GROWTH PERFORMANCE AND CARCASS DRIP LOSS AND WATER HOLDING CAPACITY OF BROILERS FED LOW DENSITY DIETS SUPPLEMENTED WITH LIQUID MULTI-VITAMINS AND AMINO ACIDS DURING PERIODS OF STRESS

Veneranda A. Magpantay, Rodeza Kristine S. Cu, Maria Cynthia R. Oliveros and Julienne Maria Undine Paz A. Hurtada

ABSTRACT

Two hundred eighty day-old broiler chicks were raised up to 35 days to compare the growth performance, drip loss and water holding capacity of the meat of broiler chicken fed normal and low density diets supplemented with liquid multi-vitamins and amino acids (LMVAA) in drinking water during periods of stress. The birds were distributed into four treatments following a Completely Randomized Design. Results showed that the group fed low density diet had similar growth performance compared with normal density diet. During the starter and finisher phases, higher (P<0.05) body weight, gain in weight, and feed consumption were noted in the group fed normal density diet. Highest income over feed and chick cost was noted in the group fed low density diet. This indicates that LMVAA supplementation in drinking water only during the 1st week of life and at 21st to 23rd day of age tends to compensate for poor nutrition and constant exposure to heat stress. However, it failed to improve drip loss and water holding capacity of the meat when supplemented during the last two days prior to harvest.

Keywords: broiler growth, diet density, drip loss, liquid multivitamins-amino acids, water holding capacity

INTRODUCTION

Exposure to sudden changes in environmental conditions, poor nutrition, disease challenge and management practices such as transportation stress, weighing and vaccination could affect the performance of animals. The animal's response to different stressors may include immunosuppression leading to increased susceptibility to diseases, dysregulated metabolism and increased energy requirement and even reproductive suppression (Dickens *et al.*, 2010). Constant exposure of broilers to heat stress during summer months was also confirmed to influence meat quality (Holm and Fletcher, 1997; McKee and Sams, 1997; Petracci *et al.*, 2001). It has been well-documented that pre-slaughter stresses result to pale,

Animal and Dairy Sciences Cluster, College of Agriculture, University of the Philippines Los Baños, College, Laguna, Philippines (email: vam0118@yahoo.com).

soft, exudative (PSE) poultry meat influenced by pre- and post-slaughter muscle metabolism (Solomon *et al*, 1998; Lin *et al*, 2007; Barbut, 2009; Strasburg and Chiang, 2009). Thus, providing nutritional interventions that could help alleviate the negative effects and decrease the vulnerability of animals from succumbing to these stressors would be an advantage to raisers. Petracci *et al.* (2009) recommended modification of the diet prior to pre-slaughter transport and provision of key nutrients (*i.e*. vitamins, amino acids, and minerals) to minimize meat quality defects.

A commercially-available liquid multi-vitamins and amino acids supplement (LMVAA) claims to lessen the negative effects of such stressors to animal's performance. The general objective of the study was to determine the effectiveness of LMVAA in improving the growth performance, drip loss and water holding capacity of meat of broiler chicken fed diets with different nutrient densities raised up to 35 days of age. More specifically, the study aimed to compare the growth performance (*i.e.* body weight, gain, feed consumption, feed conversion ratio, water consumption, livability rate and performance efficiency factor) and carcass qualities (*i.e*. drip loss and water holding capacity); and compute the economics of using LMVAA on broiler production.

MATERIALS AND METHODS

The study was conducted at the University Animal Farm, Animal and Dairy Sciences Cluster, College of Agriculture, University of the Philippines Los Baños, Philippines from April 10 to May 15, 2012, where the actual environmental temperature and relative humidity during the experiment were 32.4±2.5ºC and 68.3±10.1, respectively.

Two hundred eighty day-old broiler chicks were purchased from a reputable hatchery and distributed to four treatments with seven replications following a Completely Randomized Design. The treatments were as follows:

Treatment	Description
1	Normal density diet + LMVAA in drinking water during the 1st week of life (1.0 ml/l) and at 21st to 23rd day of age (1.0 ml/l)
2	Low density diet + LMVAA in drinking water during the 1st week of life (1.0 ml/l) and at 21st to 23rd day of age (1.0 ml/l)
3	Normal density diet + LMVAA in drinking water during the 1st week of life (1.0 ml/l) and at 21st to 23rd day of age (1.0 ml/l) and 2 days before harvest (0.5 ml/l)
4	Low density diet + LMVAA in drinking water during the 1st week of life (1.0 ml/l) and at 21st to 23rd day of age (1.0 ml/l) and 2 days before harvest (0.5 ml/l)

Day 21-23 coincides with the vaccination schedule against Newcastle Disease which will expose the broilers to stress. The specification of the LMVAA used is found on Table 1.

