EFFECT OF AN ALLOSTATIC MODULATOR (VsEs3-C®) ON ANIMAL WELFARE, CARCASS CHARACTERISTICS AND PORK MEAT QUALITY

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Abstract – The effect of supplementation of an allostatic modulator (anti-stress additive) 30 days before slaughter during two seasons (winter and summer) was studied. Animal welfare parameters during transport to the slaughterhouse and the welfare practices during the slaughtering process (unloading, stunning, breeding and scalding) were monitored. Blood samples were collected upon exsanguination to test for glucose, creatine kinase and lactate dehydrogenase (LDH). Carcass traits such as pH, temperature (at 45 min and 24 h) and color, as well as yields (refrigeration loss, RL) and morphometric characteristics, were evaluated. Meat (M. *L. thoracis*) parameters were analyzed (pH, color, texture, collagen, water holding capacity, drip loss and cooking loss). Results showed that animal welfare was respected during all stages of meat production (farm-slaughter). The addition of an allostatic modulator decreased (P<0.05) aggression among animals, blood glucose values (100.79 and 115.24 mg/dl, in treated and untreated animals, respectively) and hardness (WBSF) values of meat during both seasons (0.5% in winter and 9.2% in summer) and increased CCW (cold carcass weight), HCW (hot carcass weight), backfat, meat depth, RL, wide leg, L*and a* values. The results indicated that the use of an allostatic modulator in pigs improved animal welfare and therefore the quality of carcass and pork meat.

Key Words – Animal welfare, Allostatic modulator, Pork meat quality.

I. INTRODUCTION

Pork meat is generally recognized as having important nutritional properties due to its content of high biological value proteins, group B vitamins, minerals, especially heme iron, and trace elements and other bioactive compounds. However, pork meat also contributes to the intake of fat, saturated fatty acids, cholesterol and other substances that, in inappropriate amounts, may result in negative physiologically effects [1]. The composition of pork meat depends on many factors such as: genotype, age, sex, specific cuts/muscles, animal welfare, production system and type of feed. Typically, the day of slaughter consists of a number of potentially stressful elements, which may adversely affect both animal welfare and meat quality. However, dietary supplementation with antioxidants, cereals and oils, among other supplements, may potentially increase the rates of oxidation of pork meat components [2,3]. To the authors´ knowledge, no study has been previously performed on the use of an allostatic modulator as a dietary supplementation for pigs.

The objective of the current work was to evaluate the effect of dietary supplementation (with an allostatic modulator in drinking water) on the animal welfare, carcass characteristics and pork meat quality.

II. MATERIALS AND METHODS

In this study, 90 untreated and 90 treated pigs, supplemented with an allostatic modulator (VsEs3-C®) 30 days before slaughter and during two seasons (winter and summer) from the same farm were evaluated (N= 360 in total). Animal welfare parameters during transport to the slaughterhouse and the welfare practices during the slaughtering process (unloading, stunning, breeding and scalding) were monitored. Blood samples were

collected upon exsanguination to test for glucose, creatine kinase and lactate dehydrogenase (LDH) using commercial kits. In total, 360 *post-mortem* carcass parameters were analyzed (pH and temperature after 45 min and 24 h), as well as yields (yield and refrigeration loss, RL) and morphometric characteristics. Quality of meat was determined from 96 samples of M. *longissimus thoracis* (LT) by evaluation of pH, water holding capacity (WHC), drip loss, cooking loss weight, color (L*, a*, b*, C* and h*), texture (WBSF) and collagen (hydroxyproline/g). A factorial ANOVA was performed for the data in order to examine the effect of the different diets and seasonal conditions. Duncan´s test was carried out at a 95% confidence level ($P<0.05$). Statistical analysis of the data was performed using NCSS07 software.

III. RESULTS AND DISCUSSION

Animal welfare is necessary during meat production in order to maintain meat quality, as poor animal welfare is associated with lower meat quality. Some of the more widely recognized challenges to animal welfare during meat production are commonly associated with stress, although challenges may vary between species [1]. The results of animal welfare evaluation (Table 1) indicated that conditions of temperature and relative humidity were higher on the farm during animal transport and discharge over the course of the summer period ($P<0.05$). During animal transport (time, ramp angle, whistles, electric prods, travel transfer, distance farm-slaughterhouse and animal density) and discharge (ramp angle, electric prods and whistles) the evaluated parameters were kept within permissible reference values [3, 4].

