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Acceptance of beef obtained through genetic modification and cloning in university students and working adults in southern Chile

Aceptación de carne bovina obtenida a través de modificación genética y clonación por parte de estudiantes universitarios y adultos que trabajan en el sur de Chile

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Abstract

In order to compare the acceptance of beef obtained from a conventionally bred, cloned or genetically modified (GM) animal by working adults and university students, and to identify consumer segments in both subsamples, a survey of 400 people in southern Chile was applied, distributed by means of proportional allocation. Using a conjoint analysis in the total sample, it was determined that the production technology was more important than the price, origin, presentation or breed of the animal. The consumers preferred Argentinean beef, cut, from a conventional animal, at the lowest price. In both subsamples one segment was sensitive to the production technology, one to the price and one to the origin of the meat. Nevertheless, the proportion of adults who rejected cloning and GM was greater, whereas a significant proportion of students viewed meat from a cloned or GM animal positively. In both subsamples, the groups sensitive to the origin had a positive view of beef from a GM animal. The groups in the subsample of students were differentiated by the frequency of beef consumption. In both subsamples, the segments did not differ in the level of satisfaction with their food-related life.

Keywords
cloned animal • genetically modified animals • beef • consumer acceptance

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Resumen

Con el objetivo de comparar la aceptación de carne bovina de un animal convencional, clonado y genéticamente modificado (GM) en adultos laboralmente activos y estudiantes universitarios, e identificar segmentos de consumidores en ambas submuestras, se aplicó una encuesta a 400 personas en el sur de Chile, distribuidas mediante afijación proporcional. Mediante análisis conjunto, en la muestra total se determinó que la tecnología de producción fue más importante que el precio, el origen, la presentación y la raza del animal. Los consumidores prefirieron carne argentina, al corte, de un animal convencional, al precio más bajo. En ambas sub-muestras se distinguió un segmento sensible a la tecnología de producción, uno sensible al precio y uno sensible al origen de la carne. Sin embargo, fue mayor la proporción de adultos que rechazó la clonación y la GM, mientras una importante proporción de estudiantes se mostró positivo frente a la carne de un animal GM y clonado. En ambas sub-muestras los grupos sensibles al origen se mostraron positivos frente a la carne de un animal GM. Los grupos de la sub-muestra de estudiantes se diferenciaron según la frecuencia de consumo de carne bovina. En ambas sub-muestras los segmentos no difirieron según el nivel de satisfacción con su alimentación.

Palabras clave

clonación animal • animales genéticamente modificados • carne bovina • aceptación del consumidor

Introduction

New technologies are being continuously developed and implemented in the food chain, promising more efficient production and better quality for consumers (7). However, the application of modern technologies for creating new food products is a cause of concern for consumers (6). Following the classic scheme of Engel *et al.* (1978), the consumer's purchase decision process can be described in five stages: 1) recognition of the problem, 2) search for information, 3) evaluation of the options or alternatives, 4) selection of the purchase, and 5) post-purchase evaluation. In the second stage of this process the consumer looks for information about products, brands or services that can cover his needs, while in the third stage the consumer evaluates the options according to a series of evaluation criteria. In this regard, when evaluating food products and making purchase decisions, consumers use a broad range of criteria, considering the way a product is produced, including its technological, ethical and social implications (1, 7). Meat in general and beef in particular are an interesting and relevant case for studying consumer acceptance of new technologies.

The meat industry has been named as being among the least innovative in the food industry, particularly compared to the beverage and dairy industries (7, 35). Also, the meat and beef industry has been subject to several consecutive safety crises (11), which increases consumer concern. Therefore, it is to be expected that consumers may express fears about

novel technologies such as genetic modification applied to foods of animal origin and animal cloning, rejecting those technologies which otherwise may provide useful solutions which are also in the consumers' interest (3). In this regard, this study compares the acceptance of beef obtained from genetically modified (GM), cloned and conventionally bred animals.

The term "genetically modified animals" is rather broad, and may apply to animals fed with feed containing GM additives or enzymes, those given GM vaccines and hormones, or those that are GM themselves (23). Consumers have been found to have higher acceptance of GM technologies using plant-based products rather than animal-based products (11), although other authors report the opposite (27).

While European consumers are concerned about the use of GM in animal production (20) and meat products (21), in terms of environmental sustainability, human health and animal welfare, in the US there is evidence to indicate the opposite (6).

However, although several authors have reported that acceptance of GM foods is lower in Europe than in the US (13), some studies indicate that this situation might be changing. A recent study in the US found that consumers are willing to pay more to avoid GM foods (37).

In six European countries, O'Brien *et al.* (2012) determined that acceptance of food of animal origin which has been fat-modified using GM varies between foods. The most accepted were fish, cheese and red meats, whereas the least accepted were eggs, butter and milk.

Cloning was originally used in microbiology and agriculture, and is the process of multiplying single organisms by means of asexual reproduction to create a population of identical individuals (12). Between 2008 and 2009 the competent authorities in the US, Europe and Japan concluded that meat and milk derived from animal clones and their offspring are as safe for consumption as those derived from conventionally bred animals (3).

