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Meat Quality and Lipid Oxidation of Pork after Dietary Supplementation with Oregano Essential Oil

[1]Alma D. Alarcon-Rojo, [1]Esmeralda Peña-Gonzalez, [2]Hector Janacua-Vidales, [3]Victor Santana and [1]Juan A. Ortega

[1]Universidad Autónoma de Chihuahua, Facultad de Zootecnia y Ecología, Chihuahua, Chih, México
[2]Universidad Autónoma de Ciudad Juαrez, Instituto de Ciencias Biomédicas, Departamento de Ciencias Veterinarias, Ciudad Juαrez, Chih, México
[3]Universidad Autónoma de Chihuahua, Facultad de Ciencias Químicas, . Chihuahua, Chih, México

Abstract: This study was carried out to determine the effects of diet supplementation with oregano (*Lippia graveolens*) essential oil (OEO) on meat quality and lipid oxidation in swine. A total of 48 pigs (Landrace × Yorkshire) was randomly assigned to one of four experimental groups during the finishing period. Each group was fed a commercial diet supplemented with either 0 ppm (control), 1000 ppm, 2000 ppm or 3000 ppm OEO. Pigs were killed at 110 kg and meat quality was assessed over a 16 day storage period. With storage time, the water holding capacity of female meat increased ($P \leq 0.05$) and the drip loss of both male and female meat decreased ($P \leq 0.001$); OEO did not have a significant ($P \geq 0.05$) effect on either factor. Lipid oxidation of meat from the 1000 ppm group was lower than that of control samples at any storage period. The addition of 1000 ppm OEO to pig diet could be recommended for the production of meat of good quality and minimum lipid oxidation.

Key words: Pigs · Feed Additives · Meat Traits · Thiobarbituric Acid Reactive Substances (TBARS) · Fresh Meat · Oregano Essential Oil

INTRODUCTION

Recently, interest in phytogenic feed additives, especially for use in the swine and poultry industries, has been increasing. This appears to be strongly driven by a complete ban in 2006 on most antibiotic feed additives within the European Union [1]. This ban was implemented because of the possible risk of generating antibiotic resistance in pathogenic microbiota. Plant extracts, or their essential oils, are promising alternatives to antibiotics for protecting the health of meat animals [2-5], but there is limited information available on meat quality after dietary supplementation with oregano essential oil (OEO). Mexico ranks second in the oregano export market worldwide. Moreover, there is evidence that natural OEO can act as a growth promoter, increase antioxidant activity, enhance muscle protein sedimentation and also improve disease resistance to pathogens when added to channel catfish feed [6]. When used in broiler diets, essential oils improve body weight, daily gain and feed conversion compared with the control diet [7]. Furthermore, OEO may provide an alternative to conventional anticoccidial additives in broiler feeds [8].

The potential effects of OEO on meat quality may make it profitable to supplement pig feed with OEO. Some studies have suggested a possible beneficial impact of herb extracts on meat quality or antioxidative capacity in pigs and poultry [9-14]. Dietary supplementation with oregano oil does not affect the colour or quality of pork [12], but improves the colour intensity of lamb [15] and enhances the luminosity of beef [16], especially after refrigerated storage and without significant influence on the texture of the meat [12, 15].

The objective of this work was to evaluate the effect of dietary supplementation with Mexican oregano (*Lippia graveolens*) essential oil (OEO) on meat quality and lipid oxidation in swine.

Corresponding Author: Alma D. Alarcon-Rojo, Universidad Autónoma de Chihuahua, Facultad de Zootecnia y Ecología, Chihuahua, Chih, México. Tel: +52-614 434 0303.

