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Effect of Vitamin C Supplementation on Performance of Broiler Chickens in Cambodia

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Abstract

The hot and wet climatic conditions in the tropics limit the high performance and survival of broilers. In Cambodia heat stress is experienced nearly all year round, but is more pronounced during the transition period from the hot to the wet season. An experiment to determine the effect of Vitamin C supplementation on the productivity of broiler chickens was conducted in the Animal Experimental Station of the Royal University of Agriculture, Cambodia, from June to July, 2001. 270 day-old chicks of weight 44.49 g ± 3.23 were under a completely randomised design divided into 3 groups with 3 replications each and reared on deep litter rice husks for 42 days. Birds in each group were fed a balanced broiler diet ad libitum and supplemented with Vitamin C dissolved in drinking water of 0, 20 and 40mg/bird/day for groups A, B and C respectively. Feed consumption among groups did not differ ($p>0.05$), however, the average weight gains of groups A, B and C of 1281.64g ± 47.4, 1401.18g ± 51.7 and 1511.87g ± 46.8 respectively were significantly different ($p<0.01$). The feed conversion ratios of A (2.22 ± 0.01), B (2.11 ± 0.01) and C (2.04 ± 0.01) were also significantly different ($p<0.01$). Broiler chicken mortality was highest in group A (8.9%), followed by B (5.6%) and lowest in group C (2.2%). It was concluded that supplementation with Vitamin C at 40mg/bird/day in drinking water reduces the impact of heat stress significantly and improves the productivity of broilers under the tropical conditions of Cambodia.

Key word: Vitamin C, Heat stress, Broiler production
Abbreviation: CRD, completely randomised design

Introduction

Broiler production plays a major role in food security for the rapidly increasing Cambodian human population. Their short production cycle, high feed efficiency and high biomass per unit of agricultural land are particularly attractive for the Cambodian production system. However, compared to other domestic animals, broiler chickens are more susceptible to changing environmental conditions (Nolan et al., 1999). In particular, high ambient temperatures depressed feed intake, weight gain and increased mortality rates among broilers (Ayo et al., 1996). A possible approach to counteracting the negative effects of heat stress among chickens could be the supplementation of birds with Vitamin C. Vitamin C plays a major role in the biosynthesis of corticosterone (Bain, 1996), a primary glucocorticoid

hormone involved in gluconeogenesis to enhance energy supply during stress (Frandson, 1986). However, under critically high ambient temperatures, the production of Vitamin C in broilers is inadequate for optimum performance (Daghir, 1995a). Several researchers have reported beneficial effects of Vitamin C supplements given either in diets and / in drinking water. Supplements enhanced performance of broiler chickens with experimentally induced hypothyroidism (Takahashi et al., 1991 and Yanaka and Okumura, 1982), reduced stress-related response (Pardue and Thaxton, 1984) and improved disease resistance of the birds (Amakye-Anim et al., 2000). The fully practical relevance of such findings is however, yet to be concluded. This experiment evaluated broiler chicken performance at three planes of Vitamin C supplementation in drinking water during the hot-humid climate of Cambodia.