Table 1. Contents of liquid multi-vitamin-amino acids supplement used.

Nutrient	Level/Amount
Vitamin A	10,000,000 IU
Vitamin D3	2,000,000 IU
Menadione sodium bisulphite (Vit. K3)	500 mg
Nicotinamide	16,250 g
D-Panthenol	7,500 g
Thiamine HCl (Vit. B1)	1,750 g
Riboflavine 5 phosphate Sodium (Vit. B2)	2,500 g
Pyridoxine HCl (Vit. B6)	1,125 g
Vitamin B12	1,250 mcg
Sodium pangamate (Vit. B15)	0,500 mg
Biotin	1,000 mcg
Inositol	2,500 g

Alanine, 11,5 g; Arginine, 6,1 g; Aspartic acid, 9,5 g; Cystine, 2,1 g; Glutamic acid, 21,5 g; Glycine, 9,6 g; Histidine, 4,7 g; Hydroxyproline, traces; Isoleucine, 6 g; Leucine, 12,5 g; Lysine, 9,5 g; Methionine, 2,2 g; Phenylalanine, 5,5 g; Proline, 9,5 g; Serine, 7 g; Threonine, 5 g; Tryptophan, 2 g; Tyrosine, 5,3 g; Valine, 6,2 g; Enzymes, traces; Liquid vehicle, solubilizing and stabilizing agents q.s., 1,000 ml.

Source: Calier Laboratorios (http://www.sani.com.ar/producto.php?id_producto=5450).

From the above-mentioned treatments, there were only two treatments during the booster and starter phases, namely: Treatments 1 and 3 - Normal density diet + LMVAA in drinking water during the 1st week of life (1.0 ml/l) and at 21st to 23rd day of age (1.0 ml/l); Treatments 2 and 4 - Low density diet + LMVAA in drinking water during the 1st week of life (1.0 ml/) and at 21st to 23rd day of age (1.0 ml/l).

The chicks were raised up to 35 days following the standard procedure of growing broiler chicken. One week of brooding was implemented, where chicks were fed with booster diet. From day 8-28, chickens were fed starter mash, while from 29-35 days finisher ration was offered. The calculated nutrient compositions of the different diets are presented in Table 2. Feeds and clean water were given *ad libitum*. Vaccination against Newcastle disease was done on the 6th day of age via ocular method and on the 21st day of age via drinking water. No antibiotic was used throughout the study. The temperature and relative humidity during the growing period were 32.40±2.49ºC and 68.28±10.11%, respectively.

Body weight gain, feed intake, feed conversion ratio, water consumption and

Table 2. Calculated nutrient composition of the experimental diets used.

Nutrient	Booster		Starter		Finisher	
	Normal Density	Low density	Normal density	Low density	Normal density	Low density
Metabolizable energy kcal/kg	3000	2800	2900	2700	2905	2700
CP, %	22.50	21.5	20.70	19.3	19.30	18.00
Total Lysine, %	1.36	1.12	1.17	0.97	1.07	0.86
Total Methionine, %	0.52	0.48	0.41	0.38	0.35	0.32
Total M+C, %	0.90	0.84	0.77	0.68	0.69	0.59
Total Threonine, %	0.85	0.78	0.79	0.62	0.73	0.57
Calcium, %	0.85	0.84	0.87	0.81	0.85	0.76
Available Phosphorus, %	0.48	0.45	0.44	0.41	0.41	0.38
Total Tryptophan, %	0.28	0.22	0.26	0.19	0.24	0.16

livability rate were recorded and computed. At the end of the experiment, performance efficiency factor was computed. The following were the formula used to compute the production parameters:

Gain in weight = final weight – initial weight
Feed intake = (feed offered – feed refused) / number of birds
Feed conversion = feed intake/gain in weight
Livability rate = number of live birds / initial inventory x 100
Performance efficiency factor = (Final weight x Livability x 10,000) / (FCR x days in feed)

On the 35th day of age, eight birds from each treatment were sacrificed for carcass evaluation (*i.e.* water holding capacity and drip loss analyses). Whole breast samples were obtained from freshly dressed broilers. The samples were placed on mesh wires attached on meat trays to allow meat exudates to drip. The set-up were kept overnight in cold storage set at 2-4ºC. The initial and final sample weights were obtained. Drip loss is the loss in weight expressed as a percentage of the initial sample weight.