MATERIALS AND METHODS

Animal and Treatments: A total of 48 pigs (Landrace × Yorkshire) was randomly assigned to one of four experimental groups during the finishing period. The weight of the pigs at the beginning of the trial was 18.3±1.25 kg. There were 12 pigs per group (6 females and 6 males) and each group was divided into two subgroups of six animals each (3 females and 3 males) to have two replicates per pen/diet. Each group was fed a commercial diet supplemented with 0 (control), 1000, 2000 or 3000 ppm OEO until they reached 110 kg live weight. Animals were fasted for 16-20 h and transported to a commercial abattoir, where they were electrically stunned and slaughtered by exsanguination using conventional methods. The dressed carcasses were hung by Achilles tendon suspension in a chiller at 2°C.

Sample Preparation and Storage: At 24 h post mortem (*p.m.*), the left loin from each animal was collected on-line, individually vacuum-packaged and frozen at-15°C until used for the sensory assessments. At the same time *p.m.* the left *Semimembranosus* was also collected and used for measurement of pH, water holding capacity (WHC), drip loss (DL) and colour. The *Semimembranosus* muscles were randomly accorded an ageing period of 1, 2, 4, 6, 8, 10, 12 and 16 days *p.m.* at 4.0°C. Measurements of pH were performed at 45 min *p.m.* and then at 1, 2, 4, 6, 8, 10 and 12 days for pH, WHC, DL and colour; at day 2, 4, 6 and 8 for shear force and at 2, 6 and 16 days for thiobarbituric acid reactive substances (TBARS). These time-points were selected to represent the periods of commercial storage of fresh pork in Mexico. At the completion of the assigned ageing period, the muscles were portioned at 5°C for meat quality characteristics.

Meat Quality Determination: Meat pH was measured with a puncture pH probe attached to a pH meter Model 1001 Sentron (Integrated Sensor Technology, San Jose, CA, USA). The pH was determined as the mean of readings taken at three sites on the muscle. WHC was measured using the technique of Grau and Hamm [17], with some modifications, a 0.3 g sample was weighed in an analytical balance Model SA210 (Scientech, Boulder, CO, USA) with an accuracy of 0.1 mg, the sample was placed between two filter papers, which in turn were placed between two Plexiglas plates for 15 min and subjected to a constant weight of 5 kg. Subsequently the compressed sample was removed and the final weight recorded. WHC was calculated as the difference and expressed as a percentage of the original wet weight of the pork sample. Meat drip loss was measured in triplicate by the EZ-Drip Loss method described by Christensen [18], with some modifications, at 24 h *p.m.*, a core (25 mm, parallel to the fibre direction) was taken from the same site in each slice, individually placed in an EZ-Drip Loss container, sealed and stored for 48 h at 4°C. The meat sample was then removed and the DL was calculated as the difference and expressed as a percentage of the original wet weight of the pork sample. Colour parameters L* (lightness), a* (redness) and b* (yellowness) [19] were determined by using a CM-2002 Minolta Chroma Meter (Minolta Co., Ltd., Osaka, Japan) operating with light source D65 with 0° viewing angle on meat after 15 min blooming. An average value from three random locations on each sample surface was used for statistical analysis. Meat shear force was measured in cooked meat according to established guidelines [20]. Vacuum-packaged *Semimembranosus* portions were removed from the packaging. Two blocks ($6 \times 6 \times 4$ cm^3) were cut from the *Semimembranosus* with the longest axis parallel to the fibre direction. The meat samples were cooked in a water bath (at 80°C) Mod. Isotemp 215 (Fisher Scientific, Hanover Park, IL, USA) from internal temperatures of approximately 4 to 72°C. Temperature was measured with a needle thermometer inserted into the center of the meat block. The cooked samples were stored in a refrigerator (4°C) overnight. Round meat cores of 1.27 cm (0.5 inches) in diameter were removed parallel to the longitudinal orientation of the muscle fibres so that the shearing action was perpendicular to the longitudinal orientation of the fibres. Cores were obtained using a hand-held coring device (cork borer). The meat cores were then sheared at a right angle to the fibre direction with a Warner Bratzler shear blade (1.0 mm straight-edged blade, v-shaped, 60° angle, 100 mm/min shear rate, 1.5 mm blade slot) attached to a Material Testing Machine LR5KPlus (Chatillon, Digital Measurement Metrology, Inc., Toronto, Ontario, Canada). The peak force (reported in kg) of an average of 10 replicates per sample was recorded. Thiobarbituric acid reactive substances were used to determine the extent of lipid oxidation as described by Tarladgis *et al.* [21] with some modifications. In sampling meat from each treatment 10 g of meat was homogenized for 20 s with 97.5 ml of distilled water and 2.5 ml of 6 N HCl. The mixture was heated by steam distillation until 50 ml of distillate was