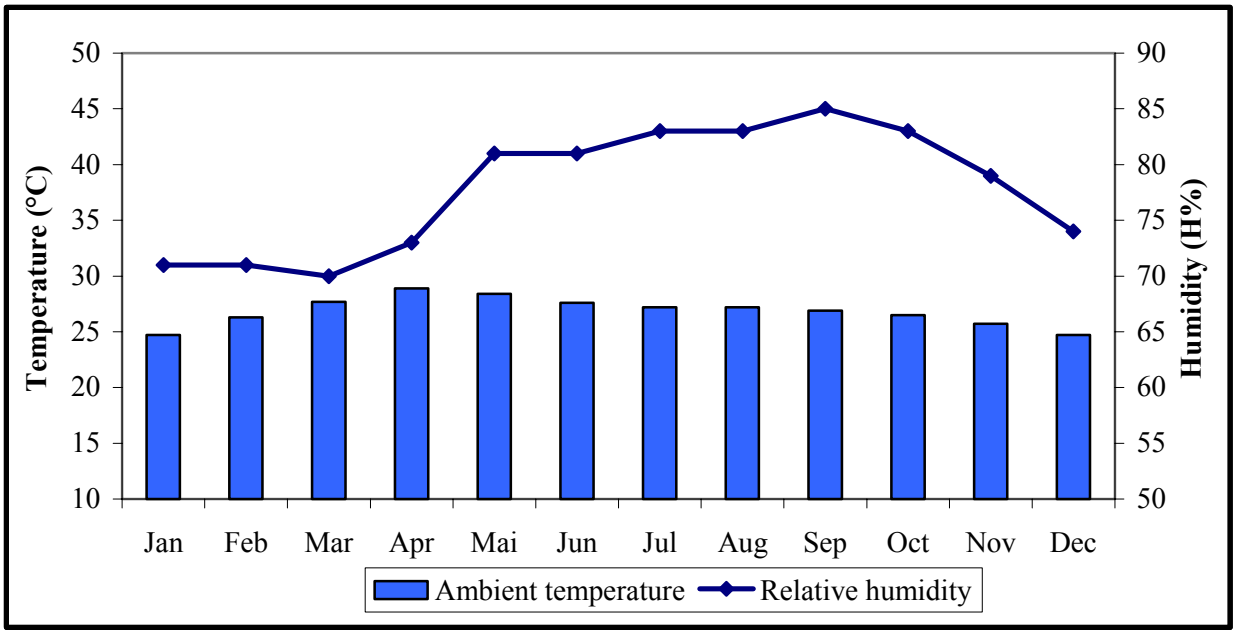

Figure 1: Ambient temperature and relative humidity in Cambodia (Source: Ministry of Meteorology and Water Resource of Cambodia). Most unfavorable condition occur in April – November

Material And Methods

The experiment was conducted in the Animal Experimental Station of the Royal University of Agriculture, Phnom Penh, Cambodia during the June – July hot-humid climate (Fig. 1). Two hundred and seventy, one-day old broiler chicks of AVIAN breed and mixed sex, weighing 44.49 g ± 3.23 were under a CRD divided into 3 groups (A, B and C) each with 3 replications of 30 chicks each and reared on deep litter rice husks for 42 days. Chickens in each group were fed a balanced broiler diet (Table 1) *ad libitum* and supplemented with Vitamin C dissolved in drinking water at a dose of 0, 20 and 40mg / bird / day for groups A (control), B and C respectively. The ambient temperatures and relative humidities (Fig. 2) were recorded daily at 6.00, 9.00, 12.00, 15.00 and 18.00 hours, while individual chicken weights were taken weekly. Feed offers and refusals as well as chicken mortalities were recorded daily. Data were analyzed using SAS General Linear Models. The model was $Y_{ij} = \mu + V_i + e_{ij}$ with Y_{ij} as the response of the j^{th} bird to the i^{th} level of Vitamin C supplementation, μ is the common mean, V_i the effect of Vitamin C supplementation and e_{ij} the residual effect.

Table 1: The research diets of chicken

	Feeding period (Week)		
Ingredient (%)	0 - 3	3 - 5	5 - 6
Maize	35.92	31.37	36.36
Rice bran	17.96	31.37	36.36
Soybean meal	13.87	10.92	17.85
Fish meal	27.75	21.84	8.93
Soybean oil	4.00	4.00	0.00
Premix	0.50	0.50	0.50
	Calculation Feed nutrient		
Protein (%)	22.71	20.00	18.03
Energy (Kcal)	3157.66	3131.46	2847.59
Calcium (%)	2.94	2.32	1.03
Phosphorous (%)	1.21	1.04	0.57

