVM name, also with the carbon trust label. Specifically, if we look at the significances and the WTP magnitudes for the individual attributes, we can notice that the production method is the attribute that mostly influences consumers' WTP. On average consumers prefer the conventional production method over the IVM method across all treatments (i.e. -$2.47/lb for CULT, -$11.02/lb for LABT and -$7.11/lb for ARTT). The second most important attribute that affects the WTPs is antibiotic use. On average, consumers' prefer products with the information "No antibiotics ever" with relatively stable WTPs across the treatments (i.e. +$1.78/lb for CULT, +$1.71/lb for LABT and +$1.20/lb for ARTT). Finally, the carbon trust label is the least important attribute as it is not significant in the LABT and ARTT treatments, although it is positive and significant in the CULT treatment (+$1.06/lb).

Next, we tested the hypothesis that the different names associated with IVM technology significantly affect WTP estimates. Table 5 reports the estimates of production method, carbon trust label and antibiotic use parameters and the corresponding *p-values* of the *t* test for the dummy variables.

Table 5 – Hypothesis test in WTP space

HYPOTHESIS TESTS	WTP($/lb)	STANDARD ERROR	P-VALUE
H_{01}: ($WTP^{LABT} - WTP^{CULT}$) = 0			
product X dtreatment	- 0.94***	0.12	0.00
carbon X dtreatment	0.14*	0.08	0.06
antibiotic X dtreatment	- 0.07	0.10	0.46
H_{02}: ($WTP^{ARTT} - WTP^{CULT}$) = 0			
product X dtreatment	-1.00***	0.17	0.00
carbon X dtreatment	-0.07	0.12	0.56
antibiotic X dtreatment	-0.18	0.12	0.14
H_{03}: ($WTP^{ARTT} - WTP^{LABT}$) = 0			
product X dtreatment	0.36*	0.21	0.09
carbon X dtreatment	0.18*	0.10	0.07
antibiotic X dtreatment	0.00	0.13	0.98

Note: ***, **, * significance respectively at 1%, 5%, 10% level.

Our first hypothesis H_{01}: (WTP^{LABT} - WTP^{CULT}) = 0 is rejected indicating that consumers' WTPs is significantly higher when production method for IVM chicken is named "cultured" (-$2.47/lb) rather than "lab-grown" (-$11.02/lb). Looking at the results of our second hypothesis, H_{02}: (WTP^{ARTT} - WTP^{CULT}) = 0 is rejected indicating that consumers' WTPs is significantly higher when IVM chicken is named “cultured” (-$2.47/lb) rather than “artificial” (-$7.11/lb). Finally, our third hypothesis, H_{03}: (WTP^{ARTT} – WTP^{LABT}) = 0 is rejected at p-value 10% indicating that consumers’ WTPs is significantly higher when IVM chicken is named “artificial” (-$7.11/lb) rather than “lab-grown” (-$11.02/lb). Thus, these results show that even if we provided the same definition of IVM across all the treatments, the name provided for the IVM technology on the food label significantly affects consumers’ WTPs.

Finally, we tested the effect of having heard the terms “cultured”, “lab-grown” and “artificial” meat prior to the current study for each treatment using equation (3). Results exhibited in Table 6 show that there are significant differences in WTP values between those who have heard and those who have not heard of the IVM technology prior to the current study across the three treatments.

Table 6 – Effect of “hearing” IVM names before on consumers’ WTP space

VARIABLES	WTP($/lb)	STANDARD ERROR	P-VALUE
product X hearing cultured	-0.96***	0.07	0.00
product X hearing lab grown	-0.28*	0.16	0.08
product X hearing artificial	-0.42**	0.19	0.03

Note: ***, **, * significance respectively at 1%, 5%, 10% level.

Specifically, consumers in the first treatment who have heard of the term “cultured” meat have lower WTP ($0.96 lower) than those who have not heard of it prior to the current study. Similarly, consumers in second treatment who have heard of “lab-grown” meat prior to the current study have lower WTP ($0.28 lower) than those who have not heard, while those who have heard the term “artificial” meat in the third treatment have significantly lower WTP ($0.42 lower) than others.

5. DISCUSSION AND CONCLUSIONS

There is brewing controversy over whether IVM products should be labelled differently in the market. While plant-based foods that look like meat can now be bought from supermarkets, it is just a matter of time before retailers stock their shelves with IVM products. This obviously worries many farmers. Some are even calling IVM products “fake meat” and are demanding that they be differentiated from conventional meat products in the market. There has been scant research, however, on how consumers would value IVM products vis-à-vis conventional meat products. If consumers would value them similarly to their conventional counterparts, then there would probably be not as much need to differentiate them between each other in the marketplace. However, if consumers would value them significantly lower than conventional products, then there would be stronger argument to enact labelling regulations that would allow consumers to differentiate between the two types of products. The main goal of this research was to investigate consumers’ stated perceptions and WTP for hypothetical IVM fresh skinless boneless chicken breast products in the United States. Specifically, we investigated how sensitive consumers’ WTP for the products are to different names (i.e. cultured, lab-grown, artificial) associated with IVM technology. We found that on average consumers highly significantly reject IVM, but the name given to IVM significantly affects consumers’ WTP. Specifically, the name “cultured” gets the least negative WTP valuation compared to “artificial” and “lab-grown” names.