The Carver Press Method was used to determine the water holding capacity of broiler breast muscles. Lean samples (0.4-0.6 g) were pressed at 500 psi for 60 sec. The meat film area and the total area were outlined in Whatman filter paper #1 and measured using a polar planimeter. The percentage free water was computed and the value represents the proportion of meat juice that was expelled after the application of pressure. The bound water value is the difference of the percentage free water from 100.

Since there were only two treatment groups during the brooding and starter stages, all data collected during the period were subjected to t-test procedure using either the Pooled or Satterthwaite Method, for equal and unequal variances, respectively at P=0.05. During the finisher stage (day 28 to day 35) and overall period (day 0 to day 35), all data gathered were subjected to analysis of variance (ANOVA) procedure at P=0.05. Pairwise mean comparison was done using Bonferroni (Dunn) t-test. Moreover, orthogonal linear contrast analysis was performed to determine effectiveness of LMVAA supplementation in low density diets and determine its effect on drip loss and water holding capacity of the meat when supplemented during the last two days prior to harvest.

Analysis of income over feed and chick cost (IOFCC) was done to evaluate the economics of using LMVAA on broiler production. The formula used is as follows:

IOFCC/kg live weight = (((Final weight * Selling price/kg live weight) - (Chick cost + Feed Cost + Additive cost)) /(Live weight)) x Livability

The following were the assumptions used (PhP):

Booster feeds (normal density)	19.70
Booster feeds (low density)	18.33
Starter feeds (normal density)	17.96
Starter feeds (low density)	17.09
Finisher feeds (normal density)	17.24
Finisher feeds (low density)	16.65
Live broiler	115.00/kg
Liquid MVAA	1,500/l

RESULTS AND DISCUSSION

Table 3 presents the growth performance of broilers during the booster and starter phases of feeding. Results showed that there was no difference (P>0.05) in the initial body weights of broilers used in the study. During the brooding stage, no differences (P>0.05) were noted in body weight, gain in weight, feed conversion ratio and water consumption between the group fed low density diet and the group given high density diet. This shows that LMVAA supplementation is effective in compensating for poor nutrition during the 1st week of life. On the other hand, body weight, gain in weight and feed consumption of the group fed normal density diet were higher (P<0.05) during the starter phase. No difference (P>0.05) was noted in terms of feed conversion ratio, which indicates that LMVAA supplementation compensated for the low density diet. From day 21 to day 23, water consumption was enhanced (P<0.05) with the group fed low density diet. During this phase, LMVAA supplementation in drinking water from day 21 to 23 tends to be not effective in improving the broiler performance fed low density diet. Higher (P<0.05) water consumption in the group fed low density diet indicates that LMVAA supplementation tends to enhance water consumption during the period of stress. Increased water consumption is an important factor to prevent occurrence of heat stress. In addition, giving vitamin supplements, in particular vitamin C which is an anti-stress agent, can be considered during periods when heat stress is anticipated (Butcher and Miles, 1996).

Table 4 shows that in the finisher stage (day 28 to day 35), the groups fed with normal density diets, with and without LMVAA supplementation during the last

Table 3. Growth performance of broilers given different treatments during the brooding and starter phases.

*

Variable	Treatment		CV, %
	Normal density diet	Low density diet	
Brooding stage (day 0 to 6)			
Initial body weight, g[ns]	47.00	47.00	na
Body weight, g[ns]	117.00	113.00	6.86
Gain in weight, g[ns]	70.00	66.00	13.35
Feed consumption, g[ns]	101.00	103.00	4.96
Feed efficiency, g/g[ns]	1.44	1.56	13.23
Water consumption, ml/bird[ns]	377.00	381.00	4.05
Starter stage (day 7 to 28)			
Body weight, g*	1233.00	1154.00	3.94
Gain in weight, g*	1117.00	1041.00	4.28
Feed consumption, g*	1835.00	1751.00	4.73
Feed efficiency, g/g[ns]	1.64	1.68	5.12
Water consumption (d21-23), ml/bird*	724.00	816.00	7.16

*Difference between the groups is significant (P<0.05).
[ns]Difference between the groups is not significant (P>0.05).

