

EXPLORATORY SURVEY AT THE MEXICAN MARKETPLACE ON PORK MUSCLES CHARACTERISTICS FROM U.S.A. AND MEXICO

Encuesta exploratoria en el mercado mexicano sobre las características de músculos de cerdos originarios de Estados Unidos y México

Rubén Danilo Méndez-Medina ¹, Edith Ponce-Alquicira ², María Salud Rubio Lozano ¹,
Suzanne Ryan ³ and Nelson Huerta-Leidenz ^{4*}

¹Laboratorio de Ciencia de la Carne, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, Av. Universidad 3000, Del. Coyoacán, Ciudad Universitaria, México D.F. 04510, México. ²Departamento de Biotecnología, Universidad Autónoma Metropolitana, Campus Iztapalapa, Av. San Rafael Atlixco 186, Col. Vicentina, Apartado postal 55-535, México D.F., C.P. 09340, México. ³Department of Animal Sciences and Industry, Kansas State University, Weber Hall, Manhattan, KS 66506-0201, United States. ⁴U.S. Meat Export Federation, Mexico. Jaime Balmes #8, Piso 6, despacho 602. Col. Los Morales Polanco, México, D.F. C.P. 11510, México. *Corresponding author: Telf: +0052555281-6100; fax: +00525552816013. E-mail address: nhuerta@usmef.org.mx (N. Huerta-Leidenz).

ABSTRACT

Trends in variation of physical, chemical and sensory traits due to country of origin (COO) were evaluated for samples from United States of America (U.S.A.) and Mexico of three pork muscles, *Rectus femoris* (RF, n = 20 from each COO), *Vastus medialis* (VM, n = 20 from each COO), and *Longissimus dorsi* (LD, n = 10 from each COO) in two separate, small-scale, exploratory surveys conducted at Mexico City. Compositional, physical and chemical properties and consumer acceptability traits of these Mexican and U.S.A. pork samples were quite similar, though Mexican pork samples generally were more variable. LD samples from U.S.A. had greater (P<0.05) water-holding and emulsifying capacities whereas both RF and LD from U.S.A. required lower shear force (P<0.05) compared to Mexican counterparts. Ratings from consumers did not indicate preference for pork from any of the countries. Because of the limited number of observations for the samples surveyed these results are preliminary and may not adequately characterize the populations of each country, but they did reveal important trends for selected traits of Mexican and U.S.A. pork currently available at the local market.

Key words: Pork quality, *Rectus femoris*, *Vastus medialis*, *Longissimus dorsi*, Mexico, USA.

RESUMEN

Se evaluaron tendencias en la variación de características físico-químicas y sensoriales debidas al país de origen (PDO), de muestras mexicanas y estadounidenses (EUA) de tres músculos del cerdo: *Rectus femoris* (RF, n = 20 por PDO), *Vastus medialis* (VM, n = 20 por PDO), and *Longissimus dorsi* (LD, n = 10 por PDO) mediante dos encuestas exploratorias separadas, a baja escala, conducidas en la Ciudad de México. Los resultados mostraron que músculos porcinos de los dos orígenes tienen propiedades físicas, químicas y sensoriales muy similares, aunque las muestras mexicanas mostraron mayor variabilidad. Las muestras de LD de EUA tuvieron mayor (P<0,05) capacidad de retención de agua y emulsificación, y al igual que las de RF, requirieron menos fuerza de corte que las mexicanas (P<0,05). Los consumidores no pudieron detectar diferencias entre muestras de diferente origen. Debido al limitado número de observaciones en las muestras encuestadas, los resultados deben considerarse preliminares y si bien no permiten caracterizar adecuadamente las poblaciones de cada país, las mismas revelan tendencias importantes para los rasgos seleccionados de la carne de cerdo procedente de México y EUA disponibles actualmente en el mercado local.

Palabras clave: Calidad porcina, *Rectus femoris*, *Vastus medialis*, *Longissimus dorsi*, México, Estados Unidos de América.