Future commercial agri-food opportunities may include the development of animals that are more efficient at converting feed and growing, and disease resistant/tolerant to climatic changes (13). While studies of consumer preference for GM foods are somewhat abundant (37), there is limited information about consumer attitudes toward food derived from animal clones (3).

Nevertheless, animal cloning shares some similarities with GM technology in terms of consumer awareness and acceptance (25). While some studies reported that between 40 and 50% of consumers would not purchase meat or milk derived from cloned animals (3, 17, 34), others found that consumers place a higher value on non-cloned products than on cloned products (2-4). This background therefore leads us to propose the following hypothesis:

H1. Consumers will prefer beef from conventionally bred animals.

However, both the acceptance of foods of animal origin GM (24) and foods obtained from cloned animals (34) differed between countries in developed countries. This knowledge, in contrast to other studies that have assessed acceptance of GM foods in developing countries (8, 27, 28, 32), there is limited research on the acceptance of animal cloning in these nations (32). It is also worthy of note that most available studies have assessed acceptance of GM foods and those from cloned animals separately, and very few studies have addressed the relative consumer acceptance of both

technologies. A recent study in the UK reported that consumers were relatively less worried about GM foods and cloning than about the use of hormones and pesticides in food production (11).

In Chile it was found that consumers preferred milk from a conventional animal and rejected milk from a cloned or GM cow, but the youngest respondents rejected cloning and the older respondents rejected GM (32).

Indeed, the acceptance or rejection of these technologies is varied, with segments in favor and others against (27, 28, 37). Some authors indicate that acceptance of GM foods is not related to consumer socio-demographic characteristics (20); yet there is evidence that women (27, 37), less educated (27, 33) and older people (25, 37) reject GM foods more strongly. Likewise, recent studies have reported that older people (5) and those with a high school education (4) are less supportive of cloning than younger people and those with a bachelor's degree or higher level of education.

In addition, in Europe de Barcellos *et al.* (2010) found that young people tended to be more favorable towards new beef technologies, whereas older people were more inclined to traditional and natural products.

Therefore, it is to be assumed that acceptance of beef obtained from a conventionally bred, cloned or GM animal is related to the consumer's age. For this reason, the study is conducted using two subsamples: working adults (WA) and university students (USt). While WA represent current and medium-term acceptance, USt may tend to acceptance over a longer period, considering that young people search for new food experiences and become increasingly neophilic, attempting to distinguish themselves from their parents' food-related values (19). This may provide orientation for the production sector, government agencies and sellers as to which technology may be most successful in the market, both in the medium and long term. On this basis, we suggest the following hypotheses:

H2. Acceptance of beef obtained from cloned, GM and conventionally bred animals will differ between WA and USt.

H3. Based on consumer preferences, it is possible to identify several (or more than one) consumer segments in the WA and USt subsamples.

Additionally, some studies explore neural reactions behind consumers' choice of food technologies (22) and relate psychological aspects to preferences for certain foods. In this regard, some studies have reported that satisfaction with food-related life is associated with the preference for foods produced with new technologies applied to food production (29), but others indicated the opposite (32).

Therefore, this study assesses whether the level of satisfaction with food-related life is associated with acceptance of beef obtained from GM or cloned animals. So, we propose the following hypotheses:

H4. In the WA subsample, consumers' preferences will be associated with their demographic characteristics and their degree of satisfaction with food-related life.

H5. In the USt subsample, consumers' preferences will be associated with their demographic characteristics and their degree of satisfaction with food-related life.

According a recent study (17), commercial cloning activity for livestock is best developed in bovine animals. Cloning technology is being applied to cattle in the US, Canada, Argentina and Australia. It may also be being undertaken in Brazil, New Zealand, Chile, China and

Uruguay based on the presence of cattle cloning companies in these countries (17). Given that over 50% of the beef consumed in Chile is imported (9) and comes from countries using cloning, it is interesting to study Chilean consumer acceptance of this technology and compare it to acceptance of beef obtained from GM and conventionally bred animals.

Goals

Thus, the aims of this study were: to compare the acceptance of beef obtained from cloned, GM and conventionally bred animals in southern Chile; to compare preferences for these products in working adults (WA) and university students (USt); and to identify consumer segments among WA and USt in terms of preferences and characterize them according to socio-demographic characteristics and level of satisfaction with food-related life.

Materials and methods

Survey

Accidental non-probability sampling was used to recruit a sample of 400 people in Temuco (a city in southern Chile). This number was obtained using the stratified random sampling formula with simple allocation for non-finite populations (N>100,000), considering 95% confidence and 5% estimation error with p and q of 0.5. Thus, 200 USt and 200 WA were surveyed.

The survey was applied personally by two previously trained interviewers in July and August 2013, after the questionnaire had been validated by means of a preliminary test with 10% of the sample. The Bioethics Committee of the Universidad de La Frontera approved the study.

A questionnaire with closed-ended questions was used to collect information to determine whether the respondents understood the meaning of a cloned or GM animal and the frequency of beef consumption.

