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SENSORY EVALUATION OF COOKED PORK MEAT (*M. BÍCEPSFEMORIS*) FED WITH AND WITHOUT RACTOPAMINE HYDROCHLORIDE ASSOCIATED TO AGE BUT NOT GENDER OF THE NON-TRAINED PANELIST

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ABSTRACT

A sensory evaluation of the cooked pork meat fed with ractopamine at doses: 0, 5, 10, and 20 parts per million over the course of 28 days without withdrawal time, a panel of 72 judges evaluated the color, odor, and flavor of the meat from the ham area. There were no significant sensorial differences between ractopamine and control meats. Panelist's age showed an association with sensorial ratings (i.e. higher scores by older panelists, $P < 0.05$) and illustrates the need of using each panelist as his or her own control. Moreover, meat from fed swine with ractopamine for 28 days without withdrawal was generally well accepted by the panel of judges.

Key words: cook, pig, beta-agonist, pork, sensorial, ractopamine.

INTRODUCTION

The ractopamine hydrochloride (RAC) is a beta agonist widely used in the pig industry in countries such as USA, South Africa, Canada, Brazil and Mexico. RAC improved weight gain and carcass quality (lean) in finishing pigs (Avendaño-Reyes *et al.*, 2006; FDA, 2006; Ritter, 2006; MPC and AHI, 2007; Apple *et al.*, 2007; EFSA, 2009; FDA, 2010). RAC in pigs is well absorbed (< 2 hours) and more than 95% is excreted in the first 48 hours, there is zero toxic effect by eating meat with the drug (Grant *et al.*, 1993; Liu *et al.*, 1994; Smith, 1998; Liang y Mills, 2001; Armstrong *et al*., 2004; Ritter, 2006; MPC and AHI, 2007; Qiang *et al.*, 2007; EFSA, 2009; FDA, 2010). In Mexico, RAC is classified into type I drugs for use in pigs and cattle (DOF, 2003a), its use is strictly regulated by the Mexican Federal Government (DOF, 2002, 2003a, 2012). While RAC is approved by many countries because of its benefits, is being evaluated in different research fields.

On the subject of sensory evaluation (hedonic) studies, they help to explore the consumer acceptance and thus obtain good reference values useful to try to influence or understand specific markets (Anzaldua-Morales, 1994; Pedrero and Pangborn, 1997; Miller, 1998). In Mexico pork meat occupies a very important place in consumer options (SAGARPA, 2010; USDA/FSA, 2010), in 2013 the consumption of pork per capita per year was 15.7 kg according to statistics published by the Confederation of Mexican Pork AC (CPM, 2013), despite this fact and that RAC has been used in this country since 2000, following publication of a sensory type for pork assessed by Mexican consumers were not found and therefore not known whether any selective preference for pork with or without RAC.

This sensory evaluation study was performed with pork meat produced in Mexico, that were fed with RAC at different concentrations, and without RAC, in order to evaluate the potential of RAC on the acceptability of pork by Mexican untrained judges.

MATERIALS AND METHODS

The RAC source used in this study was provided by a registered trademark PAFMINE®, which contains RAC 20g per kg. The concentration of RAC in the commercial product was verified by HPLC in the Laboratory of the National Center for Verification Services for Animal Health (CENAPA), part of the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA). RAC was added to the feed at doses of 5 parts per million (ppm), 10 ppm and 20 ppm, an horizontal ribbon mixer machine was occupied for making the finisher feed with capacity of 1 ton per batch with a coefficient of variation in mixing (CV) ≤ 0.12 corroborated by microtracers (red-iron-Microtracers™), and the RAC dose provided (to the RAC groups) verified by HPLC in the CENAPA

laboratory. All the pigs were fed with sorghum and soybean containing 160g / kg crude protein and it was formulated to meet or exceed the nutrient requirements recommended by the National Research Council for the species and stage production (NRC, 1988). For the RAC's groups, RAC was added at the three different commercial doses (5 ppm, 10 ppm and 20 ppm) currently licensed for the stage of completion of fattening pigs in Mexico by the regulatory government agency SAGARPA, whereas control pigs received the same nutritional quality of food without RAC.