INTRODUCTION

Population growth, rising incomes, urbanization, and an expanding middle class in Mexico have created a large demand for pork (*Sus scrofa*) products that the domestic industry has been unable to supply [8]. The Secretariat of Agriculture of Mexico [8] estimated that pork-related imports increased annually by 8.4%; approximately 35% of the pork consumed in Mexico is imported from countries such as the U.S.A., Canada, and Chile. Because production management and genetic lines differs among countries, it is likely that pork meat currently available at Mexico is heterogeneous in quality.

As Mexico's market for imported pork has increased, the country's domestic pork production industry has also modernized. During the last decade, Mexican producers invested heavily in building large, vertically integrated production systems which are complemented by modernized slaughter and processing sectors. Thus, companies now produce greater amounts of higher-quality pork allowing them, not only supply most of the domestic market, but also to become an important pork exporter to high-value Asian markets such as Japan and Korea. However, along with modernization of pork production, certain domestic pork products became more expensive for consumers. Because of that increased volumes of imported, more-affordable pork cuts and pork variety meats (PVM) are available in Mexican retail markets. Consumer's preferences for specific pork cuts (e.g., legs and loins) and PVM in Mexico, relative to consumer preferences in the U.S.A., have created a complementary foreign demand for U.S.A. pork products. Mexico pork and PVM exports on a volume basis [29].

Pork quality is determined by visual appearance and overall eating satisfaction following preparation and consumption. Visual appearance is influenced by myoglobin concentration, water-holding capacity (WHC), pH, and the amount of intramuscular fat present, while eating satisfaction is a combination of tenderness, juiciness and flavor [17, 18].

Despite the high volume of imported pork in Mexico, no reported research study has been conducted to compare characteristics of domestic Mexican pork versus U.S.A. imported pork at Mexico City. The primary objective of this study was to evaluate trends in variation of quality and compositional traits for pork *Rectus femoris* (RF), *Vastus medialis* (VM), and *Longissimus dorsi* (LD) due to country of origin (Mexico vs. U.S.A.).

MATERIALS AND METHODS

Comparison of pork *Rectus femoris* and *Vastus medialis* by country of origin.

Forty pork legs, coded by the North American Meat Processors Association (NAMP) as NAMP 401 [23] (20 from Mexico and 20 from U.S.A.) similar in color and firmness were procured from a meat wholesaler at Mexico City. RF and VM mus-

cles were dissected and three, 2.54 cm-thick chops were removed for instrumental color evaluation, chemical composition, cooking loss percentage calculation, Warner-Bratzler shear force (WBSF) determination, and consumer sensory evaluation. Samples were vacuum-packaged and frozen at -20°C until further analysis. Chops were thawed for 24 to 30 h at 2 to 4°C before analyses.

Chemical composition

Chemical composition was determined following AOAC approved techniques [1]. Moisture percent was determined by oven drying, crude fat percentage was obtained using the Soxhlet method by extraction with ether, and protein percentage was determined using the micro Kjeldahl method [1].

Cooking loss percentage and WBSF measurement

Cooking loss percentage and WBSF were determined according to the American Meat Science Association guidelines [2]. Chops were roasted to an internal temperature of 70°C , measured by iron thermocouples (Omega Engineering Inc., Stamford, CT, U.S.A.) using a portable recording thermometer. Upon reaching a final internal temperature of 70°C , chops were removed from roasters and allowed to cool to room temperature (20 - 25°C). Each chop was weighed before and after cooking to calculate cooking loss percentage as follows: $100 \times (\text{raw wt} - \text{cooked wt}) / \text{raw wt}$. After cooling, between five and eight cores for WBSF evaluation were removed from each chop parallel to the long axis of muscle fibers. Each core was sheared once perpendicular to muscle fiber orientation with Warner-Bratzler Shear Machine (United 5802 Engineer Drive, Huntington Beach, CA, U.S.A.). A higher reading indicated higher shear force and, therefore, tougher meat.

Instrumental color measurements

Chops were allowed to bloom i.e. to oxygenate at room temperature (20 - 25°C) for 15 min, after which instrumental color measurements were obtained in duplicate from each chop using a Minolta Chroma Meter CR-310 (Minolta, Osaka, Japan). Lightness (L^*), redness (a^*), and yellowness (b^*) of each sample were measured and recorded.

