

EFFECT OF DIETARY UREA SUPPLEMENTATION ON SOME PRODUCTION PERFORMANCE OF BROILER CHICKS

I.H. Hermes, M.S. Khattab and Magda M. Hozain

Department of Animal Production and Fisheries, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

SUMMARY

Number of 300 Strait-Run broiler chicks raised in cage batteries were divided into 12 groups allocated for 6 treatments, each of two replicates and were fed ad-libitum one of the following rations: starter rations for the first 4 weeks contained 22 or 25% crude protein, then finisher rations for the next 3 weeks contained 18 or 21% crude protein replaced by either zero, 7.5 or 15% urea. From 7 to 8 wks of age, the birds which were fed on 18% crude protein supplemented with different urea levels were divided into two sub-groups. The first was fed the same finisher ration, while the second was fed a ration contained the same protein level (18%) but consisted of 75% yellow corn and 25% soybean meal. At 9 wks of age, 24 males with an average live weight of 1880 gm were individually housed in metabolic cages for 2 wks to determine nitrogen balance. Results indicated:

- 1- Production performance of broiler chicks fed on the starter ration contained 22% crude protein, 2970 kcal ME/kg diet and C/P ratio 135:1 followed with the finisher ration contained 18% crude protein, 3060 kcal ME/kg diet and C/P ratio 170:1 did not differ significantly than those fed the higher protein levels (25% then 21%) with the same C/P ratio except in feed conversion.
- 2- Adding high urea levels to the starter and finisher rations depressed growth and feed conversion significantly compared with the control (without urea).
- 3- Increasing urea replacement associated with increasing uric acid contents in blood plasma, liver and muscle tissues at the 4th wk of age, then this effect was limited in muscle tissues but continued for plasma and liver tissues at the 7th and 8th wks.
- 4- Feeding yellow corn + soybean meal ration for one week at the end of the experiment did not remove the adverse effect of previously added urea on uric acid in plasma and tissues.
- 5- Supplementation high levels of urea in broiler chick rations led to a decrease in nitrogen balance of birds and this reduction increased by increasing urea levels in rations.

Keywords: Broiler performance, urea, uric acid, nitrogen balance.

INTRODUCTION

Utilization of non-protein nitrogen (NPN) compounds by poultry showed inconsistent results in several reports. Sullivan and Bird (1957) showed that chicks can use urea when fed low-protein rations, provided with adequate amounts of

essential amino acids. Featherston *et al.*, (1962) demonstrated that chicks fed semi-purified rations used urea to synthesize dispensable amino acids. Koci and Grom (1972) indicated that when urea performed up to 20% of the protein level in broiler rations, a positive response only occurred when a good animal protein source, as fish meal was included to provide adequate supplies of the most limiting amino acids (lysine and methionine).

Vincze (1977) and El-Boushy (1980) reported that low protein level broiler rations supplemented with urea caused a significant growth retardation and poorer feed conversion. Kagon and Balloun (1976) found that urea, as a protein substitute, did not improve the value of conventional broiler rations and although it could be absorbed into the blood stream but not assimilated into body protein.

Controversial results were reported in the literature concerning uric acid contents in blood and tissues of birds. Bell *et al.*, (1959) observed that plasma uric acid of chickens influenced by nutrition, age, sex, breed, reproductive status and environmental factors.

Commercial chicken rations may be based on components with low protein levels and supplemented with NPN compounds that possibly be hazard to the bird welfare or the consumer's health. Thus, the present study was designed to investigate the effects of replacing a part of crude protein requirements of broiler chicks using urea as NPN source to different types of conventional rations on broiler performance.

MATERIALS AND METHODS

A total number of 300 unsexed one-day old Arbor Acres broiler chicks was randomly categorized into 6 treatments each with two replicates and were reared in battery brooders.

Experimental rations were formulated to ensure adequate supply of all required nutrients in accordance with NRC recommendations (1994). Starter and grower rations for the first 4 weeks (Table 1), followed with finisher rations for the next 3 weeks (Table 2), were supplied with urea to replace zero, 7.5 and 15.0% of the dietary crude protein. From 7 to 8 weeks of age, each group of chicks which were fed on 18% crude protein finisher ration was divided into two sub-groups: the first was fed the same finisher ration with the same level of urea, while the second was fed a ration composed of 75% yellow corn + 25% soybean meal (marketing ration) to study the effect of removing urea from the finisher ration on uric acid contents of blood plasma, liver and muscle tissues. At 9 weeks of age, 24 male chicks (6 treatments x 4 replicates) with an average weight of 1885 gm were individually housed in metabolic cages to determine nitrogen balance.

