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Evaluation of Surgical Castration *vs* Immunocastration in Fattening Pigs

Pérez-Sato, Marcos[1]; Cruz-Cortés, Ariadna[1]; Castro-González, Numa Pompilio[1]; Valencia-Franco Edgar[1]; Pérez-Martínez, Jennifer[2]; Escobar-Hernández, Ramiro[1]; Soní-Guillermo, Eutiquio[1*]

[1]Benemérita Universidad Autónoma de Puebla. Ingeniería Agronómica y Zootecnia. Reforma 165, Tlatlauquitepec, Puebla, México. [2]Benemérita Universidad Autónoma de Puebla. Ingeniería Agronómica y Zootecnia. Carretera Tecamachalco-Cañada Morelos km 7.5, El Salado, Tecamachalco, Puebla, México.

***Corresponding author**: eutiquio.soni@correo.buap.mx

ABSTRACT

Objective: To determine the effect of surgical castration and immunocastration on productive parameters, carcass quality, as well as the physicochemical characteristics of the meat of fattening pigs.

Design/Metodology/Aproach: Ten male pigs of the York/Pietrain/Landrace breed with a body weight of 25±5 kg were used per treatment. They were housed in individual pens and fed diets according to their physiological state. The variables evaluated were analyzed with a student's t-test for independent samples.

Results: Results do not show differences ($p>0.05$) in the productive variables, quality of the carcass or physicochemical characteristics.

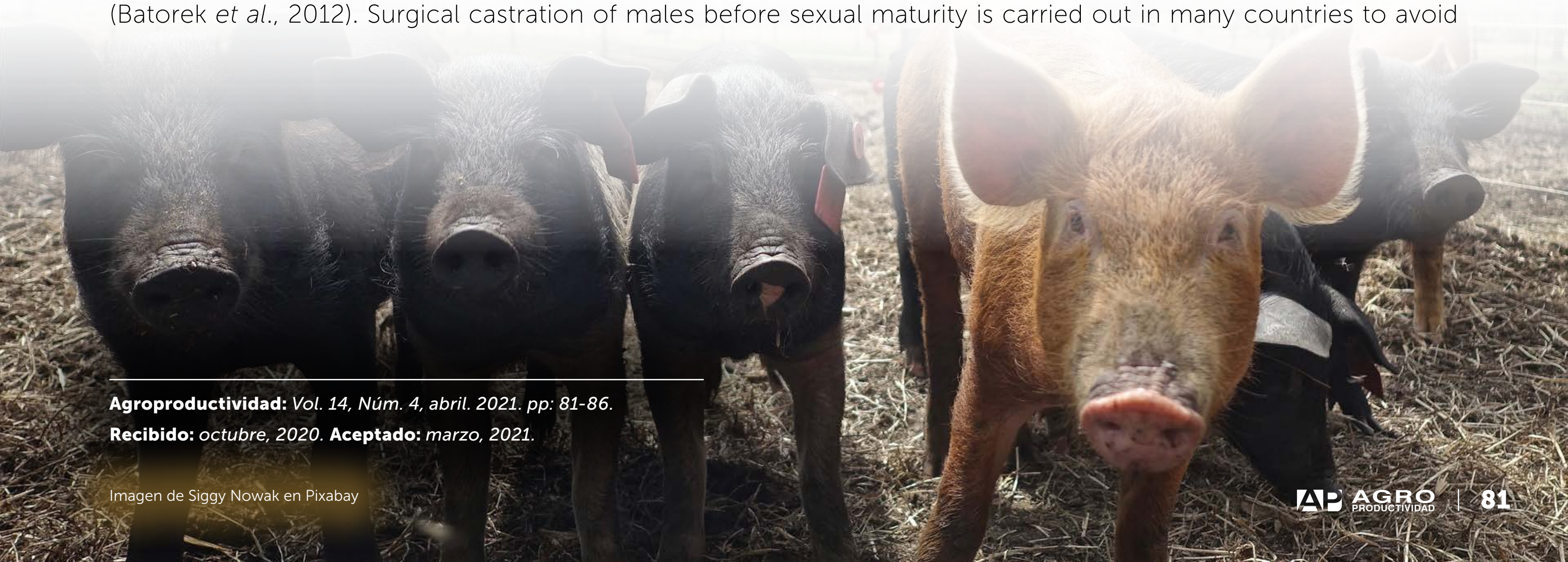
Study Limitations/Implications: The study did not consider qualitative variables such as flavor and smell of the treatments.