Consumer sensorial evaluation

A total of 107 panelists (50 female and 57 male) –students (33) and employees (74), voluntarily recruited- from different schools at the Universidad Nacional Autónoma de México, located in Mexico City participated in the sensory evaluation. Thirty eight participants had a range of age between 18 and 30, thirty four consumers were between 30 and 45 years old and thirty five were older than 45. The test was carried out in two different sessions with 59 and 48 panelists, respectively. An affective consumer test was conducted using a hedonic 7-point scale (1 = *I dislike it very much*, 7 = *I like it very much*). Chops were roasted as previously described in accordance

with AMSA guidelines [2]. Upon reaching a final temperature of 70°C, chops were removed from the roaster and cut into uniform 2 x 2 x 2 cm cubes. Three warm cubes from pork from the two countries of origin (Mexico and U.S.A.) were selected randomly and immediately served to the consumer panel. Panelists assigned scores for appearance, aroma, flavor, texture and overall acceptability for each sample.

Statistical analyses

Tests of hypothesis concerning the fixed main effects of country of origin (Mexico vs. U.S.A.) and muscle (RF vs. VM), as well as the interaction, were conducted using analysis of variance techniques; α was preset at 0.05 level [13]. To analyze sensory traits, the non-parametrical procedure of Kruskal-Wallis was used [22].

Comparison of pork *Longissimus dorsi* muscles

Twenty pork loins, coded as NAMP 413 [23] (10 Mexican and 10 from U.S.A.), free of undesirable odor or color, were purchased from six retail stores at Mexico City. All samples were already packaged in retail styrofoam trays over-wrapped with clear plastic film and displayed in refrigerated retail cases; samples were transported and maintained under refrigeration until evaluations were performed within three hours of purchase. The LD samples were grouped by country of origin; one section was sliced into 3 cm-thick chops and subsequently evaluated for cooking loss, WBSF, instrumental color, and consumer sensory traits. The remaining section was minced twice using a M12FS meat mince (Tor-rey DIMAQ, NL, Mexico) and analyzed in triplicate for chemical composition, pH, water holding capacity (WHC) and emulsion capacity (EC).

Cooking loss percentage calculation and WBSF measurement

Cooking loss percentage and WBSF were determined according to the AMSA guidelines [2]; samples were cooked and cooking loss percentage was calculated as previously described for RF and VM samples. WBSF was ascertained as previously described by shearing 6 cores per sample; each core was sheared once perpendicular to muscle fiber orientation with a Warner-Bratzler cell, using a TA-XT-2 texture analyzer (Texture Technologies Corp., Scarsdale, NY, U.S.A.), fitted with a 49-N load cell and a Warner-Bratzler cell. Data were analyzed using the Texture expert v1.20 software (Stable Micro Systems Ltd., Surrey, UK). A higher reading indicates higher shear force and, thus, tougher meat.

Instrumental color measurements

LD samples were allowed to "bloom" (i.e., oxygenate) at room temperature for 15 min and instrumental color was measured using a Hunter-Lab ColorFlex® Spectrophotometer 45/0 (Illuminant D₆₅, 10°, port 19.1 mm, Hunter Associates Lab, Inc. Reston, VA, U.S.A.). Color L^* , a^* and b^* values were obtained

with Universal v3.73 software. Chroma was calculated $[(a^{*2} + b^{*2})^{1/2}]$ as described by Little [14]. Samples were read in quadruplicate, and the sample was rotated 90° before each reading.

Consumer sensorial evaluation

An unstructured consumer rating scale [22] was used to evaluate eight LD samples (four Mexican and four from U.S.A.). Samples were cooked in a water bath until reaching an internal temperature of 70°C. A group of 30 consumers (18 female and 12 male students between 20 and 30 years old, voluntary recruited at Universidad Autónoma Metropolitana campus Iztapalapa –located at the eastern section of Mexico City) were asked to describe the attributes of flavor, juiciness, tenderness and overall acceptability using a 7-point scale (1 = I dislike it very much, 7 = I like it very much). The test was carried out in one session.

Chemical composition

LD chemical composition was determined following AOAC approved techniques [1]. Moisture percent was determined by oven drying, crude fat percentage was obtained using the Soxhlet method by extraction with ether, and protein percentage was determined using the micro Kjeldahl method [1].