The questionnaire included the Satisfaction with Food-related Life (SWFL) scale, developed by Grunert *et al.* (2007). This scale evaluates a person's overall assessment regarding their food and eating habits. This means, it evaluates subjective well-being in the domain of food and is directly related to overall life satisfaction, which constitutes the cognitive component of subjective well-being (14).

The SWFL was included in the study due to the relationship among psychological aspects and preferences for certain foods (22) and to evidence which indicates that the degree of satisfaction with food-related life is linked to the preference for foods produced with new technologies applied to food production (29).

The SWFL scale consist of five items grouped into a single dimension: 1. Food and meals are positive elements, 2. I am generally pleased with my food, 3. My life in relation to food and meals is close to ideal, 4. With regard to food, the conditions of my life are excellent, 5. Food and meals give me satisfaction in daily life.

The respondents were asked to indicate their degree of agreement with the five items using a 6-point Likert scale (1 = disagree completely, 6 = agree completely). The Spanish-language version of the SWFL was used, which has shown good levels of internal reliability in previous studies conducted in Chile (29, 31, 32).

In this study, Cronbach's α coefficients were 0.89 in the USt subsample and 0.83 in the WA subsample. Classification questions were included to establish gender, age, area of residence, level of education of the head of the household,

and possession of 10 household goods. These two last variables determine the socio-economic level, classified as ABC1 (high and upper middle), C2 (middle-middle), C3 (lower middle), D (low) and E (very low) (2).

In order to evaluate acceptance of beef obtained from conventionally bred, GM and cloned animals, a conjoint analysis (CA) was performed. CA is based on the premise that consumers assess the value of a real or hypothetical product by combining separate quantities of value that each attribute provides (16).

Table 1 shows the attributes and levels defined for the beef.

The levels established for the attribute "country of origin" was defined as the two main countries of beef imports in recent years, Brazil and Argentina, and Australia for the increase in imports from that country since 2008 (9). To avoid the effect of ethnocentrism on the choice, Chilean origin was omitted as previous studies show a strong preference for domestic beef (30), even though imported beef has represented around 50% of the meat available for consumption on the Chilean domestic market (9).

The attribute "breed" was included due to the increasing supply in the Chilean market of beef in which the animal's breed is noted as a way to differentiate the product.

The levels of this attribute corresponded to the three breeds being used to differentiate the product at the time of the survey. For the attribute "packaging" the levels corresponded to the three types of commercialization of beef in the Chilean market.

The price levels were established based on current prices in the Temuco market for 1 kg of sirloin at the time of the survey. From these attributes and levels, a total of 243 combinations (3x3x3x3x3) were obtained; however, to facilitate the respondents' answers, it was decided that a fractional factorial design would be used, obtained with the macro MktEx from the SAS Institute (18).

Table 1. Design of the conjoint experiment.

Tabla 1. Diseño del análisis conjunto.

Card	Origin	Breed	Package	Production Technology	Price (US$/kg)
A	Argentina	Wagyu	Tray	Conventional	28.0
B	Argentina	Angus	Tray	Genetically modified	22.8
C	Argentina	Overo colorado	Cut	Conventional	17.5
D	Argentina	Overo colorado	Vacuum packing	Cloned	22.8
E	Brazil	Wagyu	Cut	Cloned	22.8
F	Brazil	Angus	Tray	Cloned	17.5
G	Brazil	Angus	Vacuum packing	Conventional	28.0
H	Brazil	Overo colorado	Cut	Genetically modified	28.0
I	Brazil	Overo colorado	Tray	Conventional	22.8
J	Australia	Wagyu	Vacuum packing	Genetically modified	17.5
K	Australia	Angus	Cut	Conventional	22.8
L	Australia	Overo colorado	Tray	Cloned	28.0

The national currency values (Chilean pesos) were converted to dollars using the average 2014 value ($570.43/US$).

Los valores en moneda nacional (pesos chilenos) fueron convertidos a dólares usando el valor promedio de 2014 ($570,43/US$).

This allowed the number of stimuli to be reduced to twelve with one specification for each attribute. The stimuli were presented to respondents on cards with verbal information. The evaluation techniques commonly used in CA are classification by ranking and rating. The former, in which the respondent is asked to order the stimuli from the most to the least preferred, has the advantage of being easier for the respondent to express the magnitude of preference given the reduced number of stimuli (less than 20 as in this study).

The main disadvantage, however, lies in the difficulty of its application, because the ordering process is normally done by classifying cards with the stimuli and this procedure can only occur by means of a personal interview.

In the classification by rating, the respondents must evaluate the stimuli by assigning a score (*e.g.* using a scale from 1 to 10) for each of the stimuli, related to the degree of preference for the stimulus. Its ease of application is one of its main advantages; nevertheless, respondents can be less discriminating in their opinions than they would be with a ranking (16).

In relation to the results obtained with each technique, Sayadi *et al.* (2005) concluded that both techniques are equally valid when it comes to detecting the ordinal structure of preferences. However, these authors found the ranking method reveals more intensely the differences between levels than the rating method. In addition, they found the utility model obtained by the rating method represents the preferences expressed better than the ranking method (26).

