Effects Of Single And Combined Antioxidant Vitamins On Growing Pig Performance And Pork Quality

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Abstract: The effects of the pharmaceutical levels of single and combined antioxidant vitamins: A, C, AC, AE and CE on growing pig performance, pork quality in respect to malondialdehyde (MDA) serum concentrations and drip loss were investigated. 36 pigs of average body weight (BW) of 6 ± 0.79 were randomly divided into one of six experimental groups. The animals received similar commercial diet for one week after which they were offered their experimental diets at 5% of their BW as: To (control diet – contained vitamins at their basal levels, T_A (200mg of vitamin A), T_C (200mg of vitamin C), T_AC (100mg of vitamin A + 100mg of vitamin C), T_AE (100mg of vitamin A + 100mg of vitamin E) and T_CE (100mg of vitamin C + 100mg of vitamin E)/kg of diet, respectively for 4 weeks. Animals on the antioxidant vitamins, especially those on the combined vitamins gained at significant (P < 0.05) better rates compared with the control group. Similarly, the feed efficiency (FE) of the vitamin diets were significantly (P < 0.05) superior compared with control despite the similar (P > 0.05) feed intakes. Furthermore, the vitamin diets particularly the combined vitamin diets demonstrated lower MDA concentrations as well as lower drip loss (P < 0.05) compared with the control group. It was concluded that antioxidant vitamin combinations improved pig performance and pork quality by significantly reduced MDA levels and drip loss.

Key words: Antioxidant vitamins, Pig performance and Pork quality.

Introduction
Growing pigs are very fast growing animals. The fast growing process of the animal needs to be supported by diets that match their nutrient requirements [2], [4]. Diets deficient in the nutrients required by the pig will no doubt lead to poor animal performance and hence result in the reduction of the hog farmer profit margin. This therefore calls for the search for strategies in dealing with the situation. It is a known nutritional fact that animal health and pork quality depend on many factors. This is true because diets play critical functions in the maintenance of animal health and prevention of diseases [4]. To this point therefore, nutrition remains the fundamental key in prevention-modulation reflecting a special emphasis on diet as an important strategy in the maintenance of animal health and meat quality [2]. Nutrition science has to move towards the development of recommendations for optimal dietary ingredients, especially the micro-nutrients such as vitamins for the maintenance of good health status of the growing animals for optimal productivity and good quality pork in the commercial production level of swine. At present, it has become clearer that antioxidant nutrient requirements for the protection of the pig and good quality pork production need to be properly established as it relates to their synergies in terms of growth and health of the pig [1], [4]. Vitamins A, C and E are known as antioxidant vitamins that regulate the glutathione defense system of the animal, especially the fast growing species such as the growing pig. Preliminary studies [5] demonstrated that dietary vitamins supplementation and the rate at which they are added to the diet can have a profound effect on pork quality and drip loss. However, there is paucity of information on vitamins potentials when used singly or in combinations in the diets of pigs on performance, pork quality and drip loss. Therefore, the objectives of this study are:

1. To investigate the effects of single and combined antioxidant vitamins on the growth performance of growing pigs;
2. To examine the effects of single or combined antioxidant vitamins on pork quality and drip loss in pork.

Materials and Methods

Animals and Housing
Thirty-Six (36) growing landrace pigs of average BW of 6 ± 0.79 (mean ± SD) kg were acquired and used for the experiment. The animals on arrival at the Animal Wing of the Department of Animal Science, Rivers State University were weighed to obtain their initial BW and randomly assigned to pens. Six pigs were assigned to each dietary treatment and fed at 5% of BW (as-fed basis) twice daily at 09:00h (half of the daily meal) and 16:00h, respectively. Animals received their assigned diets for four weeks (4 weeks). They also have unlimited access to water. Animal pens were cleaned regularly.

Experimental Diets
Six corn/soybean-based diets that are isocaloric and isonitrogenous were used in the study. However, vitamins A and C, as well as their combinations with vitamin E dietary contents were different as: To (control diet), T_A (vitamin A diet), T_C (vitamin C diet), T_AC (Vitamins A and C diet), T_AE (vitamins A and E diet) and T_CE (vitamins C and...
E diet). That is, T₀ (contain basal vitamin levels only); T₁ (vitamin A 200mg/kg of diet); T₂ (vitamin C 200mg/kg of diet); T₃ (vitamin A 100mg + vitamin C 100mg/kg of diet); T₄ (vitamin A 100mg + vitamin E 100mg/kg of diet); T₅ (vitamin C 100mg + vitamin E 100mg/kg of diet), respectively.

Experimental Design
The experiment was designed and carried out as a completely randomized designed (CRD) with 6 pigs per treatment.