collected. An aliquot of 2.5 ml of the distillate was added to 2.5 ml of thiobarbituric reactive reagent containing 0.02 M TBA in 90% glacial acetic acid and incubated over boiling water for 40 min. After cooling the tubes with tap water, the absorbance of the pink solution was read at 535 nm in a SpectronicGenesys 20, 40001/4 Series (Thermo Electron Corporation, Madison, WI, USA) and expressed in mg malonaldehyde per kilogram of meat from the average of duplicates of the filtrate. Absorbance values from the reaction of 0.005 M TBA (2 ml) solution with serial dilutions of 1,1,3,3-tetraethoxypropane (TEP) were used to generate a standard curve.

Statistical Analyses: To study the effect of sex, treatment, storage and their interactions on physicochemical properties (pH, WHC, DL, L*, a*, b*, shear force and TBARS), data were analysed as repeated measures using the PROCMIXED procedures of the SAS [22]. The fixed effects were sex, treatment and time and the random effects were animal nested within treatment. When the main effects or interactions were significant polynomial contrasts were performed [23].

RESULTS AND DISCUSSION

PH: The pH of meat showed a quadratic trend ($p = 0.001$) with the time of storage at 4°C (Table 1). Although there was no interaction between OEO level and sex ($p = 0.05$), the pH measured at 45 min *p.m.* (pH_{45}) in females was higher (6.2 and 6.1) than in males (6.0 and 5.8) supplemented with 1000 and 2000 ppm OEO, respectively. The lowest pH (5.7) was observed in animals that received 3000 ppm OEO. This effect continued to 24 h at all OEO levels. At day 4 of storage, the pH in females in the 1000 ppm group remained higher (5.8) than that in males (5.6). A decline in pH in normal meat showed a pH of 6.3-6.4 at 45 min *p.m*. [24, 25] but the values of the present study were lower probably due to differences in animal handling during the ante mortem period [26] but this relatively low pH did not affect the other meat quality characteristics. In general, there was a trend of decreased pH with time of storage. The lowest pH (5.3-5.4) was observed at day 8 in all experimental groups. However, by day 12, the meat pH increased ($p = 0.001$). Normally the *p.m.* pH of meat drops to values between 5.4 and 5.8 at 24-48 h, depending on

Table 1: Effect of oregano essential oil (OEO) added to diet of finishing swine on the pH, water holding capacity (WHC) and drip loss (DL) of meat stored at 4°C

