Perception, knowledge and consumption preference of meat products produces with animal welfare in veterinary students

Percepción, conocimiento y preferencia de consumo de producto cárnico producido con bienestar animal en estudiantes veterinarios

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ABSTRACT

The present study aimed to evaluate the perception, knowledge, and consumption preferences of veterinary students regarding meat products produced according to the five freedoms of animal welfare (AW) using a questionnaire. A cross-sectional study was conducted with 244 veterinary students. A survey was applied through a virtual form with a Likert-type scale. A varimax-rotated principal component analysis was performed. Cronbach's alpha was 0.96 and content validity was 0.85. Bartlett's sphericity test was significant ($p < 0.0001$). Forty-eight percent of the students participated. No differences were observed by gender or professional interest, but differences were observed by educational core. The chicken was the most consumed meat, but if the price per kilogram were similar, the preference for meat consumption would have the following hierarchy: beef > chicken > pork > fish > sheep > goat > turkey. 46 % had a positive perception of animal welfare as an attribute to be incorporated into meat during the production process. 77 % had a positive perception of the inclusion of Animal Welfare in the labeling process. 82 % had a high level of knowledge about this system. In conclusion, the questionnaire presents validity and reliability to be replicated in similar studies. The students prefer meat with AW, perceive, and have knowledge about the meat produced.

KEY WORDS: animal welfare, meat consumption, questionnaire, validation studies.

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R E S U M E N

El objetivo del presente estudio fue evaluar la percepción, conocimiento y preferencia de consumo en los estudiantes veterinarios sobre el producto cárnico producido mediante las cinco libertades del bienestar animal a través de un cuestionario. Se realizó un estudio transversal con 244 estudiantes de Veterinaria. Se aplicó una encuesta mediante un formulario virtual con escala tipo Likert. Se efectuó un análisis de componentes principales con rotación Varimax. El alfa de Cronbach fue de 0.96 y la validez de contenido fue de 0.85. La prueba esfericidad de Bartlett fue significativa ($p < 0.0001$). Participó el 48 % de estudiantes. No se observaron diferencias en función del género o área laboral de interés, pero si por núcleo de formación. La carne de pollo fue la más consumida, pero sí el precio por kilogramo fuera similar, la preferencia del consumo de carne tendría la siguiente jerarquía: bovina > pollo > porcina > pescado > ovina > caprina > pavo. El 46 % tuvo una percepción positiva del Bienestar Animal como atributo a incorporar en la carne, durante el proceso de producción. El 77 % consideró positiva la incorporación de Bienestar Animal en el proceso de etiquetado. El 82 % tuvo un alto conocimiento sobre este sistema. En conclusión, el cuestionario presenta validez y fiabilidad para replicarse en estudios similares. Los estudiantes prefieren carne con AW, perciben y poseen conocimientos sobre la carne producida.

P A L A B R A S   C L A V E : Bienestar animal, consumo cárnico, cuestionario, estudios de validación

Introduction

The Mexican population is expected to reach 126 million in 2020, with an increase of 3.5% over the next four years (INEGI, 2021). In 2018, meat consumption was 65 kg *per capita* (beef, chicken, and pork), placing Mexico in sixth place worldwide (CMC, 2018; UNA, 2021). There are psychological, sensory, and market motivations (Font-i-Furnols & Guerrero, 2014) that promote meat consumption among Mexicans, such as family tradition, ease of preparation, price, education level, and income (Miranda-de la Lama *et al.,* 2017; Ngapo *et al.,* 2017; Tellez-Delgado *et al.,* 2016). However, society demands production models that are more ethical towards the treatment of animals. There is growing interest in the transition from traditional systems to those with sustainable practices in the livestock food production chain. In addition, meat products have been promoted to have a seal for the incorporation of animal welfare (AW) practices. Some companies have declared that, in the coming years, they will only buy meat products from animals that live in free-range pastures (Molina, 2021). AW ensures the proper functioning of the organism (nutrition and health), monitors the emotional state (absence of negative emotions such as pain and fear), and promotes the natural behavioral patterns of the species (OIE, 2021a; OIE, 2021b).

The objectives of animal production include food safety, food quality, environmental protection, and good animal welfare. In developed countries, there is a greater concern about AW. These countries offer products with descriptive quality labels and references to the treatment of animals during rearing and slaughter. Despite legal and union efforts, there are few studies in Mexico that relate the meat product to AW, which is a desirable attribute to include.

Historically, livestock production systems have maintained a strong social and cultural component in human communities. Young consumers are looking for added value in the products they consume, including the social responsibility of brands. Ringquist et al. (2016) remark that consumers want meat products that are affordable, tasty, and convenient, and include transparency factors that companies care about more than profits, such as safety, health, AW, and sustainability impacts. Production systems should seek product differentiation schemes focused on intrinsic and extrinsic attributes and animal species that contribute to the characterization of the desired product and the payment of the corresponding value (Mondragón-Ancelmo *et al.,* 2018).