General Conduct of Study
Feed intake was closely monitored. At the beginning of each day of the experimental period, orts from the previous day were collected, air-dried, weighed and recorded. The difference between dry feed delivered and the next day’s orts represents the actual feed consumed by the animal for the day. On the last day of the study, all animals were weighed. The difference between the final and initial BW represents weight gained during the study period. Accordingly, the average daily feed intake (ADFI) was obtained by dividing total amount of feed delivered by the number of days in the experiment. Average daily gain (ADG) was obtained by dividing total weight gained during the study period for each treatment group by the number of days the experiment lasted. Gain to feed ratio for the study period was obtained by dividing ADG by ADFI for each treatment group.

Blood Sample Collection for Assessing Pork Lipid Oxidation
At the end of the experiment blood samples were humanely collected from the jugular veins of the pigs into EDTA treated bottles for malondialdehyde (MDA) analyses. Serum MDA concentrations were analyzed according to the method of [12].

Sample Collection - Slaughterand Processing Procedure to Evaluate Drip loss
After weighing the pigs for their final BW gain, 3 pigs from each treatment group were randomly selected and slaughtered at the University abattoir based on standard procedures. The carcasses were then scalped, de-haired and put in already chilled coolers (4°C). After 24 h at 4°C the water holding capacity was determined from the preserved carcasses using chops from 11th and 12th rib based on drip loss technique of [6]. Briefly, muscle samples approximately 7 g were collected and placed into sealed drip loss tubes in such a way that the cut surface of the meat was perpendicular to the long axis of the drip loss tube. Drip loss was evaluated in duplicate from the core samples. The drip loss containers and samples were weighed again. Finally, muscle samples were removed and discarded while the containers were also weighed again with the exudates from the pork chops, during which percentage drip losses were computed and recorded.

Statistical Analysis
Data obtained were subjected to ANOVA using Proc. GLM of SAS (SAS Inst., Carry, NC) according to the experimental model as: \( Y_{ij} = \mu + D_i + E_{ij} \)

Where \( Y_{ij} \) = the observation; \( \mu \) = overall mean common to all treatments; \( D_i \) = the effect of the i\(^{th} \) diet and \( E_{ij} \) = the error term. Means were compared using Tukey’s test and a- level of 0.05 was used for all statistical comparison to represent significance.

Results and Discussion
The performances of the animals fed the different vitamin-based diets are shown in Table 1.

Table 1. Mean growth responses of growing pigs fed different vitamins-based diets

<table>
<thead>
<tr>
<th>Item</th>
<th>T₀</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>T₅</th>
<th>SE</th>
<th>Pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADFI (g)</td>
<td>357.33</td>
<td>356.83</td>
<td>356.00</td>
<td>354.67</td>
<td>35.45</td>
<td>35.50</td>
<td>0.95</td>
<td>0.51</td>
</tr>
<tr>
<td>ADG (g)</td>
<td>101.67</td>
<td>101.20</td>
<td>108.33</td>
<td>10.90</td>
<td>116.17</td>
<td>0.40</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>FE</td>
<td>0.23</td>
<td>0.29</td>
<td>0.29</td>
<td>0.31</td>
<td>0.33</td>
<td>0.33</td>
<td>0.01</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Means with different superscripts (a,b,c,d) are significantly (P < 0.05) different.

The average daily feed intakes of all dietary treatments were similar (P > 0.05). However, the ADG were different (P < 0.05) among the dietary treatments. Treatment (T₀) had the lowest ADG compared with treatments (T₁ and T₃) that had similar ADG. Furthermore, T₃ and T₅ had better (P < 0.05) but similar ADG compared to T₀. Overall, TCE had the best (P < 0.05) ADG compared to all other treatments. Again, despite the similar ADFI, FE mirrored ADG. To had the lowest (P < 0.05) FE of 23% compared to 29%, respectively for T₁ and T₃. Nevertheless, T₃ and T₅ had improved FE (P < 0.05) of 31% compared to T₁ and T₃ while T₅ had the best FE (P < 0.05) of 33% compared to T₃ and T₅. The results of lipid peroxidation and drip loss in pork are shown in Table 2.

Table 2. MDA and Drip Loss Levels in Pork from pigs fed different vitamin based - diets

<table>
<thead>
<tr>
<th>Item</th>
<th>T₀</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>T₅</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA (nmol/mg)</td>
<td>1.17 ± 0.016</td>
<td>1.76 ± 0.12</td>
<td>1.26 ± 0.12</td>
<td>1.33 ± 0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drip loss</td>
<td>2.78 ± 1.78</td>
<td>1.78 ± 1.78</td>
<td>1.26 ± 1.26</td>
<td>1.13 ± 1.13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means with different superscripts (a,b,c,d) are significantly (P < 0.05) different.

