RACTOPAMINE HYDROCHLORIDE AND IMMUNOCASTRATION EFFECTS ON PORK CARCASS TRAITS AND LEAN MEAT YIELDS

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Abstract - Sixty pork carcasses out of one hundred and eighty PIC crossbred pigs (G337 sire and CB22 dams) which were penned into 6 groups corresponding to 6 treatments of control and ractopamine (RAC, 7.5 mg/Kg during 21 days), and sex (female, FE, physically castrated male, PC, and immunocastrated, IC) aiming to clarify the combined effects of these two technologies on pork carcass traits and lean meat were carried out. The statistical analysis showed better results for RAC over the control, and IC over FE and PC. The IC presented heavier carcass weight ($p<0.05$), less fat thickness in the last lumbar rib ($p<0.05$), and more lean meat in the shoulder and front shank ($p<0.05$). Also, IC had higher ($p<0.05$) meat weight than PC in ham, loin, and neck. Ractopamine increased ($p<0.05$) carcass weight, loin eye area (cm2), and Hennessy loin thickness, as well as more ($p<0.05$) lean meat in ham, loin, belly, shoulder, jawl, tenderloin, and hind shank. A few interactions RAC x Sex were detected only for cut weights, favoring RAC treated FE. It was concluded that ractopamine and immunocastration have considerable effects on lean weights but the factors do not interact.

Keywords - ractopamine, immunocastration, lean pork.

I. INTRODUCTION

The current pig production chain has given the emphasis on improving carcass quality of slaughtered animals to meet consumer demand for pork [1].

In nutrition, with the use of ractopamine hydrochloride approved as an additive, is being widely used in swine diets, because increases lipolytic activity and muscle synthesis [2; 3]. The use of ractopamine improves performance and animal carcass characteristics [4; 5] in order to reduce the thickness of backfat, increases loin depth and lean gain [6]. Also, improves cut yields [7; 8].

In addition, gender is a major factor in determining the potential of growth and pig carcass quality in the growing and finishing period [9]. Therefore, in the context of animal nutrition, production of several strategies have been used like diets formulated separately for each sex, because required nutritional levels differs for barrows and gilts, and also pigs may show different responses to the use of ractopamine in the diet according to gender [1].

As an alternative method of inhibiting compounds sex fat of carcasses and reducing the accumulation of pheromone, immunocastration, temporary suppression of testicular function by vaccination against gonadotrophin releasing hormone (GnRH) [10; 11], has been widely used in world pigs's production to replace the traditional method of castration of male. Surgical castration of piglets is a practice commonly carried out with the main objective to prevent boar taint in meat from boars [12], however, has a number of disadvantages. It is an animal-unfriendly practice, which causes wound pain and stress, acute or chronic setbacks on performance efficiency and gives a higher risk for infection [13].

The objective of this research was to determine the impact of sex and addition of 7.5mg/kg ractopamine in diet, and also the combination between these two Technologies on pig carcass quality and composition.

II. MATERIALS AND METHODS

One hundred and ten AGROCERES PIC crossbred pigs (AGPIC 337 sires x CB 22 dams) from a commercial farm were grouped in females (FE), physically castrated (PC) and immunocastrated boars (IC), fed or not with ractopamine hydrochloride (7.5 mg/kg, Ractosuin, Ourofino Agrobusiness) for the final 21 days before slaughter. The boars designated to immunocastration received two doses of vaccine 8 and 4 weeks before slaughter, as recommended (Improvac, Pfizer Animal Health). Based on hot carcass weight and HPG (Henessy Grading Probe) fat and muscle depth, were selected ten pigs of each combination ractopamine dietary and sex, belonging to the average interval of ±2 standard deviations. During slaughter, these variables (hot carcass weight and HPG fat and muscle depth) were collected. After chilling, carcass weight and length, and backfat thickness (first thoracic rib, last thoracic rib and last lumbar vertebrae, and its average) were recorded. Fat depth and longissumus muscle area (LMA) were measured between the 10th and 11th rib. Then, carcasses were divided into eleven primal cuts according to the EU reference method [14]. The experiment was carried out as a factorial (2 x 3) arrangement with RAC diet (0 and 7.5 mg/kg) and sex categories (FE, PC and IC). Data were analyzed by ANOVA using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC) with a model including RAC, sex, and their interaction. Least squares means were separated by the PDIFF, and statistical differences were declared at $p < 0.05$ level.