The production decisions of young veterinarians can have a positive impact on AW. It is important to promote a market with the availability of products that integrate AW practices. However, there is little information on the opinion of young veterinarians in Mexico regarding the perception of AW as an attribute to be incorporated in meat, knowledge of production units certified in Mexico with AW practices, and preference for meat consumption by animal species (Miranda-de la Lama *et al.,* 2017). The perception of veterinary students is fundamental since they will have to apply good production and AW practices. Given this background, it is necessary to evaluate the instruments used to estimate the validity and reliability (Ventura-León & Caycho-Rodríguez, 2017). Ringquist *et al*. (2016) emphasized that cultural adaptation and validation are essential when dealing with questionnaires developed in other countries and languages. The present work presented a basis for the development and validation of a questionnaire that included the perception of AW as an attribute to be included in meat, in addition to the knowledge of certified production units in Mexico with AW by animal species and the opinion of veterinary and zootechnical students.

Material and Methods

Participants and procedures

A cross-sectional study was conducted using non-probability sampling directed at the entire student community of the Facultad de Medicina Veterinaria y Zootecnia (FMVZ) "Dr. Norberto Treviño Zapata" of the Universidad Autónoma de Tamaulipas (UAT), from March to April 2021. All students were invited to participate voluntarily by e-mail. All responses were confidential with informed consent.

The questionnaire, validity, and reliability

The questionnaire was constructed with Google Forms, with access through the web link (https://drive.google.com/open?id=1f5S1dNoYEmSqJnzBPBWNedrdvdgDdBqMZtzQ3_gkSuI) and QR codes from a Gmail account, based on reported studies (Kjaernes & Lavik 2007; Mazas *et al.,* 2013).

In the first block of questions (n=9), socioeconomic information was obtained from the surveyed students: gender (Fe: female and Ma: male), desired area of interest in professional practice (AP: production and AM: medicine), parental economic dependence, number of family members, monthly family income, family expenditure for meat consumption, the person who buys meat. By counting the participating students according to their professional advancement, the training nucleus (TN) was obtained. Basic: (first to third semester); Disciplinary: (fourth to sixth semester) Professionalization: (seventh to tenth semester). The second block consisted of questions (n=20) on the perception of AW as an attribute to be incorporated in meat during the production process on a Likert-type scale (1: totally disagree; 2: partially disagree; 3: neither agree nor disagree; 4: partially agree and 5: totally agree). The third block (n=9) included questions on the perception of AW as an attribute to be included in the meat during the labeling process on a Likert-type scale (1: strongly disagree to 5: strongly agree). The fourth block (n= 9) consisted of questions on the knowledge of production units certified in Mexico with animal welfare (1: low, 2: medium, 3: high). The fifth block (n= 23) dealt with the preference for meat consumption due to the attributes or characteristics present on a Likert scale (1: totally disagree to 5: totally agree).

Content validity

The questionnaire items were evaluated by expert judgment (Escobar-Pérez & Cuervo-Martínez 2008; Mazas *et al.,* 2013). Each expert answered nine questions related to the content of the questionnaire with a Likert scale from 1 to 5 (1: strongly agree; 2: disagree; 3: not sure; 4: agree; 5: strongly agree), as described by Marquez-Sandoval *et al.* (2014). Then, the content validity index was calculated, as indicated by Hernández-Nieto (2002) using the formula proposed by Pedrosa *et al.* (2014).

$$\text{CVC} = \text{CVC}_i\text{-Pei}$$

CVC_i = Validity coefficient for each reagent

Pe_i = error assigned to each reagent

The method of Hernández-Nieto (2002) assesses the degree of agreement between the judges for each item and requires a minimum of three (Pedrosa *et al.,* 2014); likewise, these authors recommend maintaining the content validity coefficient (CVC) higher than 0.80, according to the proposed formula.

The validation process

Reproducibility, validity, and internal consistency was completed with the application of the peer-reviewed instrument to a pilot group (n=50). Validity was calculated as a measure of sampling adequacy with the Kaiser-Meyer-Olkin (KMO) test (Mazas *et al.,* 2013). The KMO contrasts the partial correlations between variables and can be used to determine whether the variables have an invariant dimensional structure. The KMO statistic varies between 0 and 1. A value less than 0.5 indicates that the correlation between these variables is not sufficiently significant. Bartlett's sphericity test was performed (Mazas *et al.,* 2013), which contrasts the null hypothesis of the correlation matrix of the variables, in which case said variables are not correlated. The analysis of internal consistency or reliability was carried out using Cronbach's α coefficient (Ledesma *et al.,* 2002; Mazas *et al.,* 2013), considering an index higher than 0.70 as respectable.

Data Analysis

Exploratory factor analysis was used to describe the total sample variation by reducing the original data set dimension, minimizing the loss of information by transforming a set of correlated response variables into a new set of uncorrelated variables (Herrera-Haro & García-Artiaga, 2019). The obtained responses in Google Forms were downloaded to a database (csv) and saved as an Excel spreadsheet, xlsx, Microsoft package, version 2016. SPSS v.25 statistical software was used for data analysis, and significance was declared with a *p-value < 0.05*. In the descriptive analysis, quantitative variables were expressed as mean (standard deviation) and the t-test was used to assess differences between these variables. Qualitative variables were expressed as frequencies (percentages).

Results

The questionnaire was classified from good to excellent, with a score of 0.85 in the expert judgment (Table 1). Similarly, the average score of 38.5 (out of 45 possible points, n= 4) was obtained according to the methodology of Marquez-Sandoval *et al*. (2014). By transforming the score of 45 to 100% and obtaining the corresponding index of the total score, an index of 0.85 was calculated.

