

8-1940


## The Utilization of Food Elements by Growing Chicks. IX. The Nitrogen of Urea

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Ackerson, C. W.; Ham, W. E.; and Mussehl, F. E., "The Utilization of Food Elements by Growing Chicks. IX. The Nitrogen of Urea" (1940). *Historical Research Bulletins of the Nebraska Agricultural Experiment Station (1913-1993)*. 25.  
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COLLEGE OF AGRICULTURE      UNIVERSITY OF NEBRASKA  
AGRICULTURAL EXPERIMENT STATION  
RESEARCH BULLETIN 120

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by Growing Chicks**

**IX. The Nitrogen of Urea**

C. W. Ackerson, W. E. Ham, and F. E. Mussehl

LINCOLN, NEBRASKA  
AUGUST, 1940

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### SUMMARY

1. The effect of replacing one-third of the concentrate of a ration for growing chicks with a mixture of starch and urea that contained an amount of nitrogen equal to that contained in the concentrate withdrawn from the ration was studied with two lots of chicks.

2. All chicks of both lots consumed equal amounts of nitrogen during the experiment.

3. Conclusions were based on increases in body weight and content of nitrogen, calcium and phosphorus at slaughter.

# The Utilization of Food Elements by Growing Chicks

## IX. The Nitrogen of Urea

C. W. ACKERSON, W. E. HAM, and F. E. MUSSEHL

Interest in the search for synthetic substitutes for a portion of the protein concentrate in animal rations is such that a considerable amount of work is being done on the subject both here and abroad. Attempts to utilize urea for this purpose have been reviewed by Krebs (1) and more recently by Kriss and Marcy (2). The literature deals largely with studies involving the utilization of the nitrogen of urea by cattle, sheep, and rats. In the field of poultry nutrition Carstens and Prüfer (3) concluded that urea was not utilized by laying hens nor did it exhibit any protein-sparing action. The bulk of the experimental evidence indicates that utilization of urea nitrogen is limited to polygastric animals. In the absence of information on the value of urea in a ration for growing chicks it was felt advisable to investigate its possibilities at this Station.

### PREPARATION OF THE RATIONS

The ration fed one lot of chicks in this experiment was one used at this Station for several years and is designated as 8-S. Another lot was

fed a modified 8-S ration. In 8-S the protein concentrate consists of equal parts of meat meal, fish meal, and soybean meal and 15 pounds of it are mixed with 85 pounds of the base. In the modified ration 10 pounds of the concentrate, 4.08 pounds of starch and 0.92 pound of urea were mixed with 85 pounds of the base to make 100 pounds of ration 8-S-Urea. In 8-S, 39 per cent of the nitrogen is found in the 15 parts of the concentrate and 61 per cent in the 85 parts of the base. In the modified ration 61 per cent of the nitrogen is in the base, 26 per cent in the 10 parts of concen-

Ingredients	Nebr. 8-S ration	8-S-Urea ration	Nitrogen content
	<i>Lbs.</i>	<i>Lbs.</i>	<i>P.ct.</i>
Ground yellow			
corn .....	31	31	1.77
Shorts .....	20	20	2.94
Bran .....	10	10	2.50
Pulverized oats	10	10	2.34
Alfalfa meal ..	10	10	3.76
Meat meal....	5	3.33	7.82
Fish meal....	5	3.33	10.84
Soybean meal .	5	3.33	7.14
Urea .....	0	0.92	46.40
Cornstarch ...	0	4.08	....
Calcium car- bonate .....	2	2	....
Sodium chloride	1	1	....
Cod-liver oil concentrate .	1	1	....

trate used, and 13 per cent comes from the 5 parts of starch and urea. The rations were mixed as shown in the accompanying table and the ingredients contained the nitrogen as listed. Sufficient amounts of the base and concentrate were mixed from the same lots of ingredients so that the rations were identical except for the substitution of starch and urea. The experimental variable thus lay in the provision of 13 per cent of the total nitro-

gen in the form of urea nitrogen instead of an equal amount found in 5 pounds of the concentrate.

TABLE 1.—*Analyses of the rations.*

Ration	Water	Ash	Nitrogen	Calcium	Phosphorus
	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>
8-S.....	11.5	12.4	3.19	1.82	1.00
8-S-Urea.....	10.7	11.1	3.19	1.52	0.89

Ration	Crude fat	Crude fiber	Protein	N-free extract	Ratio Ca:P
	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	
8-S.....	4.6	6.6	19.9	44.9	1.82
8-S-Urea.....	4.5	6.4	19.9	47.4	1.71

### EXPERIMENTAL FEEDING

The chicks used in this experiment were produced at the Station from a Single Comb White Leghorn female and Cornish male cross. They were hatched October 18 and chicks chosen in a weight range of 37 to 41 grams were used. All chicks were fed the same amount of the pelleted rations daily in the manner described in previous work (4). Of 27 chicks started in each lot 22 were retained to the close of the trial. Seven were dropped at the end of the first four days of feeding because they were not eating at the required rate. These seven were raised in another brooder in the same room and allowed free access to 8-S pellets. At the end of six weeks their weights exceeded those of the experimental chicks, which showed that failure to learn to eat at the outset was their only difficulty. Three others were dropped because of failure to eat at the required rate during the experiment. It happened that each lot lost five chicks. There were no losses by death in the original group of 54 chicks although 10 failed to meet the requirements set by the experimental technique. The chicks were housed in electrically heated brooders in a room maintained above 70° F. In this trial the cod-liver concentrate was incorporated in the mash.