Evaluation of pH, WHC and EC

Ten grams of minced LD were homogenized with 90 mL of distilled water for 1 min using a domestic blender (450-20 Oster, Jarden Corp., NY, U.S.A.); connective tissue was removed by filtration through cheesecloth as described by Owen *et al.* [19]. The pH then was measured on a digital pH meter (ϕ 50 Beckman Coulter Inc., Fullerton, CA, U.S.A.) which previously was calibrated at pH values of 4.0 and 7.0. WHC was determined according to Hamm [9]; five grams of minced LD were homogenized with 8 mL 0.6-M NaCl, placed in an ice bath for 30 min and centrifuged at 8,000 x g for 15 min at 4°C in a centrifuge J2-M1 (Beckman, Palo Alto, CA, U.S.A.). Supernatant volume was measured and WHC was reported as the volume of 0.6-M NaCl held/100 g of meat. EC was determined using a modification of the method described by Swift *et al.* [26], Ockerman [20], Arcos-Garcia *et al.* [3], and Arslan [4]. One hundred milliliters of 0.1-M NaCl were homogenized with 20 g minced LD samples for 3 min using a domestic blender (450-20 Oster, Jarden Corp., NY, U.S.A.). A 0.5-g homogenate was transferred to an acrylic tube (32 mm diameter, 100 mm high) fitted with two copper electrodes connected to a digital voltmeter (Tektronics, Beaverton, OR, U.S.A.); while continuously stirring, corn oil was added at a rate of 0.5 mL/s to form an emulsion using an ESGS homogenizer (Mettlen, Switzerland) at 13,000 rpm. The amount of emulsified oil was determined when a sudden change in resistance was observed and phase inversion occurred; the EC was reported as volume of emulsified oil/g of protein. Soluble protein concentration was determined using the Biuret method. All determinations were carried out in triplicate.

Statistical Analyses

Hypotheses concerning effects of country of origin (Mexico vs. U.S.A.) were tested with a Student's t-test using SPSS v8.0 for Windows software [25]; α was preset at 0.05 for statistical significance. Results of consumer sensory evaluation were analyzed using a non-parametric test of Kruskal-Wallis [22].

RESULTS AND DISCUSSION

Chemical composition and quality traits of pork muscles

TABLE I shows the mean values and standard deviations (sd) for chemical composition and quality traits of pork RF and VM samples, while TABLE II shows the mean values and sd for chemical composition and quality traits of pork LD samples. Moisture and fat percent, as well as instrumental color for VM, RF, and LD did not differ ($P > 0.05$) by country of origin. However, RF and VM samples from Mexico had a greater ($P < 0.05$) protein percentage than RF and VM samples imported from the U.S.A.

Kropf *et al.* [12] stated that consumers primarily use fresh meat color as an indicator of freshness and wholesomeness. Repeated purchases of meat are a result of a positive initial perception as well as overall product satisfaction after consumption. Although no initial instrumental color differences between the samples were observed, meat color stability is an important economic factor during retail-display and future research should consider the quantification of each myoglobin form present in porcine meat. It is known that during storage the ferrous iron attached to the heme group of myoglobin, be-

comes oxidized producing the metmyoglobin brown pigment and discoloration. Factors such as pH, rearing conditions, slaughtering packaging, storage temperature and microbial population among others, may accelerate meat discoloration and economical losses for producers and sellers [10].

Many authors [5, 7, 21, 27, 28] have indicated that ultimate pH measurements can be directly or indirectly related to many important quality attributes such as color, water-holding capacity, and tenderness. One of the most widely used methods to evaluate pork quality is muscle pH. As live muscle is converted into meat, pH is reduced, causing meat to become increasingly acidic. Later on during storage this pH value raises to around six. Both the rate of this change and the final pH level are important in determining pork quality. No difference ($P > 0.05$) was detected between countries of origin for LD pH; final mean pH value for samples was normal at about 6.2.