Table 1. Determination of the logical and content validity of the questionnaire.

	I¥	II¥	III¥	IV¥	Sx1	M_x	CVC_i	Pe_i	CVC
Score	42	37	45	30	154	3.42	0.86	0.004	0.85

I¥: Expert 1; II¥: Expert 2; III¥: Expert 3; IV¥: Expert 4; Sx1: sum of the judges' scores; Mx: the mean of the item in the score given by the experts; CVC_i: Coefficient of content validity of the item; Pe_i: error assigned to each item; CVC: Coefficient of content validity.

The results showed that the overall KMO of the questionnaire maintained a high significant correlation (0.80) and therefore the questionnaire was valid for use in future studies. Also, it was observed that the correlation matrix of the variables was related by showing significance in Bartlett's test of sphericity (p = 0.0001).

The reliability of the questionnaire obtained a Cronbach's alpha greater than 0.90, except for the degree of knowledge block (0.63). The factor analysis showed a total variance explained greater than 75%, except for the degree of knowledge block (62%) (Table 2).

Table 2. Exploratory factorial analysis of the questionnaire applied to veterinary students.

PC	V	VEP (%)	VA (%)	KMO	B	α C
Block 1: Perception of animal welfare as an attribute to be incorporated into meat during the production process (n = 20)						
I.- AW	13.75	68.79	68.79			
II.- Minimum standards	1.30	6.50	75.29	0.963	0.0001	0.9630
Block 2: Perception of animal welfare as an attribute to be incorporated into meat during the labeling process (n = 9)						
I.- AW Labeling	7.12	71.16	75.29	0.909	0.0001	0.9090
Block 3: Knowledge of certified production units in animal welfare students by component (n=9)						
I.- AW Seal	2.08	23.14	23.14			
II.- Hygiene and toxicological	1.35	15.00	38.15			
III.- Social quality	1.19	12.37	62.54	0.637	0.0001	0.6370
Block 4: Meat consumption preference due to meat attributes by component (n=23)						
I.- Nutritional and Sensory Factors	16.758	72.86	72.86			
II.- Market factors	1.25	5.44	78.31	0.964	0.0001	0.9640

PC: Principal components; V: Variance; VEP: Partially explained variance; VA: Cumulative variance; KMO: Kaiser-Meyer-Olkin test; B: Bartlett's test of sphericity;α C: Cronbach's alpha; AW: Animal welfare. * $p < 0.0001$.

Socioeconomic characteristics and meat preference of FMVZ students

The total enrollment of students was 508. A total of 244 (48%) participated in the study: of which 56% were female and 44% male (Table 3). There was no difference in participation according to gender (χ^2, $p = 0.073$). The percentage distribution of area of occupational interest (AOI) was also not different (χ^2, $p = 0.073$). The training core (TN) was different among the three groups (χ^2, $p = 0.0001$). Economically dependent students were 54% and independent students were 46% (χ^2, $p > 0.05$). The values of who buys meat: parents (71%), self (20%), and relatives (7%) (χ^2, $p < 0.05$).

On the other hand, household income was: 71% earned less than 480.7 USD; followed by 24% who reported an income between 480.7 and 961.5 USD per month and only 5% had a household income higher than 961.5 USD per month (χ^2, $p = 0.0001$). The number of household members was 4.5 ± 1.4. Fifty-four percent of the students were dependent on their parents for economic support. The frequency of meat consumption by species showed that chicken meat was the most consumed, more than three times a week (50%), followed by beef, consumed less than twice a week (48%). Sixty-five percent of the students reported in two years not having eaten turkey (χ^2, $p = <0.0001$). 53% (χ^2, $p = <0.0001$) sheep meat and goat meat 65% (χ^2, $p = <0.0001$).

Obtained data suggest that, if meat were equally priced per kilogram, meat consumption preference would have the following hierarchy, from highest to lowest: beef, chicken, pork, fish, sheep, goat, and turkey.

Table 3. Socioeconomic characteristics of veterinary students.

Descriptive variables		F	%	χ^2	*p-value*
Gender	1: Female	136	56	3.213	0.0730
	2: Male	108	44		
Area of interest	1: Production	108	44	3.213	0.0730
	2: Medicine	136	56		
Training nucleus	1: Basic	61	24		
	2: Discipline	124	51	33.598	<0.0001
	3: Professionalizing	59	25		
Are you economically dependent?	1: Yes	133	54	1.984	0.1590
	2: No	111	46		
Who buys the meat for consumption?	1: You	48	20		
	2: Spouse	2	1		
	3: Partners	2	1	430.426	<0.0001
	4: Parents	174	71		
	5: Family members	18	7		

Monthly family income[1]	1: Less than 480.7	174	71		
	2: Between 480.7 and 961.5	57	24	170.270	<0.0001
	3: More than 961.5	13	5		

[1] Monthly family income expressed in U.S. dollars. * *p < 0.0001*.

Perception of animal welfare during the production process.