The experiment was conducted on a pig farm located in the state of Hidalgo, Mexico. The experimental pigs were from mothers York-Landrace and male genetic line for commercial meat production (Pietrain-LW). Of a total of 41 barrows for the experiment with an initial average body weight of 75 kg; were randomly divided into four groups, three with 10 and one 11 individuals. Each group was fed along four weeks as follow: the control group received no RAC (RAC 0 ppm) = Control; group 1: 5 ppm = RAC-05; group 2: 10 ppm = RAC-10 and group 3: 20 ppm = RAC-20. Animals received 3 kg / pig / day of animal feed following the established routine of the farm for this final stage of fattening. Weighed weekly to each and all 41 animals, were sacrificed at the end of four weeks. Once slaughtered (DOF, 1996), approximately one kilogram of meat from each animal was obtained from the area of the ham: *M. biceps femorais* (ICVGAN, 2005) according to the recommendations of the Canadian Food Inspection Agency (CFIA, 2004) and the Mexican Meat Pork Standards (DOF, 2003b).

All meat, from all groups was frozen at -10 °C for later use in sensory evaluation.

The sensory evaluation of the meat was performed comparing hedonic variables of color, odor and flavor, using a taste scale rated from 1 to 5 (1 = no acceptable, 2 = acceptable, 3 = good, 4 = very good, 5 = excellent). The preparation and cooking of the meat was identical for all samples: cuts of 2.5 cm^3, 16 g and pH 4, in a pressure cooker (EckoDelux 6078) which reaches 15 lb / 15 $pulg^2$ at 120 °C for 15 min under instruction manual, no seasoning added finally ensuring the same cooking conditions in all samples or aliquots in a short time (Myhrvold and Bilet, 2011). The different samples (2 cm^3 / 12 g and pH 5) of cooked meat were presented in white disposable plastic plates, both cooks and untrained judges (panelists) were conducted in a blinded way such that the identity of the different aliquots was guaranteed. Panelists were provided with plain water and white bread between different aliquots tasting meat with the intent to cleanse the palate and wash any residual flavor of the previous samples. The analysis was performed in the laboratory of sensory evaluation INCMNZS, taste panels were consistent with the literature (Anzaldua-Morales, 1994; Pedrero and Pangborn, 1997). A total of 72 judges generated 864 results (72 * 4 types (treatments) * 3 meat sensory characteristics).

Statistical Analysis: The results of the scale of taste for color, odor and flavor of cooked meat with RAC's treatments compared with the control using paired T test. The differences between the results for color, odor and flavor according to sex and age of judges, was evaluated using the Mann-Whitney U test. In the case of fattening pigs subjected to with or without RAC; the differences in total body weight were calculated using linear regression analysis and confidence intervals of 95%, Average Daily Gain (ADG) was calculated by dividing the weekly increase curve in seven.

RESULTS

The results of linear regression analysis are shown in Table 1, and this indicates the different average weight of each pen treated or not with RAC, also in Table 1 are observed the expected beneficial responses on live weight and daily weight gain when RAC is used in finishing pigs.

Table 1. Weekly average weight increase (slope) of the linear regression analysis of the weights of the control and experimental groups

Group	Number of			Slope		CI95%		AGD
	Pen	Pigs / Pen	r^2	Mean	SE	Low	High	kg/day
Control	1	11	0.976	4.72	0.42	3.4	6.1	0.67
RAC-05	1	10	0.988	6.72	0.43	5.4	8.1	0.96
RAC-10	1	10	0.978	7.31	0.63	5.3	9.3	1.04
RAC-20	1	10	0.943	6.39	0.91	3.5	9.3	0.91

CI95% = Confidence Interval of the curve. SE = standard error of the curve. AGD = Average daily gain

The results on Table 2 in the present study of sensory evaluation of meat from animals fed with 5, 10 or 20 ppm of RAC for four weeks showed a lack of significant difference when compared with meat from the control group for all traits tested (color, odor and flavor). Comparison of color, odor and flavor was done using the paired t-test (sensitivity was used to determine differences between groups) since only the differences between panelists were considered.