Table 4. Growth performance of broilers given different treatments during the finisher stage and from day 0 to 35.

Variable	Treatment[1]				CV,%
	1	2	3	4	
Finisher stage (day 28 to 35)					
Body weight, g	1891.00[a]	1678.00[b]	1803.00[a]	1694.00[b]	4.72
Gain in weight, g	573.00[a]	532.00[b]	582.00[a]	531.00[b]	11.84
Feed consumption, g	1722.00[a]	1316.00[b]	1477.00[ab]	1626.00[ab]	17.25
Feed efficiency, g/g	3.09	2.50	2.56	3.07	22.48
Water consumption (d33 to 35), ml/bird	-	-	868.00	811.67	9.79
Overall period (day 0 to 35)					
Gain in weight, g	1771.56[a]	1631.07[b]	1756.47[ab]	1645.07[ab]	4.88
Feed consumption, g	3691.70[a]	3179.00[b]	3380.40[ab]	3470.3[ab]	7.41
Feed efficiency, g/g	2.09	1.95	1.93	2.11	9.27
Livability rate, %	98.57	100.00	100.00	98.79	2.17
PEF	246.89	244.08	266.77	226.13	13.69

[1]Means within a row with the same superscript are not different (P>0.05).

two days prior to harvest (Treatments 3 and 1, respectively) had higher (P<0.05) body weights and gain in weight compared with the group fed low density diet with and without LMVAA supplementation on drinking water during the last two days prior to harvest. Feed conversion ratio was not different (P>0.05) among treatment means. This shows that during the finisher stage, supplementation of LMVAA during the last two days prior to harvest did not improve the growth performance of broilers fed low density diet, but in terms of the efficiency to convert feed to body weight, LMVAA supplementation compensated for the low density diet.

Overall performance of broilers showed that the groups fed with normal density diet had significantly higher body weight, gain in weight and feed consumption compared to the groups fed low density diet (Table 5). However, no differences (P>0.05) were noted among the treatments in terms of overall feed conversion ratio, livability rate and performance efficiency factor (PEF). The observed higher feed consumption of broilers fed normal density diets compared with low density diets did not agree with what has been demonstrated that the birds adjust their feed intake to satisfy their energy requirement (Pesti and Smith, 1984; Plavnik *et al.*, 1997). The inconsistencies might be due to higher body weights observed in the groups with normal density diet. Leeson and Summers (2000) and Richards and Proszkowiec-Weglarz (2007) noted that feed intake is a function of growth rate. The faster the growth rate, the higher would be the feed intake. The group in the low density diet with lower body weight had also lower maintenance requirement for nutrients.

Table 5. Linear contrast analysis of the overall performance of broilers given different treatments.

Variables	P-values	
	Normal vs. low density diets	With vs. without supplementation of LMVAA during the last two days prior to harvest
Body weight	0.0004**	0.9639 ^{ns}
Gain in weight	0.0005**	0.997 ^{ns}
Feed consumption,	0.0377**	0.9182 ^{ns}
Feed conversion ratio	0.7896^{ns}	0.9736 ^{ns}
Livability rate	0.8958 ^{ns}	0.8958 ^{ns}
PEF	0.1006 ^{ns}	0.9405 ^{ns}

*P-value is significant (P<0.05).
^{ns}P-value is not significant (P>0.05).

Table 6 presents the drip loss and water holding capacity of the meat of broilers given different treatments. Drip loss and water holding capacity of the meat from the low density diet with LMVAA were comparable (P>0.05) with the group fed high density diet. This shows that LMVAA supplementation in low density diet

Table 6. Carcass evaluation of broilers given different treatments.

Treatment	Drip Loss, %	Water holding capacity, %
1	1.69	84.91
2	1.63	85.92
3	2.72	85.65
4	1.77	85.75
CV, %	75.33	3.76

[1]Means within a column with the same superscript are not different (P>0.05).

groups during the last two days prior to harvest was not effective in retaining moisture in the meat. Drip loss and water holding capacity are important measures of meat quality that are greatly affected by changes in meat pH, which is, in turn, influenced by exposure to stress prior to slaughter (Young *et al.*, 2004).

Economic analysis (Table 7) showed that the groups fed normal density diets had the highest total feed cost compared to the low density diet groups. Highest IOFCC was noted in the group given low density diet but supplemented with LMVAA in drinking water during the first seven days of life and during the 21st to 23rd days of life. This was followed by the group given normal density diet and supplemented with LMVAA in drinking water during the first seven days, 21st to 23rd days, and last two days of life. The least IOFCC was noted in the group fed normal density diet but supplemented with LMVAA in drinking water during the first seven days of life and during the 21st to 23rd days of life.