Findings/Conclusions: Immunocastration is an alternative to surgical castration since the quality of the carcass, the productive variables and the physicochemical characteristics of the meat are not affected, and it favors animal welfare.

Keywords: surgical castration, immunocastration, carcass quality, physicochemical characteristics.

INTRODUCTION

The odor and taste of pork meat is caused primarily by the accumulation of androstenone and skatole in the fatty tissue, which is a significant quality problem of the carcass of complete males (Clarke *et al*., 2008). There are two castration alternatives to raise fattening pigs and thus avoid meat contamination, which are surgical castration and immunocastration (Batorek *et al*., 2012). Surgical castration of males before sexual maturity is carried out in many countries to avoid



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bad odor and bad flavor, increase the content of dorsal fat, and prevent stress in the farmyard. However, the preoccupation over animal welfare has increased and it necessary to resort to other castration practices (Fàbrega *et al*., 2010). The surgical castration of young pigs is associated to a higher mortality from complications such as infections and hernias; in addition, this practice is criticized since it is generally practiced without anesthesia, causing pain and a significant increase in the concentration of serum cortisol that indicates stress (McGlone *et al*., 1993; Clarke *et al*., 2008). However, immunocastration allows improving animal welfare in pork production, avoiding them suffering pain, in addition to increasing the profitability from growth to the finalization period, which is why this technique provides good meat quality (Dunshea *et al*., 2013). The objective of immunocastration is to deactivate testicular function through the neutralization of the hormone from the hypothalamus-pituitary-gonadal axis (GnRH) (Oonk *et al*., 1998). For the effectiveness of the GnRH vaccine, two applications are necessary: the first dose prepares the pig's immune system without altering the size or the function of the testicles, and the second dose stimulates the immunoprotection response that inhibits the function of the testicles (Font-i-Fornols *et al*., 2012). Because of this, the objective of this study was to determine the effect of surgical castration and immunocastration on productive parameters (average daily gain, daily feed intake and feed conversion ratio), carcass quality (backfat thickness, Longissimus dorsi mulcle área, percentage of lean meat), as well as the physicochemical characteristics of meat (water holding capacity, pH and color) in fattening pigs.

MATERIALS AND METHODS

The study was performed in a pig farm located in the municipality of Tulancingo de Bravo, Hidalgo, Mexico (20° 05' N, 98° 22' W and 2160 m of altitude). The climate is semi-dry temperate, with mean annual temperature of 14 °C, and mean annual precipitation of 553 mm (INEGI, 2003).

The treatments were the following: T1 (surgically castrated males, SCM) and T2 (immunicastrated males, ICM); the study was divided into three experimental stages: 25-50, 50-75 and 75-100 kg of body weight (BW). The experimental units were 20 hybrid males (York×Pietrain ×Landrace) with average initial body weight (IBW) of 25±5 kg, with ten pigs per treatment. The pigs were housed in individual pens (1.8× 1.8 m) equipped with hopper type troughs and nipple drinking troughs. Food and water were offered as free access. The evaluation period lasted twelve weeks. The diets were formulated with the Solver command (Microsoft Excel, 2007), according to the requirements of the NRC (2012) for the three experimental stages (Table 1).

The technique of surgical castration was executed at 7 days of age: the piglet was restrained and the scrotum was washed with drinking water, then iodine was applied, and in the lower part of the scrotum an incision was made with a scalpel and at the same time the testicle was pressured to be extracted, and the other testicle was removed in the same way. Later, an antibiotic was applied via intramuscular and a cicatrizant on the wound, the latter during three days.