Table 2. Sensory scores of color, odor and flavor of pig meat fed with different doses of RAC

Characteristics	Group	Clasification			Differences vs Control		
		N	Mean	SD	Paried-t	P	
Color	Control	72	4.06	0.67			
	RAC-05	72	4.03	0.68	0.34	0.74	NS
	RAC-10	72	3.81	1.02	1.73	0.09	NS
	RAC-20	72	3.95	0.88	0.72	0.47	NS
Odor	Control	72	3.84	0.94			
	RAC-05	72	3.89	0.99	-0.35	0.73	NS
	RAC-10	72	3.95	0.97	-0.94	0.35	NS
	RAC-20	72	3.95	0.82	-0.88	0.38	NS
Flavor	Control	72	3.81	1.07			
	RAC-05	72	3.84	1.04	-0.21	0.84	NS
	RAC-10	72	3.63	1.13	1.14	0.26	NS
	RAC-20	72	3.61	1.06	1.12	0.27	NS

NS = no significant difference, SD = standard deviation.

In the present study, the highest scores or grades were in color (N = 288, mean = 3.96 ± 0.63) and odor (N = 288, mean = 3.91 ± 0.93) and both were significantly higher than the scores for flavor (N = 288, mean = 3.72 ± 1.08).

The association between age and sex of the panelists and the outcomes, and sensory scores were explored. The judges' age and not the sex was the one that showed an association of the results (see Table 3). High results or greater flavor for the meats were awarded by older panelists (P< 0.05) while the younger rated lower, although also generally liked all the meats.

Table 3. Hedonic results according to age and sex of the 72 judges

		Group	Judge	Samples	Slope			Group differences	
			N	N	Mean	SD	U	P	
Age	Color	17-29	34	135	3.83	0.83	2.60	0.009	Adult>Young
		30-62	38	153	4.08	0.81			
	Odor	17-29	34	135	3.62	1.03	4.48	<0.0005	Adult>Young
		30-62	38	153	4.16	0.75			
	Flavor	17-29	34	135	3.59	0.95	2.61	0.009	Adult>Young
		30-62	38	153	3.83	1.17			
Sex	Color	Females	41	163	4.00	0.86	0.97	0.33	NS
		Males	31	125	3.92	0.79			
	Odor	Females	41	163	3.92	0.93	0.41	0.68	NS
		Males	31	125	3.89	0.93			
	Flavor	Females	41	163	3.72	1.15	0.39	0.69	NS
		Males	31	125	3.72	0.98			

SD = standard deviation. U = U-value. P = probability of difference due to random variation. NS = no significant difference.

DISCUSSION

The daily weight gain recorded in the pigs was consistent with the meta-analysis by Apple (2007). All the meat was well accepted, regardless of treatment with or without RAC (see Table 2). The color had a score between 3 and 5 (range good to excellent). The odor evaluation for 6 of 72 judges awarded low rating (range no acceptable to good), as the same for the flavor, just 6 judges gave an overall low score.

In the case of the judges' sex, initially it was conceived that the hypothesis for women may differ from men, but this was not different (P> 0.05). For the case of the judges' age, it was speculated that younger judges may have a less sophisticated palate which offered higher performance. However the results were unable to ensure that it depends on a sophisticated palate; adult judges (40-62 years) had the highest scores compared to younger ones (see Table 3), we do not have a plausible explanation about why panelist's age showed an

association with sensorial ratings but it illustrates the need of using each panelist as his or her own control.