Rations and water were offered *ad libitum*. Individual body weight and feed consumption were recorded weekly, growth and feed conversion (feed/gain) were calculated and mortality was recorded daily.

At the end of each experimental period (4, 7 and 8 weeks of age), 4 chicks of each treatment were slaughtered and three representative samples from blood plasma, liver and muscle tissues were prepared for uric acid determination according to Sigma Technical Bull., (1981).

Chemical analysis of the experimental rations were determined according to AOAC (1990).

Table 1. Composition of starter rations used from one-day-old up to 4 weeks.

Ingredients (%)	22% crude protein			25% crude protein		
	Urea (as CP%)			Urea (as CP%)		
	0.0	7.5	15.0	0.0	7.5	15.0
Yellow corn	59.50	59.50	59.50	50.00	50.00	49.90
Soybean meal (44% CP)	26.25	22.50	18.80	21.27	17.00	17.00
Broiler concentr. (52% CP)	10.00	10.00	10.00	10.00	10.00	10.00
Animal fat	1.95	3.00	3.00	7.85	8.00	8.00
Corn Starch	0	0	2.290	0	2.30	5.38
Corn gluten (52% CP)	0	0	0	10.00	10.00	7.00
Dicalcium phosphate	0	0	0	0.39	0.34	0.34
Limestone	0	0	0	0.22	0.22	0.22
L-Lysine	0	0.11	0.22	0.11	0.24	0.27
DL-Methionine	0.03	0.08	0.13	0	0.05	0.149
Urea (46% N)	0	0.574	1.148	0	0.652	1.304
Sand	2.270	4.263	4.912	0.160	1.198	0.436
Total	100	100	100	100	100	100
Chemical analysis						
Crude protein	21.82	21.56	21.97	25.09	25.04	25.27
Methionine (gm/Mcal ME)	1.62	1.70	1.79	1.75	1.81	1.91
" + Cystine (gm/Mcal ME)	2.73	2.73	2.73	2.91	2.89	2.89
Lysine (gm/Mcal ME)	4.08	4.08	4.09	3.71	3.73	3.73
Calcium (gm/Mcal ME)	3.33	3.29	3.25	3.35	3.29	3.29
Available P (gm/Mcal ME)	1.62	1.58	1.55	1.63	1.57	1.55
Calculated ME (k cal /kg)	2970	2970	2970	3375	3375	3375
C/P ratio	136	137	135	134	134	133

Data were analyzed statistically by analysis of variance using the general linear model and significant mean differences were determined using contrast statements according to Statistical Analysis System (SAS Institute, Inc., 1988).

RESULTS AND DISCUSSION

Body weight gain, feed intake and feed conversion

Table (3) indicates that body weight gain, feed intake and feed conversion differed from treatment to another and from period to another.

The average cumulative body weight gain at the end of starting period (4 weeks) showed that the control groups fed rations without urea contained 22 or 25% protein levels reflected no significant differences (724.3 vs 740.3 gm). On the other hand, chicks fed rations supplemented with urea resulted in significantly ($P \leq 0.05$) lower body weight gain compared with the control. Adding (1.148%) urea equivalent to 15.0% of crude protein to 22% protein basal ration depressed significantly body weight gain with about 49.4 gm representing 6.8% of the control group. The same trend was observed by adding high urea level (1.304%) to high protein basal ration (25%) in which chicks resulted in a significantly lower growth (66.7 gm) equal to 9.9% than the control. This result supported the finding of Vincze (1977) and El-

Boushy (1980), who concluded that low protein level in broiler rations supplemented with urea caused a significant depression in the weight gain of chicks.

With respect to feed consumption, chicks fed the control starter ration contained high protein level (25%) consumed about 5.6% less feed than chicks fed the ration with low protein level (22%). This may be due to the difference in the dietary energy contents (3375 vs 2970 kcal ME/kg diet), regardless a constant C/P ratio being 135:1, reflecting a negative relation between dietary energy content and low feed intake (Titus and Fritz, 1971). The groups fed rations supplemented with low or high urea levels consumed lower feed compared with the control, but differences were not significant. El-Boushy (1980) concluded that urea supplementation reduced feed consumption due to the palatability effects or due to the higher level of urea in blood plasma which may affect the appetite of the birds.