Table 1. Composition of diets.

Ingredients (%)	25 – 50 kg BW	50 – 75 kg BW	75 – 100 kg BW
Sorghum	75.06	77.80	84.53
Soybean meal	19.70	17.13	11.90
Soybean oil	2.20	2.25	0.92
Lysine[A]	0.57	0.46	0.62
DL- Methionine	0.14	0.15	0.20
L-Threonine	0.26	0.15	0.20
Vitamins and minerals [B y C]	0.30	0.30	0.30
Salt	0.20	0.25	0.30
Calcium carbonate	1.31	0.92	0.55
Calcium orthophosphate	0.56	0.89	0.75
Total	100.00	10.00	100.00
Nutritional Contribution (%)			
Metabolic energy (Mcal kg^{-1})	3.30	3.30	3.30
Crude Protein	16.10	14.5	13.50
Ca	0.66	0.59	0.64
P	0.46	0.27	0.45

[A]Supplied 50% lysine. [B]Supplied per kg of feed: vitamin A, 15,000 UI; vitamin D3, 2,500 UI; vitamin E, 37.5 UI; vitamin K, 2.5 mg; thiamine, 2.25 mg; riboflavin, 6.25 ámg; niacin, 50 mg; pyridoxine, 2.5 mg; cyanocobalamin, 0.0375 mg; biotin, 0.13 mg; choline chloride, 563 mg; pantothenic acid, 20 mg; folic acid, 1.25 mg. [C]Provided per kg of feed: Fe, 150 mg; Zn, 150 mg; Mn, 150 mg; Cu, 10 mg; Se, 0.15 mg; I, 0.9 mg; Cr, 0.2 mg. T=Treatment.

For immunocastration, two doses of the Improvac® vaccine by Zoetis of 2 mL were applied via subcutaneous at the neck's base, immediately behind the right ear. This contains analogous protein conjugate from the gonadotropin liberation factor, the first at ten weeks of age and the second four weeks after the first dose.

Productive Variables: The variables evaluated in each stage were: daily weight gain (DWG); average daily feed intake (ADFI); feed conversión ratio (FCR). These variables were measured weekly.

Characteristics of the carcass: Backfat thickness (BT) and *Longissimus dorsi* muscle area (LMA) were measured at the beginning of the experiment and later at 50, 75 and 100 kg of BW. Ultrasound equipment was used in real time (Landwind CU30VET, Shenzhen, China), performing the measurement on the loin at the height of the tenth rib. Lean meat percentage (%LM) was calculated with these data and those of Initial body weight (IBW) and final body weight (FBW), using the equation from the National Pork Producers Council (1991).

Physicochemical characteristics of the meat: These characteristics were evaluated at the end of the third experimental stage. When the pigs reached 100 kg of BW, five animals were slaughtered per treatment and samples were taken from the pigs' lumbar area to determine: pH, color, and the water holding capacity (WHC). The slaughter was performed in the farm complying with the Official Mexican Norm NOM-033-SAG/ZOO-2014 (SEGOB, 2015).

The pH and the color were measured in the loin muscle 24 h *post mortem*. The pH was measured with a potentiometer (model pH1100), according to the measurement of pH in meat homogenates (Braña *et al*., 2011). The color measurements were performed with the help of a colorimeter (Hunter Lab, Chroma meter CR-410, Konica Milolta Sesning, Inc., Japan) following the scale of the International Commission on Illumination (CIE) L*a*b*, where (L*) = luminosity, (a*) = red-green index, and (b*) = yellow-blue.

The WHC was determined in the samples according to the method proposed by Guerrero *et al*. (2002) at 24 h *post mortem*: 5 g of finely chopped meat were used, which were placed in tubes for centrifuge with 8 mL of 0.6 M sodium chloride solution. Later, they were placed in ice during 30 min, stirred in a vortex during 1 min, and centrifuged for 15 min at 10,000 rpm. The supernatant was collected by decanting and measured in a test tube. The retained water volume is reported as the amount of water retained in 100 g of meat.