Table 7. Economic analysis of using LMVAA in broiler production.

Treatment	Chick cost, PhP	Feed cost, PhP			Cost of chick, feeds,& additive PhP	Sales, PhP	IOFCC, PhP/kg live
		booster feed	starter feed	finisher Feed			
1	16.00	1.99	32.96	29.69	82.24	109.14	15.45
2	16.00	1.89	29.92	21.91	71.64	100.68	18.45
3	16.00	1.99	32.96	25.46	79.40	108.18	17.62
4	16.00	1.89	29.92	27.07	77.78	101.64	15.60

Results of this study showed that generally LMVAA may be effective in improving the performance of broilers, particularly during the brooding stage, subjected to poor nutrition (*i.e.* low density diet) and heat stress and in enhancing water consumption during the period of stress (*i.e.* vaccination at 21st day of age). However, supplementation during the last two days prior to harvest had no effect

(P>0.05) on dressing percentage, drip loss and water holding capacity of the carcass. Income over feed and chick cost was enhanced with LMVAA supplementation particularly in the group with low density diets. Based on the results of this experiment, it can be concluded that supplementation of LMVAA in drinking water can be done during the 1^{st} week of life and during 21^{st} to 23^{rd} day of life only.

ACKNOWLEDGEMENT

The authors wish to thank Vetspecialists Incorporated and Laboratorios Calier, S.A. (Spain) for providing the funds for this study, through the UPLB Foundation, Incorporated.

REFERENCES

Barbut S. 2009. Pale, soft, and exudative poultry meat - Reviewing ways to manage at the processing plant. *Poult Sci* 88 :1506-512.

Butcher GD and Miles R. 1996. *Heat Stress Management in Broilers*. Accessed June 12, 2012. http://edis.ifas.ufl.edu.

Dickens MJ, DJ Delehanty and LM Romero. 2010. Stress: An inevitable component of animal translocation. *Biol Conserv* 143: 1329-1341.

Holm CG and Fletcher DL. 1997. Antemortem holding temperatures and broiler breast meat quality. *J Appl Poult Res* 6: 180-84.

Leeson S and Summers JD. 2000. Feeding program for broiler chicken. In: *Commercial Poultry Nutrition* (3^{rd} ed.). Ontario, Canada: University Books.

Lin HS, Sui J, Jiao HC, Jiang KJ, Zhao JP and Dong H. 2007. Effects of diet and stress mimicked by corticosterone administration on early postmortem muscle metabolism of broiler chickens. *Poult Sci* 86: 545-554.

McKee SR and Sams AR. 1997. The effect of seasonal heat stress on rigor development and the incidence of pale, exudative turkey meat. *Poult Sci* 76: 1616-1620.

Pesti GM and Smith CF. 1984. The response of growing broiler chickens to dietary contents of protein, energy and added fat. *Br Poult Sci* 25: 127-138.

Petracci M, Bianchi M and Cavani C. 2009. The European perspective on pale, soft, exudative conditions in poultry. *Poult Sci* 88:1518-1523.

Petracci M, Fletcher DL and Northcutt JK. 2001. The effect of holding temperature on live shrink, yields and breast meat quality of broiler chicken. *Poult Sci* 80: 670-675.

Plavnik I, Wax E, Sklan D, Bartov I and Hurwitz S. 1997. The response of broiler chickens and turkey poults to dietary energy supplied either by fat or carbohydrates. *Poult Sci* 76: 1000-1005.

Richards M and Proszkowiec-Weglarz M. 2007. Mechanisms regulating feed intake, energy expenditure and body weight in poultry. *Poult Sci* 86: 1478-1490.

Solomon MB, Van Laack RLJM and Eastridge JS. 1998. Biophysical basis of pale, soft, exudative (PSE) pork and poultry muscle: A review. *J Muscle Foods* 9:

1-11.

Strasburg GM and Chiang W. 2009. Pale, soft, exudative turkey - The role of ryanodine receptor variation in meat quality. *Poult Sci* 88: 1497-1505.

Young JF, Karlsson AH and Henckel P. 2004. Water-holding capacity in chicken breast muscle is enhanced by pyruvate and reduced by creatine supplements. *Poult Sci* 83: 400-405.