	Storage days																
	Females								Males								
OEO (ppm)	45min *p.m.*	1	2	4	6	8	10	12	45min *p.m.*	1	2	4	6	8	10	12	*SEM*
pH[a]																	
0	5.9	5.6	5.6	5.5	5.4	5.4	5.5	5.5	5.6	5.6	5.6	5.6	5.5	5.4	5.5	5.5	0.1
1000	6.2	6.0	5.9	5.8	5.6	5.4	5.4	5.4	6.0	5.7	5.7	5.6	5.5	5.3	5.4	5.5	0.1
2000	6.1	5.6	5.6	5.6	5.4	5.3	5.4	5.3	5.8	5.7	5.7	5.5	5.4	5.3	5.5	5.5	0.1
3000	5.7	5.4	5.4	5.5	5.3	5.3	5.5	5.4	5.7	5.4	5.4	5.5	5.3	5.3	5.4	5.5	0.1
WHC,%[b]																	
0	-	62.9	62.6	62.7	61.4	69.0	69.7	65.2	-	68.2	63.8	68.0	67.7	71.5	72.2	71.8	2.5
1000	-	67.2	64.0	68.6	71.5	69.5	72.8	77.1	-	70.0	68.7	68.3	68.2	68.4	71.7	70.1	2.5
2000	-	66.2	63.1	63.2	66.0	68.6	71.2	67.9	-	65.6	64.2	65.8	68.5	64.5	71.7	68.0	2.5
3000	-	71.4	66.9	63.3	68.3	68.1	69.1	69.1	-	66.9	67.9	64.2	65.3	65.4	67.2	67.1	2.5
DL, %[c]																	
0	-	7.8	6.8	4.7	6.4	6.9	5.1	5.6	-	6.7	6.7	5.0	4.9	4.8	2.8	5.4	0.9
1000	-	8.1	5.9	5.8	8.7	4.3	5.0	5.3	-	7.3	6.0	4.5	5.4	6.1	4.2	4.9	0.9
2000	-	7.4	6.6	5.9	10.3	5.2	5.7	4.9	-	7.8	8.7	7.0	9.6	6.8	5.8	5.7	0.9
3000	-	7.5	7.4	6.9	6.1	4.0	4.2	5.4	-	7.3	8.6	7.0	5.5	3.5	4.5	5.5	0.9

[a]Quadratic trend in storage time $P = 0.001$; OEO x sex $P = 0.05$

[b]Cubic trend in storage time $P = 0.01$; sex $P = 0.05$; OEO level $P = 0.05$; OEO x sex $P = 0.05$

[c]Linear trend in storage time $P = 0.001$; OEO level x sex x storage time $P = 0.05$

p.m.=post-mortem; *SEM*= standard error of the mean

the muscle and animal species. The rate and extent of the pH decrease immediately *p.m.* determines the quality and subsequent use of the meat [26]. In the present study, meat pH showed a normal decline suggesting that the OEO supplementation did not affect this characteristic and meat can be considered of good quality.

One of the most influential parameters on the functionality of muscle proteins is the pH, which influences characteristics such as the WHC, DL, colour and texture of the meat [27, 28]; therefore, pH is an important indicator of the quality of fresh and processed meat. The meat pH at 45 min and 24 h *p.m.* observed in this study differ from those reported by others [15] who demonstrated that the use of OEO in the diet of lambs increased the pH values at 24 h *p.m.* (5.9 ± 0.09) in *Longissimus thoracis* muscle when compared with the control diet (5.8 ± 0.06). This difference could be attributed to muscle type or to the pre-slaughter stress level of the animals [29]. The effects of the addition of natural additives on meat quality have previously being investigated by Janz *et al.* [12], they observed higher pH (5.5) in *Longissimus* muscle at 3 days *p.m.* when animals were supplemented with OEO than when supplemented with rosemary essential oil (5.4). Similarly Carpenter *et al.* [30] observed pH values of 5.7 and 5.5 after 12 d of storage at 4°C when grape seed extract and bearberry extract respectively were added to raw pork and packaged in a modified atmosphere.

Water Holding Capacity (WHC): A cubic trend was observed ($p = 0.01$) in the WHC of meat during storage (Table 1). There was no effect of sex ($p = 0.05$), OEO level ($p = 0.05$) or any interaction of OEO levels with sex ($p = 0.05$) on WHC of meat. At day 2 of storage, boar meat supplemented with 1000 ppm OEO had a higher WHC (68.7%) compared with females (64.0%). Contrary to this result, boars receiving 3000 ppm had a lower WHC (66.9%) than females (71.4%) at day 1 of storage. Meat from the female control group had a lower WHC (62.9 ± 2.6%) than males (68.2 ± 2.6%). At day 4 of storage the WHC of male meat in all experimental groups decreased and maintained a constant level until day 8, while female meat from the 1000 and 3000 ppm groups showed an increase in the WHC at day 4 (68.6 and 63.3% respectively) with a further increase at day 6 (71.5 and 68.3%, respectively). The highest WHC was observed at day 10 in meat from males and females fed 0, 1000 and 2000 ppm OEO.