The results on AW showed that 46% of the students had a positive perception (Figure 3A). However, 39% considered a negative one and 15% were neutral (χ^2, *p = 0.0083*). In the occupational area of interest, it was observed that 25% of students in the area of medicine (AM) considered it harmful to incorporate AW as an attribute, these agreed with 14% of respondents in the area of animal production (AP). The neutral response of students with interest in the AM area was lower (5%) compared to the AP group (10%) (χ^2, *p = 0.0083*). Both groups (AP 21% and AM 25%) had a positive response totaling 46%. Both GE and TN had significant differences in the perception of well-being (χ^2, *p = 0.2014* and χ^2, *p = 0.5537*). The perception in the factor analysis by components is shown in Table 4. The female gender favored the incorporation of AW as an attribute of the meat for the production process, compared to the male gender (*Wilcoxon, p = 0.048*). The students that formed the basic NT agreed (*Kruskal-Wallis, p = 0.0076*) with respect to the other cores in the incorporation of AW as an attribute.

Animal welfare during the labeling process.

Students were largely positive about the inclusion of AW information as an attribute of meat in the labeling process (Figure 3B). Seventy-seven percent were positive, followed by 15% negative, and 7% neutral (χ^2, *p = 0.0001*). No differences were observed in relation to GE (χ^2, *p = 0.2581*) or by NT (*p > 0.05*). Nor in relation to AOI (χ^2, *p = 0.4506*). In the factor analysis by components, no differences were observed for GE (*Wilcoxon, p = 0.999*) or TN (*Kruskal-Wallis, p = 0.166*), but differences were observed for AOI (*Wilcoxon, p = 0.0152*; Table 4). Most students considered the incorporation of AW into the labeling process to be positive.

Table 4. Perception of AW as an attribute in the production and labeling process.

Component	GE		p-value	AOI		p-value	TN			p-value
	F	M		AP	AM		B	D	P	
CPP I Mean ± SD	4.3±1.1	4.0±1.4	0.0481*	4.2±1.2	4.1±1.3	0.4321	4.0±1.2	4.4±1.2	3.9±1.4	0.0662
EE	0.1674			0.1686			1.2974			
Median	129.4	113.7	0.048*	121.1	123.7	0.7103	134.4	107.7	112.4	--
Wilcoxon	12283			13368						
Kruskal-Wallis	3.953		0.0468*	0.7131		0.7001	9.753			0.0076*
CPP II Mean ± SD	3.0±1.6	3.2±1.5	0.2996	3.2±1.5	2.9±1.6	0.2425	3.0±1.7	3.1±1.5	3.0±1.6	0.8682
EE	0.206			0.206			1.609			
Median	119.0	126.8	0.3737	127.1	118.7	0.3467	119.8	124.5	120.8	--
Wilcoxon	13704			13855						
Kruskal-Wallis	0.795		0.3724	0.890		0.3452	0.239			0.887
CPE I Mean ± SD	3.91±1.1	3.81±1.3	0.5589	4.05±1.2	3.72±1.2	0.0384*	3.96±1.2	3.97±1.1	3.54±1.4	0.0718
EE	0.162			0.160			1.248			
Median	122.5	122.4	1	134.2	113.1	0.0152*	127.6	126.8	108.1	--
Wilcoxon	13229			14503						
Kruskal-Wallis	0.0009		0.9992	5.984		0.0144*	3.583			0.1666

CPPI: Animal Welfare; CPPII: Minimum Standards; CPEI: Animal Welfare Labeling; TN: Training Core; GE: Gender; AOI: Occupational Area of Interest; F: Female; M: Male; AP: Production; AM: Medicine; B: Basic; D: Disciplinary; P: Professional; EE: Standard error: Disciplinary; P: Professionalizing; SE: Standard error.

* *p* < 0.05.

Knowledge about production units certified in Mexico with animal welfare.

The results of knowledge of certified production units in Mexico with AW are shown in Figure 3C. Most students had high knowledge (82%), followed by medium knowledge (11%) and only 7% obtained low knowledge (χ^2, *p = <0.0001*). No differences were observed by GE (^{2},*p = 0.8922),* TN (χ^2, *p = 0.2410*), or AOI (χ^2, *p = 0.1351*). There were no differences by