III. RESULTS AND DISCUSSION

Results from carcass quality in regarding to sex and to addition of ractopamine hydrochloride in diet are presented in Table 1. There was no interaction ($P>0.05$) between the addition of ractopamine and sex for any carcass quality variables which corroborates to [1] therefore, only main effects are presented. The effect of sex were significant ($p<0.05$) to last lumbar rib fat thickness (FT3). The effect of adding ractopamine were significant ($p<0.05$) to HPG meat depth (HPGm) and 10th rib loin length (LL10th). The hot (Hc) and cold (Cc) carcass weight, *Longissimus* muscle area (LMA) were influenced by sex as well as addition of ractopamine.

Regarding sex, for Hc and Cc IC were heavier than FE, and PC had no differences from both sexes in agreement to the results found by Rikard-Bell et al. [15]. According to the authors, carcass weight increased by dietary ractopamine in all sexes, but presented lower means when compared to this study. Physically castrated boars (PC) and FE had higher mean compared to IC for FT3. Considering LMA the FE had higher area when compared to PC, but IC had both similar area agreeing with [16], exhibiting also 5cm^2 greater FE than PC and 3,8cm^2 greater for dietary ractopamina (não entendi). According to [15] carcass weight increased by dietary ractopamine in all sexes, but presented lower means when compared to this study.

Regarding the use of ractopamine, the addition of 7,5mg/kg increased Hc, Cc, HPGm, LL10th and LAM compared with the control diet.

Results from carcass composition for the variable total cut weight in recording to sex and to addition of ractopamine hydrochloride in diet are presented in Table 2. There was interaction ($p<0.05$) between the addition of ractopamine and sex for the cut weight of ham and jawl, presented in Table 4. The effect of sex were significant ($p<0.05$) to the cut shoulder and front shank. The effect of adding ractopamine were significant ($p<0.05$) to cut ham and jawl.

Regarding sex, for the cut shoulder IC were heavier than FE, and PC had no differences from both sexes. Immunocastrated boars (IC) were heavier than FE and PC for the cut front shank.

Regarding the use of ractopamine, the addition of 7,5mg/kg increased the total cut weight of ham and jawl compared with the control diet, others cuts had no significant differences ($P>0.05$). According to Amaral et al., [1] animals fed with diets supplemented with ractopamine had increases of 6.3% in the TW.

Statistical carcass composition results for the variable meat weight in recording to sex and to addition of ractopamine hydrochloride in diet are presented in Table 3. There was interaction ($p<0.05$)

between the addition of ractopamine and sex only for cut ventral part of the belly, presented in Table 4. The effect of sex were significant ($p<0.05$) to the cut ventral part of the belly, neck and front shank. The effect of adding ractopamine were significant ($p<0.05$) to the cut belly, jawl, tenderloin and leg. The cut ham, loin and shoulder were influenced by sex as well as addition of ractopamine.

Regarding to sex, it was observed that the cuts ham, loin and neck from IC had more meat than PC, and FE had no differences from both sexes. Gispert et al. [17] presented disparate results for cut ham, showing that SC had more meat than FE and IM. For the cut ventral part of the belly IC had more meat than FE, and PC had no differences from both sexes. Immunocastrated boars (IC) had more meat than FE and PC for the cut shoulder and front shank.

Taking into consideration the use of ractopamine, the addition of 7,5mg/kg increased the meat weight for the cut ham, loin, belly, shoulder, jawl, tenderloin and leg compared with the control diet, others cuts had no significant differences ($P>0.05$). According to Schinckel et al. [17] ractopamine reduces the synthesis of fatty acids in adipose tissue while increasing protein synthesis, which results in improvement of the percentage of lean meat in carcass observed in the study. Improvement of meat in ham and other major commercial pork cuts are reported by Uttaro et al. [16], Schinckel et al. [18] and Carr et al. [19]. The highest cut yields, and at the same time, the higher meat percentage as can be explained as a result of the increasing muscle fibers, specifically white and intermediate fibres [20; 21]. Results from the interaction between sex and the addition of ractopamine in diet for the carcass composition are presented in Table 4. The addition of 7,5mg/kg ractopamine in diet for females (FE) increased TW of the ham and jawl compared with the control diet. For lean meat of cut ventral part of the belly, when fed control diet IC had more than FE, and PC had no differences from both sexes.