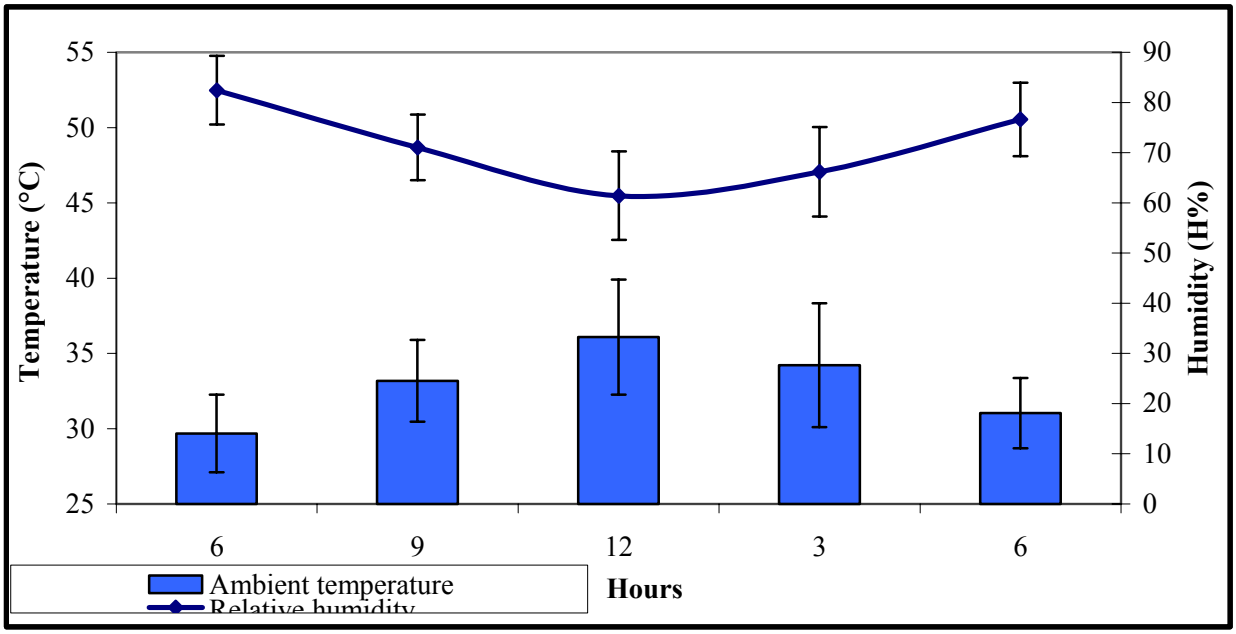

Figure 2: Average ambient temperature and relative humidity during experimental period

Result

The results of the experiment are summarized in Figure 3 and Table 2. As the general situation of Cambodia, live weight of bird in Group A is recommended for the market purpose. Moreover, the mortality rate of bird in the control group is much less than the normal situation while 10 - 20% of mortal birds were found.

Growth rate

During the first three weeks, no difference in body weight among groups was detected ($p>0.05$). A significant difference in body weight among groups was observed from the 3rd to the 6th weeks. Birds in Group C (received 40mg/bird/day of Vitamin C) were the heaviest ($p<0.01$) followed by group B and lightest in group A (Fig. 3).