Considering the advantages of the ranking evaluation and given that this study consisted of a personal interview, this evaluation technique was chosen. Thus, each participant ranked twelve cards from most to least preferred using a scale from 1 to 12 (1 = most preferred; 12 = least preferred).

Prior to asking the respondents to put the cards in order, the following definitions were read to them: "A GM organism is that in which the genetic material (DNA) has been altered in a way that does not occur naturally. It allows selected individual genes to be transferred from one organism to another, even between non-related species" (36); "Cloning is the process of multiplying single organisms by means of asexual reproduction to create a population of identical individuals" (12).

Statistical analysis

A conjoint analysis was carried out using the TRANSREG procedure by SAS (SAS Institute Inc., Cary, NC, USA). The relative importance consumers gave to the different attributes and the utility values obtained for each level of the selected factors were determined.

The root mean square error (RMSE) was calculated to measure the difference between the observed and the predicted data. An independent sample t-test was applied to investigate potential significant differences in the mean responses for USt and WA.

A hierarchical cluster analysis was chosen to determine consumer segments according to the partial utility scores of the attribute levels. A cluster analysis was carried out separately on the USt and WA subsamples. Ward's procedure, which calculates the squared Euclidean distance, was carried out using the CLUSTER procedure by SAS. To describe the segments, Pearson's Chi-square (χ^2) test was applied to the discrete variables and a one-factor analysis of variance to the continuous variables (99% and 95% confidence level).

Since Levene's statistic indicated non-homogeneous variances in all of the continuous variables analyzed,

the variables for which the analysis of variance resulted in significant differences (P<0.001) were subjected to Dunnett's T3 multiple comparisons test.

Results and discussion

Table 2 shows the sample description. The sample was balanced according to gender, and was composed principally of people residing in urban areas, people from the ABC1 and C2 socio-economic groups, and people belonging to families where the head of the household had a high-school education.

The greatest proportion of participants consumed beef two or three times a week. A large number of respondents stated they knew the meaning of cloned or GM. The mean score of the SWFL in the total sample was 24.6 (SD=3.76) from a theoretical maximum of 30.

Table 2. Description of the sample in percentages. Temuco, Chile. August, 2013.
Tabla 2. Características de la muestra (%). Temuco, Chile. Agosto de 2013.

	Composition	**Total sample (n = 400)**	**University students (n = 200)**	**Working adults (n = 200)**	**P-value**
Gender	Male	49.5	55.5	43.5	0.016[a]
	Female	50.5	44.5	56.5	
Residence	Urban	81.8	86.5	77.0	0.014[a]
	Rural	18.3	13.5	23.0	
Socio-economic status	ABC1	39.3	36.5	42.0	0.261[a]
	C2	40.5	40.0	41.0	
	C3	12.0	14.0	10.0	
	D-E	8.3	9.5	7.0	
Education	Primary school	5.5	6.0	5.0	0.568[a]
	High school	37.0	36.0	38.0	
	Tech degree	28.5	30.5	26.5	
	Undergraduate	29.0	27.5	30.5	
Age	Mean age	31.8	23.7	40.0	0.000[b]
Frequency of beef consumption	No consume	3.2	4.5	2.0	0.013[a]
	Daily	17.5	16.0	19.0	
	2-3 times/week	56.8	50.5	63.0	
	1 time/week	17.8	22.0	13.5	
	Occasionally	4.0	5.5	2.2	
	Other frequency	0.8	1.5	0.3	
Do you know what it means when an animal is cloned	Yes	97.5	98.5	96.5	0.200[a]
	No	2.5	1.5	3.5	
Do you know what it means when an animal is GM	Yes	86.3	93.0	79.5	0.000[a]
	No	13.8	7.0	20.5	
SWFL	Mean score	24.5	24.5	24.7	0.474[b]

[a] P value corresponds to the (bilateral) asymptotic significance obtained in Pearson's Chi-squared test.
Valor P corresponde a la significancia asintótica (bilateral) obtenida en Prueba Chi [2] de Pearson.

[b] P value correspond to Student's t-test for related samples (paired).
Valor P corresponde a la prueba t de Student para muestras relacionadas. GM: genetically modified.

The RMSE of the conjoint analysis was 0.18, which indicated a good goodness-of-fit (18). According to the conjoint analysis (table 3) for the entire sample, the attribute of greatest importance during the purchase process was the production technology, followed by the price, country of origin, package, and finally the breed.

The greatest importance being assigned to production technology is consistent with previous studies that have assessed the acceptance of foods produced conventionally and with new food production technologies, as is the secondary importance of the price (26-40).

Table 3. Relative importance for overall sample and subsamples based on preferences for beef produced conventionally, by cloning or by GM.

Tabla 3. Importancia relativa correspondiente a la muestra total y a las submuestras basadas en las preferencias hacia carne bovina producida en forma convencional, mediante clonación o genéticamente modificada.