Many consumers utilize visual appearance (e.g. amount of purge) as a direct indicator of pork quality, as well as an indirect indicator of eating quality [15, 17]. Pork LD samples from the U.S.A. had higher ($P < 0.05$) water-holding capacities than pork LD samples from Mexico. WHC is a primary functional property of meat and is related to juiciness and processing performance [11]. Another economically important trait is WBSF. RF and LD samples from Mexico had higher ($P < 0.05$) WBSF values than their counterparts from the U.S.A.

Cooking losses result from fat melting and evaporation of water and other volatile compounds. Bouton *et al.* [6] con-

TABLE I
MEAN VALUES AND STANDARD DEVIATION FOR CHEMICAL COMPOSITION AND QUALITY TRAITS OF PORK *Rectus femoris* AND *Vastus medialis* SAMPLES ACCORDING TO COUNTRY OF ORIGIN / MEDIAS Y DESVIACIÓN ESTÁNDAR PARA LOS ATRIBUTOS DE COMPOSICIÓN QUÍMICA Y DE CALIDAD DE *RECTUS FEMORIS* Y *VASTUS MEDIALIS* DEL CERDO DE ACUERDO AL PAÍS DE ORIGEN.

	<i>Rectus femoris</i>		<i>Vastus medialis</i>	
	Mexico	U.S.A.	Mexico	U.S.A.
Chemical composition				
N	20	20	20	20
Moisture, %	73.84 ± 1.31	74.70 ± 1.98	73.73 ± 2.00	74.60 ± 1.37
Fat, %	2.85 ± 1.19	3.24 ± 1.37	2.59 ± 1.36	1.99 ± 0.46
Protein, %	20.55 ^a ± 1.12	19.56 ^b ± 0.87	20.76 ^a ± 1.04	20.02 ^b ± 1.03
Quality traits				
WBSF ^c	21.67 ^a ± 0.74	19.02 ^b ± 0.67	23.5 ± 0.61	23.83 ± 0.58
Cooking loss, % ^d	24.45 ± 4.70	24.45 ± 6.75	24.24 ^a ± 3.98	26.67 ^b ± 4.00
L* (lightness)	42.27 ± 2.75	43.90 ± 4.33	49.47 ± 8.35	47.06 ± 7.15
a* (redness)	19.63 ± 0.94	19.81 ± 1.06	20.93 ± 2.07	21.60 ± 1.91
b* (yellowness)	4.62 ± 1.05	4.40 ± 1.08	6.24 ± 2.05	5.61 ± 1.96

^{ab} Means with different superscripts in the same row are significantly different ($P < 0.05$).

^c Warner-Bratzler Shear Force.

^d Cooking loss, % = $100 \times (\text{Raw wt} - \text{Cooked wt}) / \text{Raw wt}$.

TABLE II
MEAN VALUES AND STANDARD DEVIATIONS FOR CHEMICAL COMPONENTS AND QUALITY TRAITS OF PORK
LONGISSIMUS DORSI SAMPLES ACCORDING TO COUNTRY OF ORIGIN / MEDIAS Y DESVIACIONES ESTÁNDAR PARA
LOS COMPONENTES Y CALIDAD DEL LONGISSIMUS DORSI DEL CERDO DE ACUERDO AL PAÍS DE ORIGEN.

	México	U.S.A.
	<i>n</i> = 10	<i>n</i> = 10
Chemical composition		
Moisture, %	74.07 ± 3.96	72.97 ± 2.05
Protein, %	20.90 ± 2.46	19.46 ± 1.49
Fat, %	1.96 ± 0.84	2.94 ± 0.96
pH	6.19 ± 0.35	6.24 ± 0.29
WHC (ml NaCl retained/100g) ^c	60.24 ^a ± 4.35	68.78 ^b ± 3.28
Emulsion capacity (ml oil/g)	87.78 ^a ± 7.48	96.89 ^b ± 6.27
Quality traits		
Cooking loss, % ^d	14.22 ± 4.62	16.87 ± 1.21
<i>L</i> * (lightness)	53.71 ± 5.58	50.69 ± 2.69
Chroma ^e	20.73 ± 0.97	19.29 ± 0.78
WBSF (N) ^f	21.32 ^a ± 0.572	18.15 ^b ± 0.233

^{ab} Means with different superscripts in the same row are significantly different ($P < 0.05$).

^c Water holding capacity.