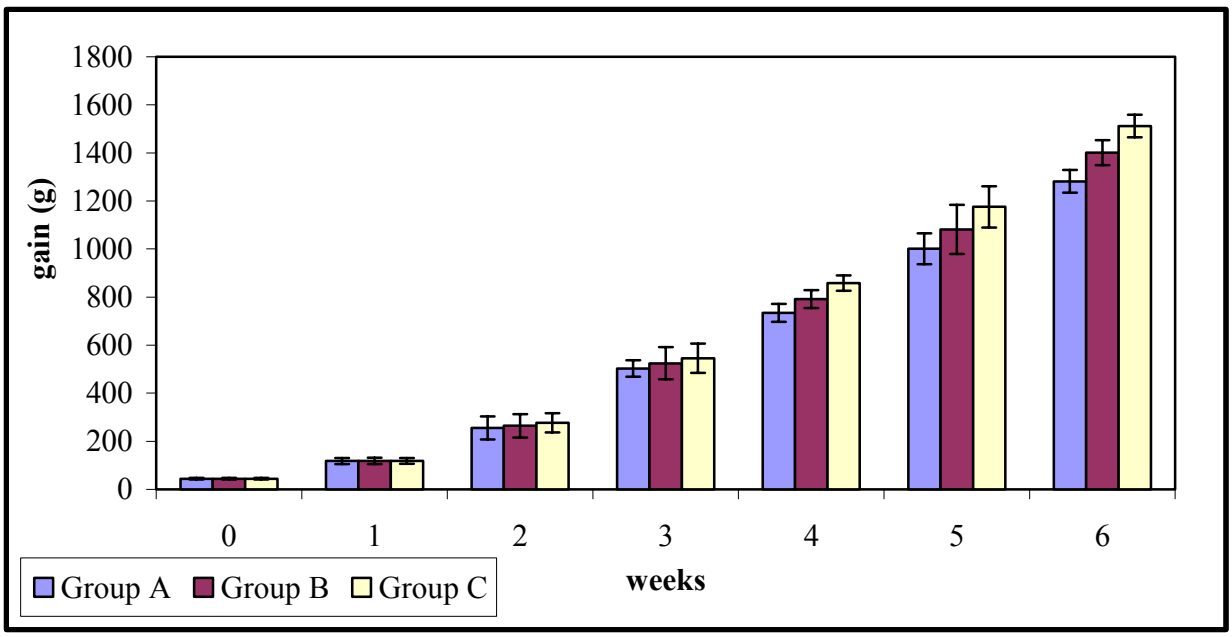

Figure 3: Growth rate of broiler chickens fed balanced diet and supplemented with vitamin C in drinking water.

Feed intake and Feed Conversion Ratio

Vitamin C supplementation did not significantly ($p>0.05$) increase feed intake among groups. However, from the 3rd week, birds in group C had the best feed conversion ratio in comparison with those of groups A and B (Tab. 2).

Table 2: Feed intake and Feed Conversion Ratio of birds

	Feed intake (g / day)			Feed Conversion Ratio		
	Vitamin C (g / bird / day)			Vitamin C (g / bird / day)		
Week	**0**	**20**	**40**	**0**	**20**	**40**
1	$18,35 \pm 3,14^{a}$	$18,29 \pm 3,43^{a}$	$18,55 \pm 3,14^{a}$	$1,74 \pm 0,02^{a}$	$1,74 \pm 0,03^{a}$	$1,76 \pm 0,02^{a}$
2	$44,37 \pm 12,64^{a}$	$47,09 \pm 13,16^{a}$	$49,68 \pm 11,93^{a}$	$2,27 \pm 0,01^{a}$	$2,25 \pm 0,02^{a}$	$2,2 \pm 0,01^{a}$
3	$61,47 \pm 48,29^{a}$	$63,32 \pm 48,85^{a}$	$64,28 \pm 39,88^{a}$	$1,74 \pm 0,02^{a}$	$1,70 \pm 0,01^{ab}$	$1,67 \pm 0,03^{b}$
4	$75,45 \pm 34,75^{a}$	$76,90 \pm 67,28^{a}$	$82,56 \pm 61,18^{a}$	$2,29 \pm 0,02^{a}$	$2,02 \pm 0,02^{b}$	$1,85 \pm 0,03^{c}$
5	$91,58 \pm 37,12^{a}$	$94,92 \pm 37,00^{a}$	$97,78 \pm 31,48^{a}$	$2,4 \pm 0,04^{a}$	$2,29 \pm 0,03^{b}$	$2,16 \pm 0,02^{c}$
6	$115,52 \pm 65,00^{a}$	$120,71 \pm 102,5^{a}$	$125,92 \pm 85,80^{a}$	$2,88 \pm 0,04^{a}$	$2,65 \pm 0,01^{b}$	$2,62 \pm 0,04^{c}$
Mean	**$67,79 \pm 47,40^{a}$**	**$70,21 \pm 51,70^{a}$**	**$73,13 \pm 46,80^{a}$**	**$2,22 \pm 0,01^{a}$**	**$2,11 \pm 0,01^{b}$**	**$2,04 \pm 0,01^{c}$**

$^{a, b, c}$ Means (± SD) in the same row with different superscripts are significantly different ($p<0.05$)

Mortality rate

Mortality rate was lowest in group C (2,2 %) followed by group B (5,6 %) and highest in group A (8,9 %).