Attribute and Levels	Total sample (n = 400)	University students (n = 200)	Working adults (n = 200)	P-value
Origin				
Argentina	0.799	0.990	0.608	0.004
Brazil	0.026	-0.105	0.156	0.004
Australia	-0.824	-0.885	-0.764	0.367
Relative importance (%)	17.3	14.3	15.1	0.054
Breed				
Angus	-0.191	-0.139	-0.243	0.371
Overo Colorado	-0.084	-0.189	0.021	0.035
Wagyu	0.274	0.328	0.221	0.391
Relative importance (%)	14.7	18.5	16.0	0.387
Package				
Tray	-0.421	-0.352	-0.491	0.196
Cut	0.239	0.170	0.308	0.270
Vacuum packing	0.182	0.182	0.183	0.992
Relative importance (%)	15.6	15.4	15.8	0.765
Production Technology				
Conventional	1.684	1.522	1.847	0.125
GM	-0.919	-0.653	-0.877	0.626
Cloned	-0.765	-0.868	-0.970	0.142
Relative importance (%)	33.7	33.8	33.6	0.915
Price				
Low	0.529	0.465	0.593	0.387
Medium	0.092	-0.038	0.224	0.028
High	-0.622	-0.427	-0.819	0.004
Relative importance (%)	18.8	18.0	19.5	0.240

P value correspond to Student's t-test for related samples (paired). GM: genetically modified.
Valor P corresponde a la prueba t de Student para muestras relacionadas. GM: genéticamente modificado.

The greater importance assigned to production technology over the food's country of origin is also confirmed (28).

The signs of the utility values indicate consumers preferred the beef imported from Argentina and Brazil (greatest preference for Argentinean beef), cut or vacuum-packed (greater preference for cut meat), from the Wagyu breed, at the lowest price.

The preference for the Argentinean product suggests that Chilean consumers perceive foods from that country positively in agreement with previous studies that indicate a preference for oil (28) and beef (30) imported from Argentina. In the case of beef, this can be associated with the management used in beef production there (15).

Consumers preferred beef from a conventional animal and rejected meat from cloned or GM animals. This result makes it possible to accept hypothesis 1, which is consistent with the results of previous studies that have assessed the acceptance of GM foods (20, 21, 27, 28, 32) and cloned foods (3, 7, 8, 32, 34) in both developed and developing countries. Nevertheless, in the case of GM foods, it contradicts the results of studies carried out both in developing (8) and developed countries (6).

In China De Steur *et al.* (2010) found consumers generally willing to accept GM foods. Cox *et al.* (2011) reported in a US sample that consumers reported preferences for milk from cows fed with GM oilseed. One remarkable aspect is the agreement with the results from a previous study conducted in Chile (32), in which respondents preferred milk from a conventional cow and rejected milk from a cloned or GM cow. This seems to indicate that, generally, consumers reject the use of these technologies in the production of food of animal origin. In this vein, De Barcellos *et al.* (2010) concluded that invasive technologies tending to deviate from conventional production practices are widely rejected.

In contrast to what was expected, significant differences were only detected between the subsamples in the preference for beef imported from Argentina and Brazil and in the preference for mid-range and high prices ($P \leq 0.05$) and not in the preferences for beef from a conventional, GM or cloned animal. These results mean that hypothesis 2 is rejected, and contradicts studies indicating that young people have a more positive attitude to GM foods (25, 37), those obtained from cloned animals (5) and towards beef new technologies in general (7).

However, it is consistent with a study conducted in the US, which reported that age did not affect attitudes and intention to purchase GM foods (38). It also agrees with a previous study in Chile, where no differences were observed in age with respect to the preference for milk from a conventionally bred animal or in the rejection of the product obtained from a cloned or GM animal (32). Therefore, the results of this study suggest that the general acceptance of foods derived from GM or cloned bovine animals is negative among consumers in southern Chile, independently of the consumer's age or generation. These attitudes are noteworthy, because public acceptance may play a major role in determining the advancement of biotechnology (33).

The cluster analysis distinguished three consumer segments in both subsamples. In the USt subsample the groups differed significantly in terms of preference for almost all attribute levels ($P \leq 0.001$ or $P \leq 0.05$), except in the preferences for Wagyu beef, packaged on a tray and at

the mid-range price (P>0.1) The groups also differed in terms of the importance assigned to all the attributes (P≤0.001) (table 4, page 152). These groups differed significantly (table 5, page 153) only in terms the frequency of beef consumption (P≤0.001):

Sensitive to the price and technology, rejection of cloning. Group USt 1 (27.5%)

This group assigned greatest importance to the production technology, but stood out as being the group that gave significantly greater importance to the price, and showed the strongest preference for the lowest price, significantly higher than the other groups. They preferred beef from a conventional animal, although significantly less than Group 3. It stood out as the group with the greatest rejection of beef from a cloned animal. It is also had a significantly stronger preference for beef imported from Brazil, from the Overo Colorado breed and vacuum-packed (table 4, page 152). This group was mainly composed of students who eat beef daily (32.7%) (table 5, page 153).

Sensitive to the country of origin, rejection of conventional beef. Group USt 2 (41.0%)

This group placed greatest importance on the country of origin and showed the greatest preference for beef imported from Argentina, significantly more than the other groups. This group stood out for the significant rejection of beef from a conventional animal and a significantly greater preference for meat from a GM or cloned animal. It was also distinguished for the significantly stronger preference for Angus beef and for the highest price, although it did not differ statistically from Group 3 in the price (table 4, page 152). This group was composed of a higher proportion of students that consumes beef two to three times a week (table 5, page 153).