component ($p \geq 0.05$, Table 5).
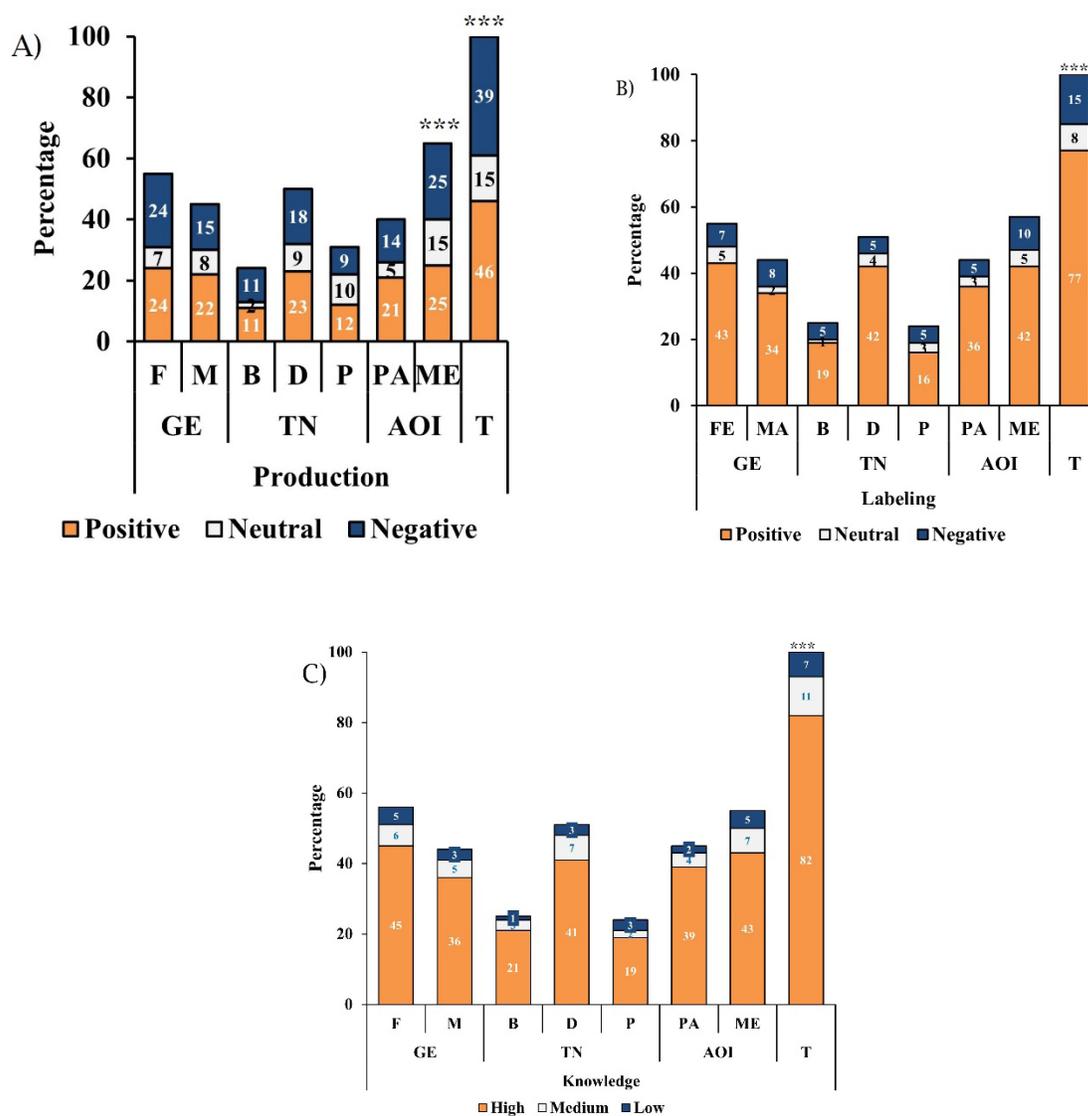
Figure 3. Perception of the students about animal welfare as an attribute to incorporate into the meat during the process of A) production, B) labeling, and C) knowledge. Based on the GE (gender, F: Female and M: Male); TN (training core, B: Basic, Disciplinary, and P: professionalizing) and AOI (area of occupational interest, AP: Production and AM: Medicine. T: total population). * *p < 0.001.***

Table 5. Knowledge about animal welfare certified units in students.

Component	GE		p-value	AOI		p-value	TN			p-value
	F	M		AP	AM		B	D	P	
C I										
Mean ± SD	2.7±0.6	2.7±0.5	0.6780	1.9±0.2	1.9±0.2	0.9732	1.9±0.2	1.9±0.2	1.9±0.2	0.3951
EE	0.075			0.030				0.232		
Median	121.4	119.5	0.4880	119.2	125.0	0.4463	122.1	126.9	113.5	0.3670
Wilcoxon	12910			12877.5						
Kruskal-Wallis	0.480			0.583				2.004		
C II										
Mean ± SD	2.7±0.3	2.6±0.3	0.1499	2.7±0.3	2.7±0.3	0.9060	2.7±0.3	2.7±0.3	2.6±0.3	0.1163
EE	0.043			0.043				0.337		
Median	127.3	116.45	0.1937	123.7	121.4	0.7838	121.8	129.13	109.2	0.1466
Wilcoxon	12577			13368						
Kruskal-Wallis	1.701		0.1921	0.076		0.7828		3.812		
C III										
Mean ± SD	2.8±0.3	2.8±0.3	0.6208	2.8±0.3	2.8±0.3	0.6466	2.8±0.2	2.8±0.3	2.7±0.3	0.2447
EE	0.041			0.041				0.323		
Median	123.17	121.65	0.8321	125.24	120.23	0.4747	131.63	121.38	115.4	0.2609
Wilcoxon	13138.5			13537.5						
Kruskal-Wallis	0.045			0.514				2.687		

C I: Animal welfare seal; C II: Hygiene and toxicological; C III: Social quality; GE: Gender; TN: Training Nucleus; AOI: Occupational area of interest; F: Female; M: Male; AP: Production; AM: Medicine; B: Basic; D: Disciplinary; P: Professional; EE: Standard error; S: Standard error: Disciplinary; P: Professionalizing; SE: Standard error.
* p < 0.0001.