The day of slaughter includes a number of novel and potentially stressful experiences for pigs, and it is well known that pigs can show stress responses during this period, which may adversely affect both the welfare of the animals and meat quality [3]. The results of the slaughterhouse evaluation (Table 2) indicated that the evaluated parameters such as stunning, stunning time, corneal reflex, shear sensitivity, bleeding time, time between stunning and shear, scalding time and scalding temperature were kept within permissible reference values [5]. These results indicated that animal welfare was respected during all stages of meat production (farm-slaughter).

After slaughter, carcass characteristic and pork meat quality were evaluated between pigs supplemented with an allostatic modulator in drinking water (Table 3) and a control group. Glucose and LDH values were reduced for those treated with the allostatic modulator during both seasons although mainly in winter; while pH 45 min, pH 24 h, CCW, HCW, backfat, meat depth, RL, carcass length and leg width values increased slightly ($P<0.05$) in pigs fed with the allostatic modulator in both seasons (summer > winter). Results also indicated that dietary supplementation had no effect on CK, yield, or LC and AP values ($P>0.05$). It has been suggested that increases in body temperature could be used as an indicator of welfare and particularly as an indicator of stress; however, thermoregulatory behavior of each pig is difficult to record during transport. Indicators of the overall burden on animals during transport could be assessed through an analysis of blood samples (glucose, creatine kinase, LDH). In addition to the blood measurements, the pH may constitute an indicator of welfare, as pre-slaughter stress may affect the subsequent muscle pH [4]. The productive performance of food animals directly affects the quality of carcasses and may be assessed by the parameters of CCW, HCW, backfat, meat depth, RL, carcass length and leg width [6].

Concerning pork meat quality, the addition of an allostatic modulator did not significantly affect WHC, DL, CL, b*, C* and h* values when compared with the control ($P>0.05$). However, these parameters showed lower values, mainly in the summer period. The L* (lightness) values of pork meat increased in both seasons with the allostatic modulator compared to the untreated pigs by 8.3% (winter) and 5% (summer), and a* (redness) values increased 10.4% in (summer); meanwhile, the texture (hardness) was reduced by 0.5% (winter) and 9.2% (summer) ($P<0.05$). Meat color is an important quality attribute during both consumer's selection of fresh meat at the retail level and the consumer's final evaluation and acceptance of a meat product at time of consumption. High L* and a* values indicate lower oxidation levels of meat and a preservation of the pink color characteristic of pork meat [7]. Texture and

collagen values decreased in samples supplemented with an allostatic modulador (P<0.05). According to Shackelford [8], a meat sample can be considered tender when it presents resistance to cutting force, determined at 1 or 2 days *post-mortem*, with less than 6 kgf. Braña [9] reported that the amount of collagen influences the hardness of meat although a direct correlation was unable to be established, as other factors must be taken into consideration, such as collagen solubility, distribution of collagen fibers and toughness provided by the myofibrillar and cytoskeletal complex.

The present results indicated that supplementation of an allostatic modulator in drinking water has an effect on some physical parameters of pork quality, mainly during the summer period.

Table 1 Animal welfare evaluations.

Parameter	Winter	Summer	Ref.
	Farm conditions		
Temp. °C	21.87^{a}	34.95^{b}	
RH (%)	46.05^{a}	49.15^{b}	
	Animal transport		
Time (min)	89.0^{b}	61.0^{a}	
Temp. °C	26.0^{a}	34.0^{b}	
RH (%)	24.0^{a}	43.0^{b}	
RA (°)	15.42^{a}	15.42^{a}	<20°
Shouting	0.0^{a}	157.0^{b}	0
Whistles	0.0^{a}	0.0^{a}	0
EP (%)	0.0^{a}	0.0^{a}	10
TT(h)	1.48^{b}	1.36^{a}	<20
DFS (km)	93.50^{b}	69.0^{a}	
AD/m^2 (120 kg)	2.33^{a}	2.33^{a}	2.35
	Animal discharge		
Time (min)	31.0^{b}	21.0^{a}	
Temp. (°C)	22.1^{a}	27.0^{b}	
RH (%)	30.0^{a}	76.0^{b}	
RA (°)	10.74^{a}	10.74^{a}	<20°
EP (%)	0	0	10
Shouting	0	9	0
Whistles	0	20	0

Temp, temperature; RH, relative humidity; RA, ramp angle; EP, electric prods; TT, travel transfer. DFS, distance farm-slaughterhouse; AD, animal density; Ref, reference value. Different superscripts (a-c) differ significantly (P<0.05).