Sensitive to the technology, rejection of GM. Group USt 3 (31.5%)

This group assigned significantly greater importance to the production technology and showed a significantly greater preference for beef from a conventionally bred animal. Although it rejected both types of unconventional beef, it stood out for a greater rejection of beef from a GM animal. This group was also noted for the greater preference from cut meat, although it did not differ significantly from Group 2 (table 4, page 152).

In the WA subsample the groups differed significantly in terms of preference for almost all attribute levels (P≤0.001 or P≤0.05), except in the preferences for beef imported from Brazil, packaged on a tray and at the mid-range price.

The groups also differed in terms of importance assigned to all the attributes (P≤0.001 or P≤0.05) (table 4, page 152). These groups did not present any statistical differences according to any sociodemographic or consumption variable (P>0.1).

Sensitive to price. Group WA 1 (21.5%)

This group gave greatest importance to the price and showed a significantly greater preference for the lowest price. It showed a similar trend to the total sample in terms of the preference for beef produced with different technologies. It stood out for having the strongest preference for Wagyu beef and for the significantly greater preference for vacuum-packed beef (table 4, page 152).

Table 4. Distribution and relative importance of clusters in both subsamples based on preferences for beef produced conventionally, by cloning or by GM.

Tabla 4. Distribución e importancia relativa de los clusters en ambas submuestras basada en las preferencias hacia carne bovina producida en forma convencional, clonada o genéticamente modificada.

	University students					Working adults				
Attribute and Levels	**Group 1 (n=55, 27.5%)**	**Group 2 (n=82, 41.0%)**	**Group 3 (n=63, 31.5%)**	**F**	**P-value**	**Group 1 (n=43, 21.5%)**	**Group 2 (n=77, 38.5%)**	**Group 3 (n=80, 40.0%)**	**F**	**P-value**
Origin										
Argentina	0.270 b	1.682 a	0.718 b	23.311	0.000	0.237 b	1.157 a	0.278 b	13.577	0.000
Brazil	0.136 a	-0.265 b	-0.106 b	3.035	0.050	-0.109	0.236	0.223	2.742	0.067
Australia	-0.406 a	-1.417 b	-0.611 a	12.446	0.000	-0.128 a	-1.393 b	-0.500 a	17.327	0.000
Relative importance (%)	12.5 b	24.8 a	15.5 b	21.131	0.000	11.3 b	22.9 a	12.0 b	21.467	0.000
Breed										
Angus	-0.679 b	0.139 a	-0.029 a	9.284	0.000	-0.654 b	-0.140 a	-0.120 a	3.583	0.030
Overo Colorado	0.303 a	-0.349 b	-0.412 b	10.028	0.000	-0.070 ab	0.256 a	-0.155 b	3.698	0.027
Wagyu	0.376	0.209	0.442	0.744	0.476	0.725 a	-0.116 b	0.275 ab	6.110	0.003
Relative importance (%)	13.0 ab	17.6 a	11.2 b	10.618	0.000	18.9 a	15.6 a	12.5 b	8.333	0.000
Package										
Tray	-0.190	-0.513	-0.285	1.702	0.185	-0.323	-0.654	-0.425	1.561	0.213
Cut	-0.125 b	0.145 ab	0.462 a	3.544	0.031	-0.433 b	0.626 a	0.400 ab	10.868	0.000
Vacuum packing	0.315 a	0.368 a	-0.177 b	3.698	0.027	0.756 a	0.027 b	0.025 b	5.815	0.004
Relative importance (%)	12.8 b	20.3 a	11.4 b	19.000	0.000	18.3 a	16.9 a	13.3 b	4.002	0.020
Production Technology										
Conventional	2.343 b	-0.635 c	3.612 a	207.340	0.000	0.870 b	0.727 b	3.453 a	80.477	0.000
GM	-0.442 b	0.531 a	-3.061 c	116.235	0.000	-0.532 b	0.893 a	-3.000 c	227.843	0.000
Cloned	-1.901 c	0.105 a	-0.551 b	37.078	0.000	-0.338 a	-1.620 b	-0.453 a	18.653	0.000
Relative importance (%)	35.0 b	20.6 c	49.8 a	76.569	0.000	17.5 c	28.4 b	47.2 a	64.052	0.000
Price										
Low	1.467 a	-0.034 b	0.241 b	24.644	0.000	2.151 a	0.027 b	0.300 b	39.469	0.000
Medium	0.136	-0.069	-0.149	0.878	0.417	0.188	0.160	0.305	0.324	0.724
High	-1.602 b	0.103 a	-0.091 a	32.009	0.000	-2.340 b	-0.187 a	-0.605 ab	39.407	0.000
Relative importance (%)	26.7 a	16.6 b	12.1 b	24.036	0.000	34.0 a	16.3 b	15.0 b	37.937	0.000

Root-mean-square error (RMSE) = 0.18. Different letters on the line indicate significant differences according to Dunnett's T3 multiple comparisons test ($P \leq 0.05$). GM: genetically modified.