Statistical analysis: The variables evaluated were analyzed with a student's t- test for independent samples, which compares the means of two populations, with two treatments of 10 repetitions each, a degree of confidence of 95%, and 0.05 degree of error, using the Statistical Analysis System software (SAS, 2010).

RESULTS AND DISCUSSION

Productive Variables and Carcass Quality

The productive variables DWG, ADFI and FCR in pigs of both treatments in the three stages evaluated were similar (Tables 2, 3 and 4) since they do not present differences ($P>0.05$). These results differ from those of other studies, which reported that the best productive parameters (DWG and FCR) were for the ICM in comparison to those of SCM in animals of 71-115 kg BW (Fábrega *et al*., 2010; Fernandes *et al*., 2017; Grela *et al*., 2020).

Poulsen Nautrup *et al*. (2018) performed a meta-analysis of 78 studies where different parameters of SCM and ICM were compared and they found that the ICM had an increase in DWG (32.54 g day^{-1}) compared to the SCM; the FCR was lower during the entire period in the ICM, which resulted in 0.23 kg of ADFI less than kg of livestock weight; it was also found that the BW was approximately 2 kg higher in the MCI compared to the SCM.

However, in this study despite not showing differences ($p>0.05$), the ICM had a lower DWG and higher index of FCR in the first period of evaluation (Table 2) and a better response in the productive characteristics compared with the SCM, in the stages of 50-75 kg and 75-100 kg (Table 3 and 4). The variation in the results from the different studies can be because of the age at which castration is done, since it can affect the growth rhythm of the animals and the higher growth of the muscular tissue as it approaches puberty (Quiles, 2005).

On the contrary, Morales *et al*. (2013) found that the ICM had a lower DWG compared to the SCM, and at the same time the ICM had a lower CAL ($P<0.001$) than the SCM with 2.33 and 2.77 kg day^{-1}, respectively. Fàbrega *et al*. (2010) mention that this could be justified due to the stress that pigs suffer when being injected, and to an increase in body temperature.

Table 2. Productive characteristics and carcass quality in male pigs with different castration techniques in the stage of 25 - 50 kg BW.

Variable	Surgical castration		Immunocastration		p Value
	MNS	SD	MNS	SD	
DWG (kg d^{-1})	0.81	0.41	0.73	0.32	0.50
DFI (kg d^{-1})	1.66	0.65	1.62	0.57	0.84
FC (kg/kg)	2.22	0.62	2.26	0.60	0.84
BT (mm)	4.66	1.29	2.56	0.91	0.16
LMA (cm^2)	27.58	3.57	28.26	2.35	0.73
LM (%)	45.68	1.05	47.51	2.28	0.14

Pr>|t|: values <0.05 are statistically different. MNS: mean; SD: standard deviation. DWG: daily weight gain; DFI: daily feed intake; FCR: feed conversion ratio; BT: backfat thickness; LMA: *Longissimus dorsi* muscle area; LM: lean meat.

Table 3. Productive characteristics and carcass quality in male pigs with different castration techniques in the stage of 50 - 75 kg BW.

Variable	Surgical castration		Immunocastration		p Value
	MNS	SD	MNS	SD	
DWG (kg d^{-1})	0.74	0.46	0.80	0.15	0.68
DFI (kg d^{-1})	2.86	0.79	2.77	0.24	0.79
FC (kg/kg)	4.08	1.17	3.73	0.43	0.51
BT (mm)	6.24	1.51	6.18	0.26	0.94
LMA (cm^2)	32.38	2.58	32.52	0.67	0.92
LM (%)	42.18	1.24	42.10	0.18	0.89

Pr>|t|: values <0.05 are statistically different. MNS: mean; SD: standard deviation. DWG: daily weight gain; DFI: daily feed intake; FCR: feed conversion ratio; BT: backfat thickness; LMA: *Longissimus dorsi* muscle area; LM: lean meat.