Table 1. Effects of sex (S) and ractopamine (R) on carcass quality.

	SEX (S)[1]			RACTOPAMINE (R)		Significance[2]	
ITEM	PC	IC	FE	0 mg/Kg	7,5mg/Kg	S	R
Hot carcass weight (kg)	48,84^{ab}	51,01^{a}	48,10^{b}	48,41^{b}	50,23^{a}	*	*
Cold carcass weight (kg)	48,17^{ab}	50,30^{a}	47,51^{b}	47,79^{b}	49,53^{a}	*	*
HPG fat depth (mm)[3]	17,16	16,66	17,88	17,87	16,60	ns	ns
HPG meat depth (mm)[3]	64,76	66,14	66,48	63,53^{b}	68,05^{a}	ns	*
Carcass length (cm)[4]	81,99	82,74	81,16	81,62	82,29	ns	ns
1st thoracic rib fat thickness (mm)[5]	35,26	34,13	33,87	34,73	34,10	ns	ns
Last thoracic rib fat thickness (mm)[6]	23,65	22,68	22,70	23,03	22,99	ns	ns
Last lumbar rib fat thickness (mm)[7]	21,11^{a}	16,91^{b}	21,37^{a}	19,94	19,65	*	ns
Average backfat thickness (mm)[8]	26,67	24,57	25,98	25,90	25,58	ns	ns
Maximum fat thickness (mm)[9]	30,97	29,75	30,86	29,75	31,30	ns	ns
10th rib fat thickness (mm)[10]	18,76	18,61	17,76	19,18	17,58	ns	ns
10th rib loin length (mm)[11]	96,73	98,81	99,57	96,49^{b}	100,25^{a}	ns	*
Longissimus muscle area (cm^2)[12]	48,75^{b}	51,10^{ab}	53,75^{a}	49,30^{b}	53,10^{a}	*	*

[a,b,c] For each line means with different superscripts among sex (S) columns are significantly different ($p<0.05$) by Tukey test.
[a,b,c] For each line means with different superscripts among ractopamine (R) columns are significantly different ($p<0.05$) by Tukey test.
[1] PC (Physically castrated boars), IC (Immunocastrated boars), FE (Females).
[2] Statistical significance by ANOVA, where *, $p < 0.05$; ns, non significant. The interaction S x R was not significant ($P>0.05$).
[3] Measurement obtained using a Hennessy Grading Probe (3rd and 4th from last thoracic vertebrae).
[4] From distal border of the pubic symphysis to the cranial edge of the first rib.
[5] FT1, [6] FT2, [7] FT3, [8] ABT, [9] MFT between the FT2 and FT3, [10] F10th, [11] LL10th, [12] LMA.

Table 2. Effects of sex (S) and ractopamine (R) on the composition of carcass for the variable total cut weight (TW).

TOTAL CUT WEIGHT	SEX (S)[1]			RACTOPAMINE (R)		Significance[2]		
	PC	IC	FE	0 mg/Kg	7,5mg/Kg	S	R	S x R
HAM WEIGHT (kg)	11,80	12,11	11,83	11,58^{b}	12,24^{a}	ns	*	*
LOIN WEIGHT (kg)	8,17	8,68	8,18	8,12	8,57	ns	ns	ns
BELLY WEIGHT (kg)	4,27	4,62	4,22	4,25	4,48	ns	ns	ns
VENTRAL PART OF THE BELLY WEIGHT (kg)	0,95	1,01	0,98	0,98	0,98	ns	ns	ns
TO VENTRAL PART OF THE BELLY WEIGHT (kg)	1,49	1,65	1,63	1,59	1,59	ns	ns	ns
SHOULDER WEIGHT (kg)	5,67^{ab}	5,81^{a}	5,41^{b}	5,58	5,68	*	ns	ns
NECK WEIGHT (kg)	4,23	4,54	4,22	4,29	4,37	ns	ns	ns
JAWL WEIGHT (kg)	1,52	1,48	1,56	1,43^{b}	1,61^{a}	ns	*	*
FRONT SHANK WEIGHT (kg)	0,94^{b}	1,02^{a}	0,90^{b}	0,95	0,97	*	ns	ns
LEG WEIGHT (kg)	1,56	1,55	1,51	1,50	1,58	ns	ns	ns

^{a,b,c} For each line means with different superscripts among sex (S) columns are significantly different ($p<0.05$) by Tukey test.
^{a,b,c} For each line means with different superscripts among ractopamine (R) columns are significantly different ($p<0.05$) by Tukey test.
[1] PC (Physically castrated boars), IC (Immunocastrated boars), FE (Females).
[2] Statistical significance by ANOVA, where *, $p < 0,05$; ns, non significant. The interaction S x R was not significant ($p<0.05$).