^d Cooking loss, % = $100 \times (\text{raw wt} - \text{cooked wt}) / \text{raw wt}$.

^e Chroma = $(a^{*2} + b^{*2})^{1/2}$.

^f Warner-Bratzler Shear Force.

cluded that cooking losses decreased as pH increased. Although cooking losses did not differ ($P > 0.05$) between pork RF and LD samples from any country of origin, VM pork samples from the U.S.A. had a greater ($P < 0.05$) cooking loss percentage than VM pork samples from Mexico. Bouton *et al.* [6] concluded that a maximum WHC and minimum cooking loss would be expected at pH of 6.1 to 6.2 in cooked meat, approximately to the pH of LD samples in the present study.

Emulsifying capacity can be used to describe meat technological aptitude. Fine paste products are complex emulsion-type systems, where particles of fat stay trapped inside a protein matrix. Myofibrillar proteins in meat act as emulsification agents because they form a barrier around fat globules. Imported U.S.A LD samples formed emulsions better ($P < 0.05$) than LD samples from Mexico; this could be a consequence of a greater availability of soluble protein.

Consumer sensorial evaluation of pork VM, and LD samples

Mexican consumers detected no differences ($P > 0.05$) in sensory attributes for VM, RF, and LD samples from Mexico and the U.S.A (TABLES III and IV). Results indicated that consumers liked these samples from low to moderate levels. Similarities between pork from Mexico and U.S.A. may be explained by the use of similar genetic lines. Highly-integrated pork producers for both domestic and international markets, which are the main pork suppliers for Mexican supermarkets,

primarily use pork cross-breed lines; Landrace or Hampshire females crossed with Duroc or Hampshire males [24]. However, results reported in this study may not reflect such international standardization for pork meat marketed by small Mexican producers; as they may tend to use native breeds such as "Pelón Mexicano" known as Hairless Mexican pigs (HMP), which is characterized by its excellent adaptation and rusticity degree [16]. HMP are short, thick animals with good conformation but which yield rather fatty carcasses; because of the higher proportion of trimmable fat and lower yield of lean cuts HMP have a relatively low commercial value. In a previous study with HMP pigs, percent crude fat in lean cuts such as ham, loin and shoulder ranged from 8.6 to 9.4% [16]. The range of fat content in HMP lean cuts contrast with results found in this study, showing that fat percentage in modern commercial pigs were much lower and fluctuated between 1.96 ± 0.84 and 3.24 ± 1.37 for the three muscles under study.

CONCLUSIONS AND IMPLICATIONS

This preliminary survey revealed trends in variation of certain characteristics of pork currently available in Mexico. Similarities were found in composition, physical and chemical properties, and consumer acceptability between Mexican and U.S.A. pork, though the Mexican pork samples showing a larger variability for some traits. Further research should consider a detailed color analysis. The significant values for

TABLE III
MEAN RATINGS AND STANDARD DEVIATIONS ASSIGNED BY MEXICAN CONSUMERS (N = 107) FOR SENSORY ATTRIBUTES OF PORK VASTUS MEDIALIS AND RECTUS FEMORIS ACCORDING TO COUNTRY OF ORIGIN / MEDIA Y DESVIACIONES ESTÁNDAR PARA LOS ATRIBUTOS SENSORIALES DEL MÚSCULO VASTUS MEDIALIS Y RECTUS FEMORIS SEGÚN PAÍS DE ORIGEN.

	<i>Vastus medialis</i>		<i>Rectus femoris</i>	
	México	U.S.A.	México	U.S.A.
Appearance ^a	5.13 ± 1.32	5.26 ± 1.33	5.11 ± 1.36	5.07 ± 1.31
Aroma ^a	5.22 ± 1.20	5.10 ± 1.31	5.09 ± 1.32	5.11 ± 1.19
Juiciness ^a	5.23 ± 1.29	5.37 ± 1.28	5.46 ± 1.41	5.42 ± 1.25
Flavor ^a	5.39 ± 1.20	5.39 ± 1.31	5.62 ± 1.29	5.51 ± 1.21
Tenderness ^a	5.33 ± 1.40	5.39 ± 0.30	5.66 ± 1.27	5.60 ± 1.24
Overall acceptability ^a	5.37 ± 1.21	5.40 ± 1.25	5.68 ± 1.15	5.55 ± 1.12

^a Consumer sensory panel 7-point scale (1 = I dislike it very much to 7 = I like it very much).