There was an improvement in feed conversion with about 7.2% by increasing dietary protein and energy levels during the starting period. This conclusion is in agreement with that reported by Pesti and Fletcher (1984), who found that increasing the dietary protein level improved feed conversion.

Table 2. Composition of finisher ration used from 5 - 7 weeks.

Ingredients (%)	18% crude protein			21% crude protein		
	Urea (as CP%)			Urea (as CP%)		
	0.0	7.5	15.0	0.0	7.5	15.0
Yellow corn	60.00	60.00	60.00	55.00	55.00	55.00
Soybean meal (44% CP)	17.10	14.03	10.96	13.00	13.00	13.00
Broiler concentr. (52% CP)	10.00	10.00	10.00	10.00	10.00	10.00
Animal fat	5.50	6.38	7.26	11.2	12.44	13.96
Corn gluten (52% CP)	0	0	0	8.75	6.11	3.49
Dicalcium phosphate	0.15	0.20	0.26	0.58	0.61	0.63
Limestone	0.04	0.04	0.04	0.29	0.27	0.25
L-Lysine	0	0.09	0.18	0.20	0.23	0.25
DL-Methionine	0	0.04	0.08	0	0.08	0.16
Urea (46% N)	0	0.47	0.94	0	0.548	1.096
Sand	7.21	8.75	10.28	0.93	1.712	2.234
Total	100	100	100	100	100	100
Chemical analysis						
Crude protein	17.95	17.84	19.87	20.92	21.08	20.94
Methionine (gm/1Mcal ME)	1.28	1.34	1.41	1.46	1.54	1.63
" + Cystine (gm/1Mcal ME)	2.15	2.15	2.15	2.38	2.38	2.38
Lysine (gm/1Mcal ME)	3.09	3.09	3.09	3.08	3.09	3.08
Calcium (gm/1Mcal ME)	3.29	3.30	3.31	3.28	3.28	3.28
Available P (gm/1Mcal ME)	1.58	1.58	1.59	1.58	1.58	1.58
Calculated ME (k cal/ kg)	3060	3060	3060	3575	3575	3575
C/P ratio	170	171	171	171	169	170

Rations contained the low protein level (22%) with high urea level showed a significant depression in feed conversion (1.90) compared with (1.74) for low urea level. This result confirmed the findings of Kock *et al.* (1985) who concluded that feed

conversion tended to increase with increasing the dietary urea in low protein level while the higher urea level depressed feed conversion compared with the lower urea level (1.74 vs 1.70) but the difference was not significant.

During the 5-7 weeks period (Table 3), the studied traits had inconsistent trend and there was a depression with adding urea compared with the control. However, most differences were not significant. El-Boushy (1980) reported depression in broiler performance by increasing the dietary urea for birds up to 6 weeks of age.

Considering the cumulative period (0-7 weeks of age, Table 3), body weight gain for chicks fed low protein level with or without urea did not differ significantly between treatments, but in case of high protein level, chicks offered low or high urea levels showed a significantly less body weight gain compared with its control. In the same order, there was no significant difference between treatments in feed intake. Feed conversion of chicks offered high urea level was significantly low than the control in case of the high protein level but not at the low protein level.

Table 3. Effects of dietary urea supplementation on body weight gain (BWG), feed intake (FI) and feed conversion (FC).

Intake (FI) and feed conversion (FC)								
Trait	Age	Low protein level			High protein level			SE
	weeks	Urea %			Urea %			
		0.0	7.5	15.0	0.0	7.5	15.0	
BWG,g	0-4	724.3 ^a	734.9 ^a	674.9 ^b	740.3 ^a	694.5 ^{ab}	673.6 ^{ab}	16.1
FI		1312.7	1229.8	1280.5	1243.4	1181.6	1193.8	63.5
FC		1.81 ^{ab}	1.74 ^b	1.90 ^a	1.68 ^b	1.70 ^b	1.77 ^a	0.04
BWG,g	5-7	744.5 ^{ab}	727.9 ^b	745.3 ^{ab}	797.6 ^a	736.7 ^{ab}	704.4 ^b	20.3
FI		2000 ^{ab}	1994 ^{ab}	2082 ^a	1910 ^{ab}	1915 ^{ab}	1799 ^b	75.5
FC		2.69 ^a	2.74 ^a	2.79 ^a	2.40 ^b	2.60 ^{ab}	2.55 ^{ab}	0.07
BWG,g	0-7	1469 ^{ab}	1763 ^{ab}	1420 ^b	1538 ^a	1431 ^b	1378 ^b	27.5
FI		3313 ^a	3274 ^a	3363 ^a	3154 ^a	3097 ^a	2993 ^a	121.7
FC		2.26 ^{ab}	2.24 ^{ab}	2.37 ^a	2.05 ^c	2.16 ^{bc}	2.17 ^b	0.05

^{a,b} Means within rows with no superscripts are significantly different ($P \leq 0.05$).