### DISCUSSION

The feeding trial was started October 18 and continued to November 30 when the chicks were killed by ether anesthesia. The sex and mean net weights were noted after removal of the contents of the digestive tract. Data on the mean net weight and a primary analysis of the net weight are presented in Tables 2 and 3. The latter analysis shows the mean net weight of the chicks fed the 8-S-Urea ration to be significantly lower than that of the chicks fed 8-S.

TABLE 2.—Mean net weights<sup>1</sup> and their standard errors.

Lot	Males	Females	Males and females (unweighted mean)
	<i>g.</i>	<i>g.</i>	<i>g.</i>
8-S .....	404.50±4.57	372.60±5.00	388.55±3.37
8-S-Urea .....	367.50±5.00	346.17±4.57	356.84±3.37
Unweighted mean .....	386.00±3.37	359.39±3.37	372.69±2.38

<sup>1</sup> The net weight is the weight of the chick after removal of the contents of the digestive tract.

TABLE 3.—Primary analysis of the net body weights.

Source of variation	Degrees of freedom	Sum of squares	Variance	Standard deviation
Subclass .....	3	19,851.23	6,617.08	...
Error .....	40	9,979.57	249.49	15.8
Total .....	43	29,830.80	.....	...

F = 26.52 with a 1 per cent point of 4.32.

Table 4 presents a summary of the growth and analytical data on the chicks. It also shows the amounts of nitrogen, calcium, and phosphorus fed to the chicks and the calculated retentions of the three elements by the chicks. No significant differences are to be found in the percentages of calcium and phosphorus found in the chicks or retained from the amounts ingested.

In the matter of rate of gain, gain per gram of nitrogen fed, and percentage retention of total nitrogen fed, differences are markedly in favor of the 8-S lot.

The 8-S ration as fed in this trial contained 19.9 per cent protein. The 8-S-Urea contained the same percentage of nitrogen but its protein content was lower by 6.25 times the 0.428 per cent of urea nitrogen contained in the ration. The protein content of 8-S-Urea was therefore 17.2 per cent. On this basis it is expected from previous work (5) that the urea-fed lot would show a lower rate of gain per unit of dry matter fed. In the 905 grams of airdry feed given each chick of both lots there were 28.85 grams of nitrogen. In ration 8-S-Urea 3.87 grams came from urea so that 24.98 came from the nonurea portion. If this figure is used in Table 4 to calculate the percentage of nitrogen retained by the chicks of the 8-S-Urea-fed lot the values become 44.8 for the males and 41.5 for the females. These figures are almost identical with the values obtained with 8-S.



TABLE 4.—*Summary of growth and analytical data on chicks.*

Item	Ration 8-S		Ration 8-S-Urea	
	Male	Female	Male	Female
Number of chicks.....	12	10	10	12
Net weight (g.).....	404	372	367	346
Gain in weight (g.).....	365	334	329	306
Dry matter fed (g.).....	801	801	809	809
Rate of gain (p.ct.).....	45.6	41.7	40.9	37.9
Gain per gram nitrogen fed (g.).....	12.7	11.6	11.5	10.6
Nitrogen in chick (p.ct.).....	3.37	3.40	3.30	3.27
Calcium in chick (p.ct.).....	1.01	0.98	1.00	0.97
Phosphorus in chick (p.ct.).....	0.73	0.74	0.73	0.73
Ratio Ca:P in chick.....	1.38	1.33	1.36	1.34
Nitrogen in gain (p.ct.).....	3.47	3.51	3.38	3.38
Calcium in gain (p.ct.).....	1.08	1.05	1.07	1.04
Phosphorus in gain (p.ct.).....	0.79	0.79	0.79	0.78
Ratio Ca:P in gain.....	1.38	1.33	1.36	1.34
Ether extract (p.ct.).....	3.9	5.0	3.6	4.3
Nitrogen intake (g.).....	28.85	28.85	28.85	28.85
Nitrogen in gain (g.).....	12.69	11.73	11.19	10.36
<b>Nitrogen retained (p.ct.).....</b>	<b>44.0</b>	<b>40.7</b>	<b>38.8</b>	<b>35.9</b>
Calcium intake (g.).....	16.43	16.43	13.77	13.77
Calcium in gain (g.).....	3.96	3.52	3.51	3.21
<b>Calcium retained (p.ct.).....</b>	<b>24.1</b>	<b>21.4</b>	<b>25.5</b>	<b>23.3</b>
Phosphorus intake (g.).....	9.05	9.05	8.04	8.04
Phosphorus in gain (g.).....	2.86	2.64	2.59	2.40
<b>Phosphorus retained (p.ct.).....</b>	<b>31.6</b>	<b>29.2</b>	<b>32.2</b>	<b>29.9</b>

## CONCLUSIONS

1. The substitution of a mixture of starch and urea for one-third of the protein concentrate of Nebraska ration 8-S on an equivalent nitrogen basis resulted in a lower growth rate among the chicks of the urea-fed lot.

2. The chicks of the urea-fed lot retained 12 per cent less of the total nitrogen fed than the chicks of the 8-S lot.

3. The gain per gram of nonurea nitrogen fed was slightly greater in the urea-fed lot than in the lot fed 8-S.

4. When fed with Nebraska 8-S ration urea nitrogen was not utilized by chicks up to six weeks of age.

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