TABLE IV
MEAN RATINGS AND STANDARD DEVIATIONS ASSIGNED BY MEXICAN CONSUMERS (N = 30) FOR SENSORY ATTRIBUTES OF PORK *Longissimus dorsi* ACCORDING TO COUNTRY OF ORIGIN / MEDIAS Y DESVIACIONES ESTÁNDAR PARA LOS ATRIBUTOS SENSORIALES DEL MÚSCULO *Longissimus dorsi* SEGÚN EL PAÍS DE ORIGEN.

	México	U.S.A.
Flavor ^a	4.19 ± 2.06	4.03 ± 2.26
Juiciness ^a	4.16 ± 2.40	4.90 ± 1.70
Tenderness ^a	5.25 ± 1.90	5.84 ± 1.15
Overall acceptability ^a	5.28 ± 2.20	5.43 ± 1.17

^a Consumer sensory panel 7-point scale (1 = I dislike it very much to 7 = I like it very much).

WHC, and emulsion capacity, and the lower WBSF exhibited by imported U.S.A. pork LD and RF muscles need to be corroborated. More reliable comparisons must include a more systematic sampling program, covering other geographical locations of Mexico and involving a larger number of samples. However, similarities in acceptability traits for both origins can suggest that Mexican and U.S.A. trade associations might start joining forces to increase pork consumption, which is traditionally low in Latin America.

ACKNOWLEDGMENTS

This research was carried out with the support of Facultad de Medicina Veterinaria y Zootecnia at the *Universidad Nacional Autónoma de México (UNAM)* in collaboration with the U.S. Meat Export Federation and the Departamento de Biotecnología at the Universidad Autónoma Metropolitana (UAM).

BIBLIOGRAPHIC REFERENCES

[1] ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. OFFICIAL METHODS OF ANALYSIS (AOAC). Washington DC. USA. 39.1-39.9 pp. 1995.

[2] AMERICAN MEAT SCIENCE ASSOCIATION & NATIONAL LIVESTOCK AND MEAT BOARD. (AMSA). Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Chicago. IL.145-170 pp. 1995.

[3] ARCOS-GARCIA, G.; TOTOSAUS, A.; GUERRERO, I.; PEREZ-CHABELA, M.L. Physicochemical, sensory, functional and microbial characterization of horse meat. **Rev. Bras. de Agrocién** 8: 43-46. 2002.

[4] ARSLAN, S. Effects of salt and phosphates level on emulsion properties of fresh and frozen hen meats. **Afric. J. of Biotechnol.** 5: 1006-1012. 2006.

[5] BENDALL, J. R.; SWATLAND, H. J. A review of the relationships of pH with physical aspects of pork quality. **Meat Sci** 24: 85-126. 1988.

[6] BOUTON, P. E.; HARRIS, P. V.; SHORTHOSE, W. R. The effect of pH upon the water-holding capacity and tenderness of mutton. **J. of Food Sci.** 36: 435-439. 1971.

[7] BRISKEY, E. J. Etiological status and associated studies of pale, soft, exudative porcine musculature. **Adv Food Res.** 13: 89-178. 1964.