Uric acid in blood plasma, liver and muscles tissues

As shown in Table (4), statistical analysis revealed significant ($P \leq 0.05$) differences among treatments at 4, 7 and 8 weeks of age. At the end of each period, the group of chicks fed the control ration containing the low crude protein levels had significantly lower uric acid contents of blood plasma, liver and muscle tissues compared with those fed the control ration containing the high crude protein level. This result support the finding of Asker *et al.* (1988), who reported that uric acid contents of blood, liver, kidney, pancreas and muscles of broilers were much affected by quality and quantity of dietary protein.

Adding urea in the level equivalent to replace 15% crude protein to 22% crude protein basal ration at 4 weeks old, showed a significant higher blood plasma uric acid content (9.88 mg/100 ml) followed by those fed the ration supplemented with low

urea level equivalent to replace 7.5% of crude protein being 7.5% of crude protein being 7.93 mg/100 ml and the lowest value was recorded for those fed the control ration being 6.41 mg/100 ml. The same trend was obtained by feeding rations containing high crude protein with different levels of urea at the end of each experimental period.

In the same order, liver uric acid contents (Table 4) increased parallel with increasing urea levels for both low and high dietary protein at all studied periods. At 4 weeks of age, control group achieved 3.16 and 4.25 mg/gm when fed rations contained 22 or 25% crude protein, respectively, while corresponding values were 4.05, 4.90 and 5.26, 6.06 mg/gm when 7.50 and 15% crude protein basal ration were replaced by urea.

The effect of adding urea on muscle uric acid content (Table 4) was less pronounced. At 4 week of age, the higher limit value was 0.47 mg/gm for 15% urea of the high protein level and the lower limit value was 0.39 mg/gm for chicks fed control ration contained low protein level indicating significant differences. At 7 and 8 weeks of age, the differences did not show a specific trend of limited effect as chicks became older.

Considering, the sub-group of chickens continued feeding on the same finisher ration supplemented with urea during 7 - 8 week period, reflected relatively significant higher uric acid contents in studied traits (plasma, liver and muscle tissues) compared with the other sub-group of chickens which fed only corn+soya ration without urea. However, it did not completely remove the adverse effect of previously added urea.

Table 4. Effects of dietary urea supplementation on uric acid contents of blood plasma, liver and muscle tissues.

		plasma, liver and muscle tissues.						
	Age	Low protein level			High protein level			MSE
Trait	week	Urea %			Urea %			(+)
		0.0	7.5	15.0	0.0	7.5	15.0	
Blood plasma mg/100 ml	4	6.41 ^f	7.93 ^d	9.88 ^b	7.14 ^e	8.78 ^c	11.90 ^a	0.12
	7	5.90 ^e	7.22 ^c	9.03 ^b	7.38 ^c	9.04 ^b	11.36 ^a	0.08
	8A	6.05 ^e	7.59 ^c	9.47 ^b	-	-	-	0.07
	8B	6.08 ^e	6.64 ^d	8.30 ^c	-	-	-	0.07
Liver, mg/gm	4	3.16 ^d	4.05 ^c	4.90 ^b	4.25 ^d	5.26 ^b	6.06 ^a	0.09
	7	2.91 ^d	3.74 ^b	4.51 ^a	3.64 ^c	4.66 ^b	5.64 ^a	0.06
	8A	3.71 ^f	4.91 ^e	5.93 ^c	-	-	-	0.06
	8B	3.00 ^b	3.44 ^b	4.15 ^{ab}	-	-	-	0.06
Muscle, mg/gm	4	0.39 ^d	0.43 ^c	0.44 ^d	0.40 ^b	0.45 ^{ab}	0.47 ^a	0.01
	7	0.36 ^b	0.39 ^a	0.36 ^b	0.46 ^b	0.49 ^a	0.46 ^b	0.01
	8A	0.37 ^b	0.42 ^b	0.38 ^b	-	-	-	0.01
	8B	0.37 ^b	0.36 ^b	0.33 ^b	-	-	-	0.01

a,b means in same period with no superscripts are significantly different ($P \leq 0.05$).

