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

Johnson, N. C., Popoola, S. O., Owen, O. J.

Rivers State University, Department of Animal Science, Faculty of Agriculture
ntinya@alumni.uoguelph.ca

Rivers State University, Department of Animal Science, Faculty of Agriculture
dimeji222@yahoo.com

Rivers State University, Department of Animal Science, Faculty of agriculture
congomfx@yahoo.com

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 malondialhyde (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 thereforecalls 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_1 (vitamin A diet), T_2 (vitamin C diet), T_3 (Vitamins A and C diet), T_4 (vitamins A and E diet) and T_5 (vitamins C and

E diet). That is, T_O (contain basal vitamin levels only); T_1 (vitamin A 200mg/kg of diet); T_2 (vitamin C 200mg/kg of diet); T_3 (vitamin A 100mg + vitamin C 100mg/kg of diet); T_4 (vitamin A 100mg + vitamin E 100mg/kg of diet) ; T_5 (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 werecollected, 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 scalded, de-haired and put in already chilled coolers (4^0C). After 24 h at 4^0C the water holding capacity was determined from the preserved carcasses using chops from 11^{th} and 12^{th} 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; μ= overall mean common to all treatments; D_i= the effect of the i^{th} diet andE_{ij}= the error term. Means were compared using Tukey's test and α- 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*

Item	T_O	T_A	T_C	T_{AC}	T_{AE}	T_{CE}	SEM	*Pvalue*
ADFI (g)	357.33	356.83	356.00	354.67	353.50	355.50	0.95	0.51
ADG (g)	81.17^a	101.67^b	101.50^b	108.33^c	109.00^c	116.17^d	0.43	0.04
FE	0.23^a	0.29^b	0.29^b	0.31^c	0.31^c	0.33^d	0.001	0.002

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 (T_O) had the lowest ADG compared with treatments (T_A and T_C) that had similar ADG. Furthermore, T_{AC} and T_{AE} had better (*P < 0.05*) but similar ADG compared to T_O. 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 T_A and T_C. Nevertheless, T_{AC} and T_{AE} had improved FE (*P < 0.05*) of 31% compared to T_A and T_C while T_{CE} had the best FE (*P < 0.05)* of 33% compared to T_{AC} and T_{AE}. 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*

			Treatments					
Item	T_0	T_A	T_C	T_{AC}	T_{AE}	T_{CE}	SEM	*P-value*
MDA(nmol/mg)	1.17^a	0.16^b	0.16^b	0.14^c	0.11^d	0.11^d	0.001	0.001
Drip loss	2.78^a	1.78^b	1.76^b	1.26^c	1.25^c	1.13^c	0.12	0.042

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

MDA concentration is significantly (P < 0.05) higher in T_O, the control group than any other group. MDA levels however were similar in the T_A and T_C groups that were significantly (P < 0.05) higher compared with the T_{AC} group. Overall, the T_{AE} and T_{CE}groups had the lowest

levels of MDA. The drip loss in pork also mirrored the MDA observed pattern. The T_0 group showed a significant ($P < 0.05$) higher drip loss value compared with the T_A and T_C groups that had similar ($P > 0.05$) levels of drip loss that were significantly ($P < 0.05$) higher than those of T_{AC}, T_{AE} and T_{CE}, 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 libitum* [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 T_O 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: T_{AC}, T_{AE} and T_{CE} gained at the best rates as 108.33, 109 and 116.17 g/d, respectively (Table 1). These compared to T_O animals represents an increase of 25.26%, 25.05%, 33.46% and 34.29%, respectively while T_{CE} animals ADG was the best with an increment of 42.12% more than that of T_O. The feed efficiency (FE) again mirrored the trend observed in the ADG. Thus, as was with the ADG, the FE of T_O 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 T_A, T_C, T_{AC}, T_{AE} were 26.09%, 26.09%, 34.78% and 34.78%, respectively higher than the control (T_O) while T_{CE} diet demonstrated the best FE of 43.48% higher than that of T_O. 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.

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