Meat consumption preference by meat attributes

Preference for meat consumption by attributes: nutritional, meat sensory (flavor, odor, color, fat content, and juiciness), and market (brand, packaging, cut selection, label, advertising, product seasonality, and animal welfare practices) was better valued by the female gender (*CI, Wilcoxon p = 0.0293*). This is shown in Figures 1 and 2. It was also observed that there were no

differences in the valuation of meat consumption preference, due to meat attributes as a function of AOI, nor by NT ($p > 0.05$ Table 6).
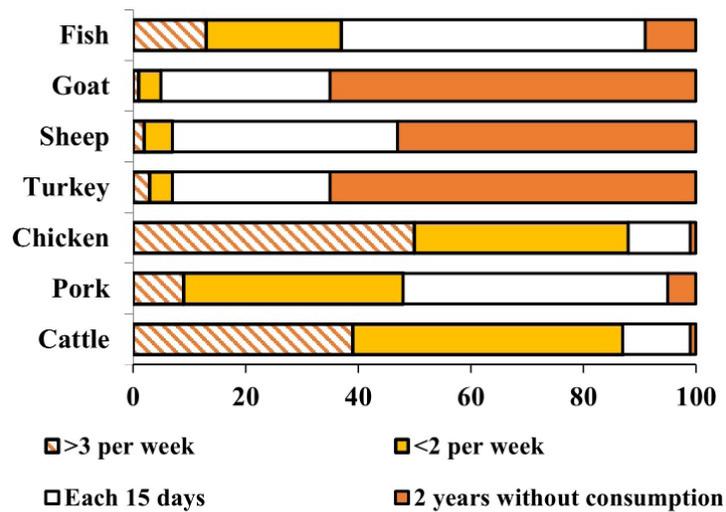
Figure 1. Meat consumption frequency.
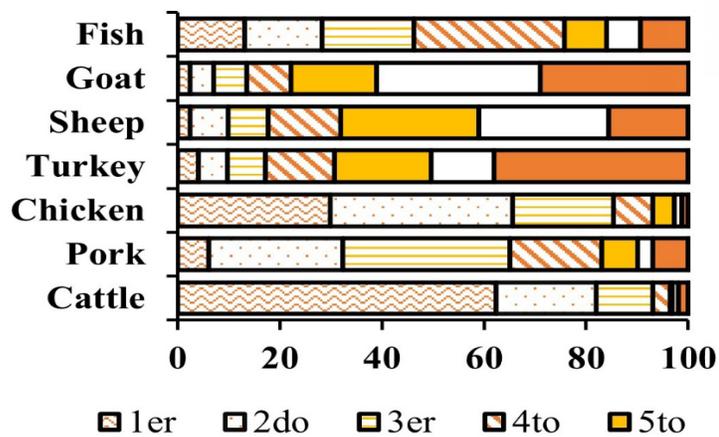
Figure 2. Preference of meat consumption by species if it had the same price

per kilogram

Table 6. Meat consumption preference due to the meat attributes by component.

Component	GE		p-value	AOI		p-value	TN			p-value
	F	M		AP	AM		B	D	P	
C I										
Mean ± SD	4.0±1.3	3.8±1.5	0.0361*	4.0±1.4	4.0±1.4	0.9629	4.1±1.4	4.0±1.4	3.9±1.4	0.8066
EE		0.185			0.187			1.450		
Median	130.2	112.7	0.0303*	121.9	122.9	0.9105	127.6	123.3	115.4	0.5529
Wilcoxon		12175			13175					
Kruskal-Wallis		4.749			0.012			1.185		
C II										
Mean ± SD	3.80±1.2	3.65±1.3	0.3719	3.80±1.3	3.69±1.3	0.5001	3.75±1.3	3.75±1.3	3.71±1.3	0.9799
EE		0.169			0.169			1.318		
Median	124.6	119.7	0.5790	126.7	119.1	0.3862	125.0	122.4	119.0	0.9138
Wilcoxon		12938			13686					
Kruskal-Wallis		0.3097			0.7554			0.180		

C I: Nutritional and sensory factors; C II: Market factors; GE: Gender; TN: Training Nucleus; AOI: Occupational area of interest; F: Female; M: Male; AP: Production; AM: Medicine; B: Basic; D: Disciplinary; P: Professional; EE: Standard error: Disciplinary; P: Professional; EE: Standard error. * *p* < 0.05.

Discussion

Content Validity, Construct Validity, and Reliability of the Questionnaire.

Content validity has been estimated in several studies using several methods: Tuckey's factor analysis, Lawshe's index, Rovinelli and Hambleton index, Aiken's V, Sireci and Geisinger's cluster analysis, Levine, Maye, Ulm, and Gordon's minimum ability method, Fitch's symmetry method, Rubio's factor analysis, Claeys, Neve, Tulkens, and Spinewine's index, and Hernández-Nieto's method (2002). Some of these procedures are only designed to measure the agreement between two judges, while others require a specific number of judges (Galicia *et al.,* 2017). The Hernández-Nieto method (2002) assesses the degree of agreement between judges on a per-item

basis and requires a minimum of three judges (Pedrosa *et al.,* 2014). These authors recommend keeping the content validity coefficient (CVC) higher than 0.80. Thus, the questionnaire was classified as good to excellent since it obtained a CVC of 0.85. Likewise, in the eating behavior study proposed by Marquez-Sandoval et al. (2014), the average score obtained was 42.5 out of 45 (n=15), in this research, a total score of 38.5 (out of 45 possible points, n=4), was obtained. Transforming the score of 45 to 100% and obtaining the corresponding index of the total score, we had an index of 0.85, which is comparable to the result obtained by the methodology of Hernández-Nieto, (2002).