In any muscle, WHC is minimal at the final pH but it tends to increase with maturation of meat due to protein degradation and changes in electric charges associated with intermolecular reorganization [26]. In the present study WHC changed with pH, being low at low pH (pH = 5.5) and increasing with pH (pH > 5.5). It is known that low pH causes shrinkage of the network of polypeptide chains and reduces the ionic groups to bind free water, thus the WHC of meat is closely related to the pH measured at 24 h *p.m.* [26]. During meat maturation the major cause of the increase in WHC is the rise in pH which takes place during this process [31]. This effect was obvious in the present study at day 10 and 12, at which the highest WHC of meat was observed. If the WHC is low, moisture or weight losses during storage are greater and this has a significant effect on meat quality.

Drip Loss (DL): DL of meat presented a linear trend ($p = 0.001$), decreasing during storage (Table 1). This trend was significant for OEO levels, sex and storage time ($p = 0.05$). At day 1, meat from females fed a diet supplemented with 1000 ppm OEO showed higher DL (8.1%) than male meat. In general, DL decreased with storage time and the lowest value was observed at day 10 of storage in the experimental groups. However, at day 12, OEO-treated meat showed a slight increase in DL.

There is an inverse relationship between WHC and DL. We observed an increase in WHC with storage time and a subsequent decrease in DL. As is known, if WHC is low, water loss during storage is increased as a result of surface evaporation or exudation from meat as DL [29]. A rapid *p.m.* drop in pH accelerates *rigor mortis*, thus decreasing WHC and producing greater amounts of exudate [32]. An inverse relationship exists between DL and pH, so when pH is low, DL is high [33]. Although meat from the 1000 ppm OEO male group showed a relatively low pH_{45}, representing a rapid decline in pH, there was no effect on WHC and DL of that meat.

Colour (L*, a*, b*): There was no trend ($p = 0.05$) in the luminosity (L*) of the meat with regard to storage time, although an interaction of sex, OEO level and storage time ($p = 0.01$) was observed (Table 2). Meat of animals fed diets supplemented with 2000 and 3000 ppm OEO had lower L* during the first 2 days of storage than that of animals supplemented with 0 and 1000 ppm. In contrast, meat from the 0 and 1000 ppm groups had a high luminosity at the beginning of the storage period but low

Table 2: Effect of oregano essential oil (OEO) added to diet of finishing swine on luminosity (L*), redness (a*) and yellowness (b*) of meat stored at 4°C

	Storage days														
	Females							Males							
OEO (ppm)	1	2	4	6	8	10	12	1	2	4	6	8	10	12	*SEM*
L*[a]															
0	45.8	44.9	43.0	42.3	41.0	42.6	42.4	47.0	45.9	43.9	42.4	42.7	44.4	43.8	2.3
1000	45.8	47.5	41.4	41.8	46.0	42.3	44.2	46.9	45.9	42.3	40.5	41.3	40.0	43.4	2.3
2000	43.1	43.1	46.5	45.4	47.2	45.3	45.1	38.8	39.5	46.7	44.6	44.9	45.3	42.7	2.3
3000	39.7	39.6	48.0	46.4	34.4	34.5	48.6	36.8	36.9	42.8	44.5	34.7	37.1	47.1	2.3
a*[b]															
0	7.8	6.7	7.1	6.9	5.4	5.2	7.0	8.9	7.7	5.2	4.8	4.1	3.2	4.5	1.0
1000	2.2	1.8	5.1	4.5	2.5	3.7	3.5	7.0	5.9	5.1	6.6	3.7	4.4	5.2	1.0
2000	3.5	3.5	4.9	5.3	3.3	4.8	5.4	6.1	5.6	4.5	6.1	3.5	3.9	4.0	1.0
3000	5.7	6.0	6.3	5.7	4.2	5.8	5.4	4.1	4.2	7.2	5.1	4.0	4.5	4.6	1.0
b*[c]															
0	14.3	13.3	15.4	15.4	13.5	13.5	15.3	13.1	12.0	14.0	14.0	14.7	13.1	13.9	2.9
1000	11.9	12.0	13.9	12.7	13.8	13.2	13.8	12.6	11.5	12.9	14.5	15.6	12.7	14.1	2.9
2000	13.2	11.9	15.1	16.5	15.3	15.8	14.9	9.2	9.8	13.5	15.1	13.9	12.3	12.7	2.9
3000	12.6	13.5	16.6	12.2	12.2	15.0	16.9	13.0	13.0	16.7	11.8	11.6	16.5	15.9	2.9