Letras distintas en una misma fila indican diferencias estadísticamente significativas según Prueba de Comparaciones Múltiples T3 de Dunnett ($P \leq 0,05$). GM: genéticamente modificado.

Table 5. Characteristics with significant differences (Chi^2) in groups (%) identified by cluster analysis in the university student subsample.

Tabla 5. Características de los segmentos identificados (%) con diferencias estadísticas (Chi^2) entre ellos obtenidas con análisis cluster en la submuestra de estudiantes universitarios.

Characteristic	Group 1 (n=55, 27.5%)	Group 2 (n=82, 41.0%)	Group 3 (n=63, 31.5%)
Frequency of beef consumption		**P=0.001**	
Do not consume	3.6	2.4	7.9
Daily	32.7	9.8	9.5
2-3 times/week	32.7	64.6	47.6
Once a week	27.3	18.3	22.2
Occasionally	1.8	4.7	9.5
Other frequency	1.8	0.2	3.2

P value corresponds to the (bilateral) asymptotic significance obtained in Pearson's Chi-squared test.
Valor P corresponde a la significancia asintótica (bilateral) obtenida en Prueba Chi ^{2} de Pearson.

Sensitive to the country of origin, preference for GM beef. Group WA 2 (38.5%)

This group assigned high importance to the production technology, although it was distinguished as being the group that gave the greatest importance to the country of origin and showed the strongest preference for Argentinean beef. This group was also the only one that preferred beef from a GM animal and significantly rejected meat from a cloned animal (table 4, page 152).

Sensitive to the technology, rejection of GM. Group WA 3 (40.0%)

This group assigned the greatest importance to the production technology, significantly higher than the other groups. They showed to the greatest preference for beef from a conventional animal and the greatest rejection of GM (table 4, page 152).

The results of the cluster analysis mean that hypothesis 3 can be accepted, but at the same time hypotheses 4 and 5 are rejected, because the segments identified in each subsample did not differ in demographic characteristics or according to level of satisfaction with food-related life. Although these results contradict studies that report differences in the acceptance of foods obtained from GM or cloning associated with the consumer's gender and level of education (27, 33, 37), they confirm the results of studies that found that acceptance of GM foods (20) and food obtained from cloned animals (32) is not related to consumer socio-demographic characteristics in either developed or developing countries.

With respect to satisfaction with food-related life, the result here contradicts a previous study that reported people with a high level of satisfaction with food-related life as being more receptive to the use of nanotechnology in food production (29), but agrees with a recent investigation in which no association was found between the acceptance of milk obtained from a cloned or GM cow and the level of satisfaction with consumers' food-related life. Therefore, it is possible that the existence of a relationship between satisfaction with food-related

life and acceptance of new technologies applied to food production depends on the type of technology being evaluated.

In terms of the respondents' preferences, in both subsamples there was one segment sensitive to production technology, which showed a strong preference for beef from a conventionally bred animal and a greater rejection of GM (USt subsample: 31.5%, WA subsample: 40.0%). These results vary from those of a previous study on milk, in which both working adults and university students were separated into two consumer segments sensitive to the production technology that differed in the level of rejection of cloning and GM (32).

In addition, in this study both subsamples revealed a consumer segment sensitive to the price, with a strong preference for the lowest. However, while the segment sensitive to the price in the USt subsample (27.5%) was also sensitive to the production technology (strongly rejecting cloning), the group sensitive to the price in the WA subsample (21.5%) assigned low importance to this attribute.

In both subsamples a segment sensitive to the country of origin was also distinguished, which confirms the importance of this attribute in the decision to purchase beef (30). Both segments agreed in the greater preference for beef imported from Argentina and in the acceptance of beef from a GM animal, but they differed in the importance assigned to the production technology and in the preference for beef from a conventionally bred or cloned animal.

For the group sensitive to origin in the USt subsample (41.0%) the importance of the production technology was secondary, but for the group sensitive to origin in the WA subsample (38.5%) the production technology was the most relevant attribute in the decision to purchase. In the WA subsample (38.5%) the consumers sensitive to origin showed a preference for beef from a conventionally bred animal and strongly rejected beef from a cloned animal. By contrast, the group sensitive to origin in the USt subsample (41%) was the only one that rejected beef from a conventionally bred animal and showed acceptance of beef from a cloned animal. It is worth noting that both groups sensitive to origin showed acceptance of beef from a GM animal. Therefore, independent of the age, the segments sensitive to the origin of the beef were more positive about new production technologies. Therefore, companies endeavoring to introduce animal meat produced with these technologies onto the Chilean market in the future should target this type of consumer in their marketing strategy.