Table 3. Effects of sex (S) and ractopamine (R) on the composition of carcass for the variable meat weight (ME).

MEAT	SEX (S)[1]			RACTOPAMINE (R)		Significance[2]		
	SC	IC	FE	0 mg/Kg	7,5mg/ Kg	S	R	S x R
HAM WEIGHT (kg)	7,98^{b}	8,63^{a}	8,29^{ab}	7,98^{b}	8,62^{a}	*	*	ns
LOIN WEIGHT (kg)	4,08^{b}	4,50^{a}	4,27^{ab}	4,09^{b}	4,48^{a}	*	*	ns
BELLY WEIGHT (kg)	2,75	3,01	2,73	2,69^{b}	2,96^{a}	ns	*	ns
VENTRAL PART OF THE BELLY WEIGHT (kg)	0,39^{ab}	0,45^{a}	0,38^{b}	0,39	0,42	*	ns	*
TO VENTRAL PART OF THE BELLY WEIGHT (kg)	0,77	0,87	0,74	0,77	0,82	ns	ns	ns
SHOULDER WEIGHT (kg)	3,47^{b}	3,75^{a}	3,40^{b}	3,44^{b}	3,64^{a}	*	*	ns
NECK WEIGHT (kg)	2,61^{b}	2,92^{a}	2,70^{ab}	2,67	2,81	*	ns	ns
JAWL WEIGHT (kg)	1,00	1,03	1,06	0,97^{b}	1,10^{a}	ns	*	ns
TENDERLOIN WEIGHT (kg)	0,57	0,61	0,62	0,55^{b}	0,65^{a}	ns	*	ns
FRONT SHANK WEIGHT (kg)	0,38^{b}	0,42^{a}	0,38^{b}	0,38	0,41	*	ns	ns
LEG WEIGHT (kg)	0,85	0,86	0,87	0,81^{b}	0,90^{a}	ns	*	ns

^{a,b,c} For each line means with different superscripts among sex (S) columns are significantly different ($p<0.05$) by Tukey test.
^{a,b,c} For each line means with different superscripts among ractopamine (R) columns are significantly different ($p<0.05$) by Tukey test.
[1] PC (Physically castrated boars), IC (Immunocastrated boars), FE (Females).
[2] Statistical significance by ANOVA, where *, $p < 0.05$; ns, non significant.

Table 4. The effect of the interaction between sex (S) and ractopamine (R) on the composition of carcass.

	RAC	SEX[1]		
	mg/kg	SC	IC	FE
HAM WEIGHT (kg)				
Total Cut Weight	**0**	11,73^{Aa}	11,90^{Aa}	11,11^{Ba}
	7,5	11,87^{Aa}	12,31^{Aa}	12,55^{Aa}
JAWL WEIGHT (kg)				
Total Cut Weight	**0**	1,44^{Aa}	1,50^{Aa}	1,36^{Ba}
	7,5	1,60^{Aa}	1,45^{Aa}	1,77^{Aa}
VENTRAL PART OF THE BELLY WEIGHT (kg)				
Meat	**0**	0,41^{Aab}	0,42^{Aa}	0,32^{Ab}
	7,5	0,36^{Aa}	0,47^{Aa}	0,43^{Aa}

Within sex columns, means with different lowercase letters differ ($p<0.05$) by Tukey test.
Within ractopamine row, means with different capital letters differ ($p<0.05$) by Tukey test.
[1] PC (Physically castrated boars), IC (Immunocastrated boars), FE (Females).

IV. CONCLUSIONS

Ractopamine and immunocastration have considerable effects on lean weights, however the factors do not interact.

V. ACKNOWLEDGMENT

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