The KMO contrasts the partial correlations between the variables and allows us to know if the variables maintain a dimensional structure that is invariant. The results showed that the overall KMO of the questionnaire maintained a high significant correlation (0.8). This means that the questionnaire is valid for future research (Lacave *et al.,* 2015). Likewise, it was observed that the correlation matrix was related by obtaining significance in Bartlett's test of sphericity (p = 0.0001). These results were superior to those observed by Jiménez, (2011) in his study "Analysis of animal welfare as an attribute to be incorporated in pork", where a KMO of 0.59 was found. In another study, Miranda-de la Lama *et al*. (2017) found a KMO of 0.80, similar data to the present study.

The questionnaire obtained a Cronbach's alpha of 0.96, thus, it is reliable. Márquez-Sandoval *et al*. (2014), in their study "Design and validation of a questionnaire to assess eating behavior in Mexican health students", found similar results. On the other hand, Miranda-de la Lama *et al*. (2017) in their study "Perceptions and attitudes of Mexican consumers towards farm animal welfare and their willingness to pay for welfare-friendly meat products" found a Cronbach's alpha of 0.66. The minimum acceptable value for Cronbach's alpha coefficient is 0.70, below which the internal consistency of the scale used is low (Oviedo & Campos, 2005). Our questionnaire was reliable and consistent.

Socioeconomic Characteristics and Meat Preferences of FMVZ Students

The students of the basic and disciplinary core were more participative compared to those of the professionalizing core. Ceballos-Olvera *et al*. (2021) reported that this was due to the greater empathy of the students for the AW topic, in the first semesters of the veterinary career. Similarly, most students in the first semesters rely on their parents to buy meat for family consumption. Forty-six percent are not economically dependent. The family income of the majority is less than USD 480.7 per month. This figure is considered low-income (Alvarado-Lagunas *et al.,* 2012). The majority of FMVZ-UAT students come from low-income families, and some may have to seek income-generating activities while studying.

The number of family members was 4.5, similar to that reported by INEGI (2021). On the other hand, Núñez-López *et al*. (2012) concluded that the size of the family (2 to 5 members, 79.5%) influenced the amount and frequency of meat consumed per week. The lower the income, the inclusion of other less preferred species was observed. In low-income families, chicken and pork were consumed. Alvarado-Lagunas *et al*. (2012) found that in the Valley of Mexico, the

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purchase and preference of chicken were influenced by the number of family members (the more people, the lower the consumption), income (only 11.6% had a high income, USD 913.39 per month), and price (the higher the price, the lower the purchase). In the present study, it was observed that the consumption of chicken meat was higher compared to other meats. However, beef would be the most consumed meat if the cost per kilogram did not differ among the different types of meat (Figure 2). Alvarado-Lagunas *et al*. (2012) reported that the preference for chicken meat was high, showing that the main motivation was its nutritional content. On the other hand, beef was ranked second in terms of preference, and this result is similar to that observed in the present research (Figure 1).

Schnettler *et al*. (2008) showed that consumers in the Bio-Bio and Araucanía regions of Chile had a preference for beef and chicken, and therefore had higher consumption. Similarly, a national trend for chicken consumption was observed in Mexico. *Per capita* consumption was 33 kg in 2020, making it the most consumed meat by the Mexican population (UNA, 2021). The consumption preference for beef is consistent with that reported by Alvarado-Lagunas *et al*. (2016), where the consumption preference of young people aged 14 to 21 years in the city of Monterrey is preferably beef. Consumption by students takes place outside the home, and it is also considered a healthy food.

Perception of Animal Welfare During the Production Process

Segovia *et al.* (2005) found that psychological factors and intrinsic and extrinsic attributes of the meat determine beef consumption behavior. On the other hand, Mondragón-Ancelmo *et al*. (2018) found that the type of animal was important for the type of finished product. Barbacoa, a regional Mexican dish, was created by the influence and customs of the region. Núñez-López *et al*. (2012) reported that the purchase of beef was related to: family tradition (46.3%), ease of preparation (42.7%), and price (28.9%). Ortega-Gutiérrez *et al*. (2020) showed that consumption in Ciudad Cuauhtémoc and Delicias Chihuahua (Mexico) was 1 to 2 kg of beef/week. This practice is related to ease of preparation and family tradition, but not to income level. In general, the veterinary and zootechnical student population in northeastern Mexico has a preference for chicken and beef consumption, due to ease of access and family tradition.

AW is positively associated with the quality of meat products (De Aluja, 2011) because it minimizes animal suffering, as animals are considered sensitive beings, and enriches the marketing strategies of meat products (Del Campo, 2006). In Italy, 48% of consumers accept the social responsibility of AW and therefore there is a demand for products with AW attributes (Vecchio & Annunziata, 2012). In the Papaloapan region of Veracruz, Mexico, 42% of consumers would be willing to pay 5% more for beef with certified quality and safety (Vilaboa-Arroniz *et al.,* 2009). For their part, Miranda de la Lama *et al*. (2017) showed that consumers in self-service stores are willing to pay for a product certified with good AW practices. Therefore, it can be shown that the perception of AW will be positioned with a greater boom in the coming years and will be a value-added attribute in meat products in the domestic market.