We also investigated whether WTP for IVM differs between consumers who have heard and those who have not heard about IVM prior to the current study. Interestingly, in all the treatments, those who have heard of IVM (i.e., the names “cultured”, “lab-grown” and “artificial” meat depending on the treatment) have lower WTP for IVM than those who have not heard, suggesting perhaps that prior knowledge about the existence of the controversial technology negatively impacts consumers’ valuation for the IVM. If true, then this could have significant implications for how to educate consumers and how to promote IVM products in the future.

In terms of practical implications, the results of study suggest that producers of IVM should use the name “cultured” meat on food labels to label IVM products rather than the names “lab-grown” or “artificial”. The results also imply that the name assigned to products produced by IVM technology can make a difference in consumers’ mind, which then have important implications for future labeling policies both for policy makers and IVM producers and sellers. In terms of the future of the IVM market, the significantly lower valuations given by consumers to IVM products in this study could pose a non-trivial challenge to IVM producers given the higher production costs currently associated with these products (Post, 2012). While this study represents a first attempt at getting answers related to how consumers would value IVM food products and how terminologies would matter in terms of how these products should be named, more studies are needed to definitively answer questions surrounding the market potential of IVM food products and to test the robustness of our findings.

ACKNOWLEDGMENTS

Thanks also to the European Commission through the Marie Curie Actions Intra European Fellowship (IEF), call FP/-PEOPLE-I2012-IEF – project title ‘‘Innovative Methodologies for New Food Product Development: combining Sensory Science and Experimental Economics – NEFOMET” for the support.

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Appendix A – Final choice sets used in the study.

Choice set	ALTERNATIVE A				ALTERNATIVE B			
	Price ($)	Product	Carbon	Antibiotic	Price ($)	Production method	Carbon trust label	Antibiotic use
1	11.5	Cultured/Lab grown/artificial	Label	No antibiotics ever	8.5	Conventional	No label	No antibiotics ever
2	2.5	Cultured/Lab grown/artificial	No label	No antibiotics ever	5.5	Conventional	No label	No information
3	11.5	Conventional	Label	No antibiotics ever	2.5	Cultured/Lab grown/artificial	No label	No antibiotics ever
4	8.5	Conventional	No label	No antibiotics ever	2.5	Cultured/Lab grown/artificial	Label	No antibiotics ever
5	8.5	Cultured/Lab grown/artificial	No label	No information	2.5	Conventional	Label	No antibiotics ever
6	5.5	Conventional	No label	No antibiotics ever	11.5	Cultured/Lab grown/artificial	No label	No antibiotics ever
7	8.5	Conventional	Label	No information	5.5	Cultured/Lab grown/artificial	No label	No antibiotics ever
8	2.5	Conventional	Label	No information	5.5	Conventional	No label	No antibiotics ever
9	2.5	Cultured/Lab grown/artificial	Label	No antibiotics ever	2.5	Cultured/Lab grown/artificial	No label	No information
10	11.5	Cultured/Lab grown/artificial	No label	No information	5.5	Cultured/Lab grown/artificial	Label	No information
11	5.5	Cultured/Lab grown/artificial	Label	No information	5.5	Conventional	Label	No antibiotics ever
12	5.5	Conventional	No label	No information	11.5	Conventional	Label	No information
13	2.5	Conventional	No label	No information	8.5	Cultured/Lab grown/artificial	Label	No antibiotics ever
14	11.5	Conventional	Label	No information	2.5	Conventional	Label	No information
15	2.5	Cultured/Lab grown/artificial	No label	No information	5.5	Cultured/Lab grown/artificial	Label	No information
16	5.5	Cultured/Lab grown/artificial	Label	No information	2.5	Conventional	No label	No information
17	5.5	Conventional	Label	No antibiotics ever	11.5	Conventional	No label	No information
18	8.5	Cultured/Lab grown/artificial	Label	No information	8.5	Conventional	Label	No information
19	5.5	Cultured/Lab grown/artificial	No label	No antibiotics ever	11.5	Conventional	Label	No antibiotics ever
20	11.5	Cultured/Lab grown/artificial	No label	No antibiotics ever	11.5	Cultured/Lab grown/artificial	Label	No antibiotics ever
21	11.5	Conventional	No label	No information	8.5	Cultured/Lab grown/artificial	Label	No information
22	2.5	Conventional	Label	No antibiotics ever	11.5	Cultured/Lab grown/artificial	No label	No information
23	8.5	Conventional	No label	No antibiotics ever	8.5	Conventional	No label	No antibiotics ever
24	8.5	Cultured/Lab grown/artificial	Label	No antibiotics ever	8.5	Cultured/Lab grown/artificial	No label	No information

Appendix B – An example of a choice set

Imagine you are in a store and you would like to purchase a package of fresh skinless boneless chicken breast product. Would you choose Option A, Option B or Option C?