Discussion

It is generally known that an ambient temperature of 32-35°C is most appropriate for brooding chicks (Gietema, 1996) and therefore young chickens are more adaptable to high temperatures than mature ones (Payne and Wilson, 1999). Only during transportation would temperatures exceeding 35°C endanger young chickens. This study examined the effect of 2 planes of Vitamin C supplementation on broiler chicken performance and mortality during the

hot-humid climate of Cambodia. The results of the present study are similar to those of Jaffar and Blaha (1996) who observed a 10,9 % increase in body weight of chicken supplemented Vitamin C at 20mg/bird/day in drinking water during acute heat stress (29 - 43°C and 40 - 85% of relative humidity). Blaha and Kreosna (1997) observed an even higher increase (18%) among chicken fed *ad libitum* with similar supplementation. Vitamin C supplementation in this study was up to 40mg/bird/day and the weight gain increased proportionally. In the hot climate of Nigeria, Vitamin C supplementation also improved body weight of broiler chickens (Njoku, 1984 and Njoku, 1986). On the centrally, Puron et al. (1994) examined the 200 ppm dietary Vitamin C supplements and found no effect on performance and survivability when the average environmental temperature was 26°C. Similarly, Sykes (1977) pointed out that only a slight effect of Vitamin C on the performance of broiler would be expected. Apparently, beneficial effects of Vitamin C supplementation would be most expressed under high ambient temperatures.

Although the harsh climatic conditions may have interfered with feed consumption during the day time, it is probable the favorable temperatures at night may have enhanced feed intake since birds were fed *ad libitum*. During the experiment, light was provided throughout the night. This observation may explain the lack of significant differences in feed intake among groups. This result is in agreement with Blaha and Kreosna (1997) and Jaffar and Blaha (1996) who reported, that feed intake of broilers was not affected by the supplementation of Vitamin C. The results also demonstrated a better FCR with increasing vitamin C supplementation. This was in agreement with the findings of Blaha and Kreosna (1997) and Mckee and Harrison (1995) who also detected an improvement in FCR of broilers as a result of Vitamin C supplementation during heat stress. Vitamin C could be implicated in these observations because it is associated with the conversion of body proteins and fat into energy for production and survival through increased corticosterone secretion (Marshall and Hughes, 1980; Bain, 1996). Vitamin C enhances secretion of corticosterone and thus could be a useful stress management strategy. This study reported higher broiler mortalities in birds of the control group (no Vitamin C supplementation). Significant differences in mortality rates among groups supplemented with or without vitamin C were also reported by Giang and Doan (1998), Doan (1998) and Pardue et al. (1985). Vitamin C could still play a role in these findings as it has been shown that it takes part in the synthesis of leukocytes especially phagocytes and neutrophiles which play a part in the defense system of the chickens (Null, 2001).

Conclusion

Broiler chickens subjected to heat stress in the hot–humid climate of Cambodia respond favorably to Vitamin C supplementation. Vitamin C supplements up to 40mg / bird / day increase performance and reduce the mortality rates of broiler chickens. Experiments to determine the optimum level of Vitamin C supplementation for maximum economic benefit are recommended.

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References

Amakye-Anim J, Lin T., L., Hester P. Y., Thiagarajan D., Watkins B.A. and Wu C. C. 2000. Ascorbic acid supplementation improved antibody response to infectious bursal disease vaccination in chickens. Poultry Sci ,79(5):680-8

Ayo, J. O., Oladele, S. B. and Fayomi, A. 1996. Effect of heat stress on livestock production: A review. Nigerian Veterinary Journal, 58-68, Special edition, 1(1): 58-68