In the context of veterinary and zootechnical students, PAs, compared to MEs, promote the implementation of AW practices in the production process. This can be explained by the fact that jobs in PA depend on the sale of live animals or meat products. They also depend on the sale of feed, feedlots, or TIF (Federal Inspection Type) slaughterhouses.

Animal Welfare During the Labeling Process

Similarly, Jiménez (2011) reported that students from the three university faculties of medicine, engineering, and agronomy in Santiago de Chile considered it positive that the label of the meat product should have an animal welfare seal. If it existed, they would pay more for it, in addition to the intrinsic qualities of the meat and the price. Customers in the state of Mexico, Mexico want the label to show information on health, environmental protection, AW, or benefits for local producers (Santurtún-Oliveros *et al.,* 2012). Alonso *et al.* 2020 point out that in the last two decades, the number of consumers has increased. They demand more ethical production systems and refuse to buy products that do not comply with AW concerns. Therefore, there is an interest among students to obtain information on the treatment of animals and thus have a higher quality product label. This is reflected in the establishment of AW policies. In this study, a discrepancy was observed between the desire for the inclusion of AW in product labeling (total 77%) and the positive perception of the implementation of AW in production (total 46%). More emphasis may be needed in the basic courses to clarify the aspects related to production and labeling with AW.

Knowledge of Certified Animal Welfare Production Units in Mexico

Alvarado-Lagunas *et al.* (2016) found that students of the Faculty of Accounting and Administration in Monterrey, Mexico, in their majority (91%), indicated that they did not know the meaning of AW, production systems, or feedlots. These results may be because students of veterinary medicine and animal husbandry have subjects related to AW: Bioethics Seminar, Animal Management, and Behavior, while this is not the case with careers in the field of exact sciences: Engineering and Accounting.

The majority of students had high knowledge (82%), followed by medium knowledge (11%) and only 7% were low. In this sense, Jimenez, (2011) found a segmentation of 33% of informed students and the rest had no knowledge or were indifferent to pork attributes: product traceability and product origin.

Preference of Meat Consumption by Meat Attributes

The difference by gender was because they have a high level of emotional empathy for animals compared to male students (Paul & Podberscek, 2000). Another explanation may be that women are in charge of shopping for food preparation at home. They check the labels at the time of purchase. Ortega-Gutiérrez *et al.* (2020) reported that in the cities of Cuauhtémoc (74%) and Delicias (78%) in Chihuahua, Mexico, women are the ones who decide on the type of meat consumed at home.

Obtained data show that chicken is consumed more than three times a week, followed by beef, twice a week. This is in agreement with Alvarado-Lagunas *et al*. (2012), who reported that the preference for chicken meat was high. The main reason for its consumption was the consideration of high nutritional value, with beef in second place (Schnettler *et al.,* 2008; UNA, 2021). The preference for beef consumption is also consistent with that reported by Alvarado-Lagunas *et al*. (2016) where beef consumption was through grilled beef tacos, hamburgers, or stews. These authors mention that this student consumption is frequently carried out outside the home, and young people consider it to be a healthy food. Segovia *et al*. (2005) suggest that psychological factors and consumer characteristics determine beef consumption behavior. Also, Núñez-López *et al*. (2012) suggest that beef purchase was related to family tradition (46.3%), ease of preparation (42.7%), and price (28.9%). Similarly, Ngapo *et al*. (2017) mentioned that the Mexican market is influenced by a variety of domestic consumer preferences: Mexico City, Guadalajara, Hermosillo, and Veracruz. They also observed that the most important criterion was fat coverage, with 62% preferring low coverage and marbling, and 59% preferring no marbling. This was followed by dark red meat color (29%) and light red color (24%).

Preference for meat consumption based on meat attributes was better evaluated by the female gender, perhaps because of emotional empathy or because of shopping and observing labels (Paul & Podberscek, 2000; Ortega-Gutiérrez *et al.,* 2020).

Conclusions

The questionnaire designed to assess the perception of veterinary students on meat consumption was valid. Different types of meat are preferred according to economic characteristics and intrinsic qualities.

Students are interested in meat produced with AW. This is a desirable attribute for new generations of veterinarians. There are AW courses in veterinary curricula; however, there is a need to monitor AW livestock production led by graduates to observe the inherent strengths and weaknesses.

It is important to develop public policies that include measures for the meat industry that promote the welfare of animals destined for consumption.

Authors contribution

"Conceptualization, PALY, APJ, and RMGN; methodology development, PALY, APJ, and RMGN.; software management, PALY; experimental validation, APJ, and RMGN; analysis of results, PALY, APJ; Data management, PALY, APJ, and RMGN; manuscript writing and preparation, PALY, APJ, and RMGN; writing, revising and editing, PALY, APJ, and RMGN.

"All authors of this manuscript have read and accepted the published version of this manuscript."

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Statement of Informed Consent

Informed consent was obtained from all subjects involved in the study.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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