- [8] GALLARDO N., J. L.; VILLAMAR A., L.; BARREAR W., M. A. Situación actual y perspectiva de la producción de carne de porcino en México. 2006. Coordinación General de Ganadería. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. En línea: <http://www.sagarpa.gob.mx/Dgg/estudio/sitpor06d.pdf>. 22 febrero. 2008.
- [9] HAMM, R. Water holding capacity of meat. In: **Meat** D.J.A. Cole and R.A. Lawrie, (Eds) Butterworths, London. 321-337 pp. 1975.
- [10] HONIKEL, K. The use and control of nitrate and nitrite for the processing of meat products. **Meat Sci.** 78:68-76. 2007.
- [11] HUFF-LONERGAN, E.; LONERGAN, S. M. Mechanisms of water holding capacity of meat: The role of postmortem biochemical and structural changes. **Meat Sci.** 71: 194-204. 2005.
- [12] KROPF, D. H.; HUNT, M. C.; PISKE, D. Color formation and retention in fresh meat. In **Proceedings Meat Indust. Res Conference American Meat Institute** Washington, DC. Pp. 62. 1986.
- [13] LENTNER, M.; BISHOP, T. **Experimental Design and Analysis**. Valley Book Company, Blacksburg, VA. 63-65 pp.1986.
- [14] LITTLE, A. C. A research note of on a Tangent. **J of Food Sci** 40: 410-411. 1975.
- [15] MACKEY, A. O.; OLIVER, A. W.; FANG, S. C. Chemical constituents, physical properties of palatability of frozen pork. **Food Res.** 17: 409-418. 1952.
- [16] MENDEZ M., D. R.; BECERRIL H., M.; RUBIO L., M. S.; DELGADO S., E. J. Carcass traits of Hairless Mexican pigs of Mizantla in the state of Veracruz in Mexico. **Vet. Mex.** 33: 27-37. 2001.
- [17] MILLER, R. K.; MOELLER, S. J.; GOODWIN, R. N.; LORENZEN, C. L.; SAVELL, J. W. Consistency in Meat Quality. In **Proceedings 46th International Congress Meat Science and Technology**. Buenos Aires, Argentina. 27 August-1 September 2000. Pp. 566-579. 2000.
- [18] NAUMANN, H. D.; RHODES, V. J.; BRADY, D. E.; KIEHL, E. R. Discrimination techniques in meat acceptance studies. **J. of Food Technol.** 2: 123-132. 1957.
- [19] OWEN, J. E.; NUÑEZ, F. A.; ARIAS, M. T.; DE, C. A., RÍOS, O. Calidad de carne. Manual de prácticas del curso de tecnología de la carne. Facultad de Zootecnia. Universidad Autónoma de Chihuahua, México. 17-25 pp 1982.
- [20] OCKERMAN, H. W. **Quality Control of Postmortem Muscle Tissue**. 2nd Ed, Vol. 2, The Ohio State University, Columbus, OH. Pp 51- 70.1985.
- [21] PENNY, I. F.; VOYLE, C. A.; LAWRIE, R. A. The comparison of freeze-dried beef muscle of high and low ultimate pH. **J. of the Sci. of Food and Agri.** 14: 53. 1963.
- [22] PEDRERO, D.L.; PANGBORN, R.M. Métodos Analíticos. Evaluación sensorial de los alimentos. México City. Editorial Alhambra Mexicana. Pp. 300. 1996.
- [23] NORTH AMERICAN MEAT PROCESSORS ASSOCIATION. (NAMP). **The Meat Buyer's Guide**. John Wiley & Sons, Inc. Hoboken, New Jersey. Pp 140-155. 2007.
- [24] SECRETARÍA DE AGRICULTURA, GANADERÍA, DESARROLLO RURAL, PESCA Y ALIMENTACIÓN. Coordinación General de Ganadería Informe sobre la situación de los recursos genéticos pecuarios de México. 2003. En línea: <http://www.sagarpa.gob.mx/ganaderia/FTP/infofao.pdf>. October 2008.
- [25] SPSS for Windows Ver. 16.0. Professional Statistics SPSS Inc. Chicago, IL. 1997.
- [26] SWIFT, C. E.; LOCKETT, C.; FRYAR, A. J. Comminuted meat emulsion-the capacity of meats for emulsifying fats. **Food Technol.** 15: 468-473. 1961.
- [27] SWATLAND, H. J. Evaluation of pH-related aspects of pork quality by capacitance measurements in an abattoir. **Can J. of Anim Sci.** 62: 725-730. 1982a.
- [28] SWATLAND, H. J. Meat color of pork chops in relation to pH and adductor capacitance of intact carcasses. **J. of Anim Sci.** 54: 264-267. 1982b.
- [29] INTERNATIONAL MARKETS, STRATEGIC MARKET (USMEF). Profile Report (SMP), 2007. On line: http://www.usmef.org/TradeLibrary/files/07_06_Pork.pdf. October, 2008.