It was not found any report for color on cooked pork fed with RAC, for that reason it is important to note that in general the "chemical" senses of smell and taste are critical in the subjective assessment of food, while the "physical" as vision, hearing and touch senses play a secondary role (OTIACM, 2008). Thus, odor and flavor are predominant for the consumers' acceptance elements; however the final acceptance of the food is an interaction of the physical and chemical properties of food (Miller 1998; OTIACM 2008). If we rely on the above work, the meat has been well accepted even though the taste (chemical influence) obtained a lower value compared to the color (physical influence) under the same chemical and physical food characteristic. The general acceptance could be explained because the smell as a dominant chemical characteristic, was above the color and flavor, thus influencing better acceptance in all meats. Under this argument it is logical that the smell and color interact to influence a passing grade for taste. The lack of published studies, about sensory evaluation of the color of cooked meat from pigs fed with ractopamine, was not possible to compare these results. It is recognized that there are other variables that may interact in the sensory evaluation, but which were not measured in this study, such as resistance to cutting raw meat (Warner-Bratzler shear force),which it is related to tenderness of the same sensory evaluation, both variables have already been evaluated by other authors as mentioned by Apple (2007), where in his meta-analysis reports that while ractopamine increases Warner-Bratzler shear force, decreases the values for tenderness. The chosen cooking method is very important because it can affect the sensation of tenderness of the meat (Myhrvold *et al*., 2011), in this study the high-pressure cooker was used. For the flavor evaluation, a literature review was found (EFSA, 2009), discussing the arithmetical differences in the results of the meats with RAC vs meats without RAC, within a scale of -2.0 to 2.0. Considering this publication, as was performed for the results of this study, we found similarities in negative values with difference of RAC-20 (-0.2) and RAC-10 (-0.18), but in the case RAC-05 the lightweight difference was positive (+0.03), this suggests, maybe there is a discreetly possible differences between meat with and without RAC. Also, it could be indicated by different authors, that the fat proportion can change the appreciation of the flavor of the meat (EFSA 2009, Apple *et al.*, 2007, Stoller *et al.*, 2003, Fernández-Dueñas *et al.*, 2008, Carr *et al.*, 2005), and we know that the proportions of fat and muscle are different in animals that have been fed with RAC (Apple *et al.*, 2007). The differential analysis about the flavor described by EFSA (2009), motivated us to conduct a similar exercise, but for the color and the odor, observing the differences in the results between meats with RAC versus without RAC. In the case of the color all were negative (RAC-10 = -0.25, RAC-20 = -0.11 y RAC-05 = -0.03), but in the case of odor, all groups were positive for meat with RAC (RAC-20 +0,11, RAC-10 +0,11, y RAC-05 +0,05), again it leads us to believe that the chemical properties preponderance over the physical properties of meat, these observations encourage to rethink new sensory studies considering the results of the arithmetic difference between the meats without RAC versus meats with RAC (EFSA 2009), trying to relate them to some other variable of interest such as the meat fat ratio.

Conclusion: There are not sensorial changes of the palatability of the pork meat fed with RAC at any commercial doses (5, 10 or 20 ppm), despite the fact there was no retirement time before slaughter of animals. This work is statistical evidence, which until now was just an observation that was assumed to be no differences in the acceptance of meat from feedlots fed with or without RAC since it began to be used in 2000 in México. The results of the sensory comparisons for the variables: color, odor, and flavor of pig's cooked meat fed with or without RAC confirm the absence of difference between RAC doses treatments. Despite the fact that the use of ractopamine does not produce major changes on meat that can be evidenced by the traditional and most common forms of analysis, other variants may show slight differences that could be a subject of study, as we did in this work of sensory evaluation, where the taste (as a predominant chemical property) obtained a lower value compared to the color (as a secondary physical property) or in the case of the significance of the judges' age but not the sex.

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