Therefore, even though the overall test of differences between the subsamples, in their preferences for the technology associated with the animal from which the beef was obtained, did not yield any significant differences, the results of the cluster analysis suggest a greater rejection of GM and cloning among the WA subsample. Although the segments that rejected beef from a GM animal represent a proportion close to 60% in both subsamples (USt Groups 1 and 3: 59.0%; WA Groups 1 and 3: 61.5%), if only the groups with a strong rejection of GM are considered, the proportion is 40.0% (Group 3) in the WA subsample and 31.5% (Group 3) in the USt subsample. In the case of cloning, while the proportion of rejection in the USt sample reached 59.0% (Groups 1 and 3), in the WA subsample the three segments identified rejected it. In addition, in both subsamples there was a segment which strongly rejected cloning, which reached 27.5% in the USt subsample

(Group 1), but bordered on 40% in the WA subsample (Group 2, 38.5%).

One noteworthy result is the preference for beef from a cloned or GM animal and the rejection of beef from a conventionally bred animal in the segment sensitive to origin in the USt sample (Group 2, 41.0%), which indicates a more positive attitude on the part of young people to the consumption of beef from animals obtained with these new technologies. This result differs from a previous study, in which all the consumer segments identified preferred milk from a conventionally bred animal (32). Therefore, it can be suggested that acceptance of cloning and GM in animal production may be associated with the food, a result consistent with a previous study in Europe (24), which revealed greater acceptance of GM red meat than GM milk. At the same time, the results of this study make it possible to expect a more positive attitude to new production technologies applied to beef production in the future in southern Chile, when the current USt are in charge of food purchases for their households.

Finally, the differences in the consumption frequency of beef in the USt sample seem to confirm that the preferences for GM foods are related to food consumption habits (32). Nevertheless, it is also possible to associate them with sensitivity to the price because Group 1 reported a greater daily consumption of beef and the strongest preference for the lowest price.

From the perspective of developing marketing strategies for each production technology, in the USt subsample Groups 1 (27.5%) and 3 (31.5%) are attractive market segments for the marketing of conventionally produced beef. Although in both groups the marketing mix should emphasize the traditional nature of production on the package or label, these segments should be addressed with a differentiated marketing strategy.

For successful marketing in Group 1, the marketing mix must emphasize a lower price, which could, however, be unattractive for companies or producers who wish to differentiate themselves by the traditional or natural nature of their product. In relation to the product, the meat should be marketed in vacuum packing. By contrast, the marketing mix aimed at Group 3, the most attractive segment for meat produced traditionally due to its greater size and low sensitivity to price, should consider Argentinean beef, marketed based on the cut and offered at a price above that of the competition. Group 2 (41.0%), on the other hand, would make an attractive alternative for the market introduction of beef obtained from GM and cloned animals. In terms of product, Argentinean beef would be well received and should be marketed in vacuum packing that would highlight the origin of the product. It would also be feasible to differentiate it by indicating the breed of the animal and setting a higher price.

Likewise, in the WA subsample Groups 1 (21.5%) and 3 (40.0%) are the most attractive market segments for conventional beef, whereas Group 2 (38.5%) is seen as a possible alternative for the introduction of beef obtained from GM animals. Similar to what was proposed for the USt subsample, the marketing mix aimed at Groups 1 and 3 of the WA subsample should emphasize the traditional nature of production on the package or label. However, to access Group 1 successfully, it is also relevant to offer a low price, to market the meat in vacuum packing and differentiate it by the breed of the animal. In the marketing mix of Group 3, which is more attractive due to its size, the meat

must be marketed based on the cut, and a higher price would be possible, which makes it more attractive for producers and businesspeople. To access Group 2 successfully, in terms of product the beef could come from a GM or traditional animal, but the Argentinean origin of the meat must stand out. In this respect, although in this group it is recommended that the meat be marketed based on the cut, retailers must be able to present its origin.

Limitations of this study include the non-probabilistic nature of the sample, which does not allow generalization of the results. At the same time, the sample is not representative of the country's population distribution. Also, all data were self-reported, thus responses may be affected by social desirability and recall or response bias. Another limitation of the study is the small size of the consumer segments, which stands out when the two subsamples are studied separately. Therefore, future investigations must include either larger samples or samples of similar size but where the variables USt and WA are used as a characteristic that identifies the profile of the possible market segments.

Conclusions

In southern Chile, using a sample of WA and USt, it was found in general that respondents preferred beef from a conventionally bred animal and rejected beef from a cloned or GM animal. Although a comparison of the preferences for technologies associated with animals revealed no differences between WA and USt, the cluster analysis performed separately on both subsamples showed that a greater proportion of WA rejects GM and cloning, whereas a significant proportion of the USt viewed beef from a GM or cloned animal positively.

Nevertheless, in both subsamples the consumer segments sensitive to the origin of the beef were positive to meat from a GM animal. Therefore, the existence of market segments in which the introduction of beef from a GM or cloned animal could be successful bodes well for the research bodies and companies currently investing in these production technologies. At the same time, the existence of market segments in both subsamples with a strong rejection of cloning and others of GM arise as opportunities for producers and entrepreneurs from the beef industry who can differentiate their product for its natural character (organic production, animal well-being, natural meat, etc.).

From a research point of view, it is important to emphasize the need to study market behavior in segmented form and not to rest on the results of the total sample or the comparison between people who share a characteristic, such as the difference in age in this study.

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