[a]Trend $P = 0.5$; storage time $P = 0.05$; sex x OEO level x storage time $P = 0.01$

[b]Trend $P = 0.5$; storage time $P = 0.01$

[c]Trend $P = 0.5$; storage time $P = 0.001$

SEM= standard error of the mean

Table 3: Effect of oregano essential oil (OEO) added to diet of finishing swine on the shear force (SF) and thiobarbituric acid reactive substances (TBARS) of meat stored at 4°C

	Storage days								
	Females				Males				
OEO (ppm)	2	4	6	8	2	4	6	8	*SEM*
SF, kgf[a]									
0	3.5	3.2	3.1	3.5	3.2	3.0	2.8	3.6	0.2
1000	3.4	2.6	3.0	3.0	3.2	3.2	3.0	3.3	0.2
2000	3.0	2.6	2.8	2.8	3.1	2.9	3.1	3.2	0.2
3000	2.4	2.8	2.4	2.8	2.5	2.6	2.4	2.5	0.2

	Storage days						
	Females			Males			
	2	6	16	2	6	16	*SEM*
TBARS, mg/kg meat[b]							
0	0.365	0.507	0.656	0.162	0.400	0.533	0.064
1000	0.085	0.488	0.439	0.168	0.185	0.249	0.064
2000	0.253	0.471	1.124	0.222	0.400	0.293	0.064
3000	0.199	0.943	0.647	0.258	0.719	0.821	0.064

[a]Quadratic trend in storage time $P = 0.01$

[b]Quadratic trend in storage time $P = 0.01$

SEM=standard error of the mean

luminosity from day 4 to day 8 and it then increased until day 12. This effect was similar for males and females and it was consistent across all supplement levels and storage times. Redness (a*) of meat tended to decrease with time ($p = 0.01$), being more consistent in males than in females until day 12 of storage. At the beginning of the storage period, the control group (0 ppm OEO) showed the highest a* values in females (7.8 ± 1.0) and males (8.9 ± 1.0) compared with the lower a* values in the 1000 ppm OEO group of females (2.2 ± 1.0) and the 3000 ppm

group of males (4.1 ± 1.0). These values decreased significantly during the storage period in the control group and in the males fed diets supplemented with 1000 and 2000 ppm OEO. However, meat from females fed diets supplemented at all OEO levels showed an increase in redness at day 12. An interaction was observed between OEO levels, sex and storage time (p =. 001) and yellowness (b*) of meat. At 24 h *p.m.*, the b* value was higher in females at any level of supplementation than in males. Yellowness of meat at all treatment levels and sexes was higher at day 12, with females showing the higher values compared with males at all levels of supplementation.