Table 2 Slaughterhouse evaluation.

Parameter	Cw	Tw	Cs	Ts
Stunning	1.6 A 200 V	1.6 A 200 V	1.6 A 372 V	1.6 A 372 V
Stunning time (seg)	2	2	2	2
Corneal reflex (#)	0	0	5	0
Shear sensitivity (#)	0	1	5	0
Bleeding time (seg)	29.0^{c}	29.3^{c}	26.2^{b}	24.9^{a}
Time between stunning and slaughter (seg)	4.8^{a}	4.8^{a}	8.0^{b}	7.8^{b}
Scalding time (min)	5.2^{b}	5.1^{b}	6.0^{c}	4.3^{a}
Scalding temperature (°C)	56.3^{a}	57.6^{a}	60.0^{a}	60.0^{a}

C, control; T, treatment; w, winter; s, summer. (#), number of animals. Different superscripts (a-c) within the same season differ significantly (P<0.05).

Table 3 Carcass characteristics and pork meat quality.

Analysis	Cw	Tw	Cs	Ts
	Carcass quality			
Glucose	113.91^{b}	100.79^{a}	125.41^{b}	115.24^{a}
CK	369.75^{a}	369.16^{a}	371.91^{a}	369.86^{a}
LDH	181.09^{a}	179.45^{a}	181.20^{a}	180.52^{a}
pH 45min	6.24^{b}	6.42^{a}	6.02^{b}	6.14^{a}
pH 24 h	6.11^{b}	6.22^{a}	6.00^{b}	6.14^{a}
T 24 h	1.05^{a}	1.96^{b}	0.59^{a}	0.82^{b}
CCW	99.96^{a}	100.64^{a}	99.03^{b}	105.68^{a}
HCW	98.96^{a}	99.93^{a}	97.38^{b}	104.13^{a}
Backfat	1.55^{a}	1.71^{a}	1.72^{a}	1.82^{a}
Meat depth	6.28^{a}	6.32^{a}	5.84^{a}	6.12^{a}
RL	0.99^{b}	0.71^{a}	1.43^{a}	1.49^{a}
Yield	52.49^{a}	52.54^{a}	51.57^{a}	51.34^{a}
Carcass length	92.05^{a}	91.96^{a}	91.53^{a}	92.92^{a}
Wide leg	75.32^{a}	78.03^{b}	76.29^{a}	78.18^{b}
	Meat quality			
pH	5.56^{a}	5.54^{a}	5.77^{b}	5.70^{a}
WHC (%)	92.24^{a}	92.10^{a}	93.44^{a}	93.46^{a}
DL (%)	2.49^{a}	2.58^{a}	5.60^{a}	5.49^{a}
CL (%)	16.55^{a}	17.69^{a}	15.54^{a}	15.66^{a}
L*	51.92^{a}	55.04^{b}	50.17^{a}	52.52^{b}
a*	11.12^{a}	10.31^{a}	7.67^{b}	8.47^{a}
b*	10.34^{a}	11.58^{a}	8.40^{a}	8.65^{a}
C*	10.01^{a}	10.03^{a}	7.78^{a}	8.04^{a}
h*	47.26^{a}	47.95^{a}	47.90^{a}	47.04^{a}
Texture	5.51^{b}	4.96^{a}	4.69^{b}	4.21^{a}
Collagen	0.53^{a}	0.58^{b}	0.52^{a}	0.54^{a}

C, control; T, treatment; w, winter; s, summer; CK, creatine kinase; LDH, lactate dehydrogenase; CCW, cold carcass weight; HCW, hot carcass weight; RL, refrigeration loss; WHC, water holding capacity; DL, drip loss; CL, cooking loss. Different superscripts (a-b) within the same season differ significantly (P<0.05).

IV. CONCLUSION

In conclusion, supplementation of a pig´s diet with an allostatic modulator is a mean of increasing carcass and pork meat quality and decreasing susceptibility of pork meat to oxidation without affecting other parameters of meat quality.

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