(A) Birds continued fed on the same finisher ration, (B) Birds fed on corn-soya ration without urea during 7-8 weeks of age.

Nitrogen balance

Table (5) indicated that all treatments resulted in a positive nitrogen balance. In case of starter ration, control chicks fed low protein level (22%) without urea gave a lower N-balance (2354.7 mg N/day) compared with (2534.1 mg N/day) for high protein level (25%). By feeding the control finisher ration (18% crude protein), chicks retained 2052.2 mg N/day compared with 2163.1 mg N/day for chicks fed the ration contained 21% crude protein. Orthogonal comparison between rations supplemented with urea (low or high levels) and the control rations indicated that adding urea resulted in a significantly lower N-balances using starter and finisher rations. The depression in N-balance resulted by adding urea may be due to the depression in feed consumption and N-intake versus untreated groups, supporting the finding of El-Boushy (1980). The obtained results showed that nitrogen balance in broiler chicks decreased proportionally with increasing urea level for both starter and finisher rations, confirming the findings of Kobayashi *et al.* (1985) in cockerels.

Table 5. Effects of dietary urea supplementation on daily nitrogen intake (DNI), daily nitrogen in excreta (DNE) and daily nitrogen balance (DNB).

nitrogen in excreta (DNE) and daily nitrogen balance (DNB).								
	Type of ration	Low protein level			High protein level			SE
Trait		Urea %			Urea %			(±)
		0.0	7.5	15.0	0.0	7.5	15.0	
DNI (mg)	Starter	2971	2413	2262	2918	2935	2630	340
DNE (mg)		615.9 ^{ab}	490.2 ^{ab}	457.6 ^b	383.4 ^a	527.4 ^{ab}	455.9 ^{ab}	73.5
DNB (mg)		2355	1923	1805	2534	2408	2174	288
DNI (mg)	Finish	2594	2581	2387	2715	2731	2526	98
DNE (mg)		541.7 ^{ab}	642.5 ^{ab}	488.6 ^b	551.8 ^a	626.2 ^{ab}	564.4 ^{ab}	33.3
DNB (mg)		2052	1938	1898	2163	2104	1962	88

^{a,b} means within rows with no common superscripts are significantly different ($P \leq 0.05$).

Under the conditions of the present study, all chicks appeared healthy with the exception of 4% total mortality without clear differences among treatments. However, it could not be advised to use urea in broiler rations without complete understanding the biochemical-physiological mechanism of its utilization by the chicks.

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conversion tended to increase with increasing the dietary urea in low protein level while the higher urea level depressed feed conversion compared with the lower urea level (1.74 vs 1.70) but the difference was not significant.

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FC		1.81 ^{ab}	1.74 ^b	1.90 ^a	1.68 ^b	1.70 ^b	1.77 ^a	0.04
BWG,g	5-7	744.5 ^{ab}	727.9 ^b	745.3 ^{ab}	797.6 ^a	736.7 ^{ab}	704.4 ^b	20.3
FI		2000 ^{ab}	1994 ^{ab}	2082 ^a	1910 ^{ab}	1915 ^{ab}	1799 ^b	75.5
FC		2.69 ^a	2.74 ^a	2.79 ^a	2.40 ^b	2.60 ^{ab}	2.55 ^{ab}	0.07
BWG,g	0-7	1469 ^{ab}	1763 ^{ab}	1420 ^b	1538 ^a	1431 ^b	1378 ^b	27.5
FI		33137 ^a	3274 ^a	3363 ^a	3154 ^a	3097 ^a	2993 ^a	121.7
FC		2.26 ^{ab}	2.24 ^{ab}	2.37 ^a	2.05 ^c	2.16 ^{bc}	2.17 ^b	0.05

^{a,b} Means within rows with no superscripts are significantly different ($P \leq 0.05$).

Uric acid in blood plasma, liver and muscles Aissues

As shown in Table (4), statistical analysis revealed significant ($P \leq 0.05$) differences among treatments at 4, 7 and 8 weeks of age. At the end of each period, the group of chicks fed the control ration containing the low crude protein levels had significantly lower uric acid contents of blood plasma, liver and muscle tissues compared with those fed the control ration containing the high crude protein level. This result support the finding of Asker *et al.* (1988), who reported that uric acid contents of blood, liver, kidney, pancreas and muscles of broilers were much affected by quality and quantity of dietary protein.

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