Bains, B. S. 1996. The role of Vitamin C in stress management. World Poultry, 12(4): 38-41
Bláha, J. and Kroesna, K. 1997. effect of Vitamin and electrolytes supplements on broilers' performance, slaughter value and chemical composition of meat during the heat stress. Universitäs Agriculturäe Praga Press, 30: 103-113
Daghir, N. J. 1995a. Nutrient requirements of poultry at high temperature, in Poultry production in hot climate, Page 101-125, CAB International, UK
Daghir, N.J. 1995b. Broiler feeding and management in hot climate, in Poultry production in hot climate, Page 185-219, CAB International, UK
Doan, B. H. 2000. Effect of different level of dietary calcium and supplemental Vitamin C on growth, survivability, leg abnormalities, total ash in the tibia, serum calcium and phosphorous in 0-4 week-old chicks under tropical conditions, Livestock research for Rural Development, CIPAV Publication, Colombia,12(1)
Frandson, R. D. 1986. Anatomy and physiology of farm animals, Chapter 32: Endocrinology, Page 481-507, Lea & Febiger Publisher, Philadelphia, USA
Giang, V. D. and Doan, B. H. 1998. Effect of Vitamin C supplementation on the absorption of a diet for 0-4 week old chicks on the absorption of calcium and phosphorous, in Livestock research for Rural Development, CIPAV Publication, Colombia, 10(2)
Gietema, B. 1996. Chicken farming Book 1, Chapter 4: Management of chicken flocks, Page 35-50, STOAS Publisher, Wageningen City, Netherland
Gross, W.B. 1988. Effect of ascorbic acid on the mortality of leghorn-type chickens due to overheating, Avian Disease, 32: 561-566
Jaffar, G.H. and Bláha, J. 1996. Effect of ascorbic acid supplementation in drinking water on growth rate, feed consumption and feed efficiency of broiler chickens maintained under acute heat stress conditions, Universitas Agriculturae Praga Press, 41(1): 485-490
Marshall, P. T. and Hughes, G. M. 1980. Physiology of mammals and other vertebrates, Chapter 11: The endocrine system, Page 277-300, Cambridge University Press, USA
McGilvery, R. W. 1970. Biochemistry, Chapter 27: Nutritional requirement, Page 655-691, Saunder Company Publisher, Philadelphia, USA
McKee, J. S. and Harrison, P. C. 1995. Effect of supplemental ascorbic acid on the performance of broiler chickens exposed to multiple concurrent stressors, Poultry Science, 74: 1772-1785
Njoku, P. C. 1986. Effect of dietary ascorbic acid supplementation on broiler chickens in a tropical environment, in Animal Feed Science and Technology, Elsevier Publisher, Netherlands, 16: 17-24
Njoku, P.C. 1984. The effect of ascorbic acid supplementation on broiler performance in a tropical environment, in Poultry Science, 63: 156 (Abstract)
Nolan, J., Hinch, G., Twaites, J. and Walkden-Brown, S. 1999. Constrains to animal production, Chapter 2: Climatic constrains, Lecturer Paper 12, Animal Science Group Publisher, Australia
Null, G. 2001 The antioxidant Vitamin –Vitamin C, in www.Vitamincfoundaion.org,
Pardue, S. L. and Thaxton, J. P. (1984), Evidence of amelioration of steroid-mediated immunosuppression by ascorbic acid, Poultry Science 63 (6) 1262-1268
Pardue, S. L., Thaxton, J. P. and Brake, J. 1985. Role of ascorbic acid in chicks exposed to high environmental temperature, Journal of Applied Physiology, 58(5): 1511-1516
Payne, W. J. A. and Wilson, R. T. 1999. An introduction to animal husbandry in the tropic, Chapter 1: The effect of climate, Page 3-24, Black-Well Science Publisher, UK
Puron, D., Santamaria, P. and Segura, J. C. 1994. Effect of Sodium Bicarbonate, Acetylsalicylic and Ascorbic acid on broiler performance in a tropical environment, Journal of Applied Poultry research, 3: 141-145
Sykes, A.H. 1977. Nutrition-environment interaction in poultry, in Nutrition and the Climatic Environment, Page 17-31, Butterworth Group, Nottingham, UK

Takahashi K., Akiba Y. and Horiguchi, M. 1991. Effects of supplemental ascorbic acid on performance, organ weight and plasma cholesterol concentration in broiler treated with propylthiouracil, in British Poultry Science 32 (3): 545-554

Yanaka, M. and Okumura, J. 1982. Influence of ascorbic acid on the adverse effect of feeding a diet containing excess tyrosine to chicks, in British Poultry Science 23 (3): 239-245