MDA concentration is significantly (P < 0.05) higher in T₀ the control group than any other group. MDA levels however were similar in the T₁ and T₃ groups that were significantly (P < 0.05) higher compared with the T₅ group. Overall, the T₅ and T₃ groups had the lowest
levels of MDA. The drip loss in pork also mirrored the MDA observed pattern. The T0 group showed a significant (P < 0.05) higher drip loss value compared with the TAC and TCE groups that had similar (P > 0.05) levels of drip loss that were significantly (P < 0.05) higher than those of TAE, TAC and TCE, respectively. As shown in Table 2 the dietary supplementation of antioxidant vitamins, especially when combined resulted in significant reductions in lipid peroxidation as judged by the levels of MDA and drip loss. This finding is in agreement with that of [3]. The most possible explanation to this observation would be that the ingested vitamins preserved the integrity of the pork muscle cell membranes by preventing the oxidation of phospholipids membranes during storage. This phenomenon was capable of inhibiting the passage of sarcoplasmic fluid through the muscle cell membrane. All animals in the six dietary treatment groups readily consumed their respective diets and grew throughout the duration of the experiment. The average daily feed intakes of pigs on all the dietary treatments were similar (P > 0.05) as there were no significant differences in feed intakes (Table 1). This is not surprising since the animals were of similar age and body weight and were fed at 5% of their body weights. The choice of feeding them at 5% of their body weights is close to what obtains during practical production process in which the animals are fed ad litem [4]. Although feed intakes were similar for all treatments the trend was different in the average daily gain. Despite the similarity in ADFI, there were significant differences (P < 0.05) in the ADG. For instances, while the ADG for T0 animal is 81.17 g, the diets with added vitamins gained significantly (P < 0.05) at better rates compared with the control that contained vitamins at only the basal levels. Animals with either added vitamin A or C gained 101.67 and 101.5 g per day, respectively; while diets with combined dietary vitamins: TAC, TAE and TCE gained at the best rates as 108.33, 109 and 116.17 g/d, respectively (Table 1). These compared to T0 animals represents an increase of 25.26%, 25.05%, 33.46% and 34.29%, respectively while TCE animals ADG was the best with an increment of 42.12% more than that of T0. The feed efficiency (FE) again mirrored the trend observed in the ADG. Thus, as was with the ADG, the FE of T0 was 23% and increased linearly (P < 0.05) as the levels of vitamins increased in the diets to pharmaceutical levels, especially for the combined vitamins diets. For instances, the FE of TAC, TAE, TCE, TAC, TAE were 26.09%, 26.09%, 26.09%, 34.78% and 34.78%, respectively higher than the control (T0) while TCE diet demonstrated the best FE of 43.48% higher than that of T0. Previous studies [7], [8] speculated that for improved performance of porcine, their diets should be fortified with antioxidant vitamins up to their pharmaceutical levels of 200mg/kg of diet to enable them exert their antioxidant potentials. Therefore, the enhanced ADG and FE data observed in this current study were expected. The feeding of pigs’ antioxidant vitamins at 200mg/kg diet results in 2.5 to 3.0 times higher of the vitamins in the plasma and tissues of the animals compared to pigs fed at the basal level of 30mg/kg of diet [9]. The accumulations and the presence of these vitamins in the plasma and tissues of the fed animals at pharmaceutical levels would no doubt reduce the stress often associated with fast growing animal species, such as the pig [4]. To this point, the improved performance of pharmaceutical levels fed pigs were in agreement with the studies of [10]. In the study of [10], the pigs fed pharmaceutical vitamin levels also demonstrated significant greater dressing percentage than non-supplemented groups. However, from the findings of this current study, the combining of antioxidant vitamins to result in the pharmaceutical levels showed more synergy in improving the pig’s growth and FE, particularly the combinations of vitamins C and E. This may be related to the fact that vitamin C is capable in regenerating vitamin E [11] thereby showing a symbiotic relationship in their antioxidant potentials. As vitamin C regenerates vitamin E, combining them to result in pharmaceutical levels in diet would better guarantee their availability in plasma and tissues and as such be readily available when needed more than other antioxidant vitamins as well as other antioxidant vitamins’ combinations.

Conclusion

It was concluded that dietary antioxidant vitamins, particularly when combined improved performance indices of growing pigs and pork quality. It also reduced drip loss percentage from pork. Therefore, the use of dietary antioxidant vitamins is recommended as a strategy in enhancing swine production and quality of pork.

References