Meat colour depends on pH, after slaughter, muscle pH decreases as a result of the conversion of glycogen into lactic acid and this causes modification of the optical properties of meat as it becomes opaque and a clear solid red [29]. Abnormal colour conditions such as PSE (pale, soft and exudative) and DFD (dark, firm and dry) can appear [26] when meat reaches a pH of 5.5 at 40 min *p.m.* or a pH of 6.8 at 24 h *p.m*, respectively. When the pH is near the isoelectric point of muscle proteins the meat becomes brighter [34]. This may have happened with the male meat in the control group, in which the pH decreased rapidly and at 45 min *p.m*, the pH was 5.6 and the meat was brighter in colour than the female meat. It has been previously reported that meat from pigs fed OEO is brighter in colour after storage [12, 16] compared with the control animals. Others have reported more yellowness and redness of female meat when supplemented with OEO (1 ml/kg) in the finishing diet [15], possibly because females reach maturity slightly faster than males. The use of other natural extracts (grape seed extract, rosemary) also increases beef redness and yellowness during storage [16], as does the use of vitamins D3 and E in swine [25].

Shear force (SF): The SF of meat showed a quadratic trend (p = 0.01) during storage (Table 3). At day 3, meat of both sexes from the 0, 1000 and 2000 ppm OEO groups showed the highest SF, whereas the lowest SF was observed in meat from pigs fed 3000 ppm OEO. On average, SF decreased in meat from animals supplemented at all OEO levels at day 6 and day 8 of storage and this effect was similar in both sexes. These results suggested that increasing the level of OEO decreased the SF of meat.

Storage results in a decrease in meat toughness due to muscle protein degradation caused specifically by several endogenous enzyme systems [26] such as lysosomal cathepsins, the proteinase multicatalytic system and calcium-dependent protease or calpain [29]. Most studies of the addition of natural additives to animal diets do not report any effect on SF [12, 15, 25].

Lipid Oxidation: The shelf life of meat is related to lipid oxidation which may cause rancidity, affecting the colour, smell and taste of meat [35, 36]. Nutritional characteristics can also be affected through the formation of potentially toxic compounds [37, 38]. Oxidation is a process involving proteins, carbohydrates, lipids, pigments, vitamins and DNA in muscle and fatty tissue, which increases with *p.m.* time and shortens the shelf life of meat and meat products [39]. Research has demonstrated that the use of natural antioxidants minimizes the development of lipid oxidation [40-42] and improves the shelf life of meat [2, 43]. In the present study, the oxidation of meat, measured as the formation of malonaldehyde (MDA) using the TBA technique (Table 3) showed a quadratic trend (p = 0.01) during the storage period. Meat from animals fed a diet containing 3000 ppm OEO showed the highest levels of MDA in males, while meat from both males and females fed a diet supplemented with 1000 ppm showed the lowest TBA values.

There are several reports suggesting that natural extracts, including OEO, decrease oxidation of fresh meat from different species even though the levels and natural extracts differ [2, 15, 27, 30, 35, 37, 39]. The antioxidant effect has been attributed to the action of substances such as thymol and carvacrol present in the OEO, which protect lipids from oxidative damage; however these aspects have not been extensively investigated in pigs and poultry [44]. In the present study, we did not find any lipid protection due to the use of OEO in the pig diet. It is known that meat from monogastric species is easily influenced by dietary changes that may affect the degree of unsaturation of fatty acids in animal muscle and meat [12, 45, 46] such that a greater deposition of unsaturated fatty acids in meat leads to a high susceptibility to oxidation. This may be the situation in the present study, where the oxidation of the meat increased with storage time and with OEO levels, probably because pigs fed high OEO levels were fatter than those fed low OEO and control animals (data not shown).

The present study contributes to a better understanding of the relationship between oregano essential oil (OEO) and quality characteristics of pork. For pork quality special attention should be put on the optimal OEO dose and storage time to ensure higher water holding capacity, lower drip loss and the inhibition of lipid oxidation. Meat traits were influenced by sex, storage

time and OEO doses. An important conclusion was that lipid oxidation in meat was inhibited most by 1000 ppm OEO. The meat industry can benefit substantially by taking into account the OEO dose supplemented to pigs.

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