Table 4. Productive characteristics and carcass quality in male pigs with different castration techniques in the stage of 75 - 100 kg BW.

Variable	Surgical castration		Immunocastration		p Value
	MNS	SD	MNS	SD	
DWG (kg d^{-1})	0.92	0.46	1.01	0.47	0.52
DFI (kg d^{-1})	3.52	0.98	3.44	0.70	0.81
FC (kg/kg)	4.69	2.68	3.97	1.78	0.43
BT (mm)	8.28	2.67	7.24	1.55	0.47
LMA (cm^2)	43.72	8.61	44.64	7.41	0.86
LM (%)	41.92	2.85	42.32	2.68	0.82

Pr>|t|: values <0.05 are statistically different. MNS: mean; SD: standard deviation. DWG: daily weight gain; DFI: daily feed intake; FCR: feed conversion ratio; BT: backfat thickness; LMA: *Longissimus dorsi* muscle area; LM: lean meat.

Dalla Costa *et al*. (2020), found that immunocastration improved DWG, FLW and FC (P<0.008), which also improved the reduction of DF (P<0.0001) and increased %LM (P<0.0001) in the ICM carcasses, because the androgenic hormones produced by the testicles in the second dose promote a redistribution of nutrients to favor the synthesis of muscular and bone tissue, and consequently the adipose tissue is reduced compared to surgically castrated pigs (Boler *et al*., 2011).

On the contrary, Daza *et al*. (2016) did not observe differences in BT and LMA due to the type of castration, results that are similar to this study since differences were not obtained (p>0.05) between BT, LMA and %LM treatments. However, although there were no differences in the present study, in the treatment of ICM the values of LMA were higher and the BT lower in the three stages compared to SCM (Table 2, 3 and 4); in the first stage (25-50 kg BW) there was a higher %LM in ICM, from the second application of the vaccine and the behavior of this variable is very similar to those of the SCM. These results are similar to those by Fábrega *et al*. (2010), who observed that the ICM presented higher LMA compared to the SCM.

Physicochemical Variables of the Meat

Table 5 shows that the values obtained in pH, WHC and color did not show differences (P>0.05) between treatments, which is similar to that reported by Fernandes *et al*. (2017). Zamaratskaia and Krøyer (2015) point out that the parameters of meat quality and of meat in general differ between ICM and SCM, similar results to those obtained in this study.

Braña *et al*. (2011) describe that the WHC is influenced by the muscle's pH. The further away the pH is from the isoelectric point (5.0-5.5) of meat proteins, the more water they retain. Considering this affirmation, the fact that there is not difference in the WHC between the treatments can be because the pH is also similar between both treatments.

In addition to the pH, there are other factors that affect WHC, among them the race, the type of fiber, the oxidative stability of their membranes, the maturation process, and if the case may be, the system used to freeze and thaw the meats (Braña *et al.*, 2011).

Table 5. Physico-chemical characteristics of loin meat in male pigs with different castration techniques.

Variable	Surgical castration		Immunocastration		p Value
	MNS	SD	MNS	SD	
pH	5.28	0.30	5.15	0.27	0.19
WHC (ml)	14.0	8.55	11.40	4.72	0.24
Color:					
L*	45.97	3.91	43.96	2.41	0.05
a*	6.12	2.18	6.11	1.61	0.99
b*	6.59	1.71	6.05	1.41	0.27

Pr>|t|: valores <0.05 existe diferencia significativa, MNS: mean; SD: standard deviation, WHC: water holding capacity, Color: CIEL*a*b*, L* scale: brightness a*: red-green index b*: yellow-blue index.

CONCLUSIONS

Immunocastration does not affect the productive parameters, carcass quality, or physicochemical characteristics of the pork meat compared with surgical castration, which is why the first is an alternative to surgical castration, since this technique produces less stress in the pig and is more in accordance to animal welfare, in addition to immunocastration demanding less time invested.

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