# POTASSIUM REQUIREMENT OF MULE DUCKLINGS

C. L. Chu, H. W. Wei, B. J. Chen and T. F. Shen[1]

Department of Animal Science, National Taiwan University, Taipei 106, Taiwan

## Summary

Experiments were conducted to determine potassium (K) requirement of mule ducklings. One-day-old ducklings with equal number of both sexes were fed diets containing graded levels of K for three weeks. In experiment 1, corn-soybean meal diet (CP 18.7%, ME 2,890 kcal/kg, K 0.80%) was used. The addition of K (0.00, 0.10, 0.20, 0.30, 0.40%) to the diet by potassium carbonate resulted in a decrease in weight gain and feed efficiency with the group fed on basal diet having the best performance. This means that the existing K in the basal diet is adequate for the growth of ducklings. In experiment 2, low K corn-isolated soy protein diet (K, 0.19%) was used. The supplementation of K (0.00, 0.16, 0.32, 0.48, 0.64%) resulted in an increase in weight gain and feed efficiency with the control group having the lowest performance. The minimum K requirement was found to be 0.49% for both maximum growth and best feed efficiency as determined by using bent-stick model.

(**Key Words** : Potassium, Requirement, Duckling)

## Introduction

Potassium, sodium and chloride are macroelements required by animals. They are classified as homeostatic elements for maintaining the acid-base balance, electrolyte balance, and osmotic pressure of the body fluids. The dietary requirement of potassium for broilers has been established (National Research Council, 1994). And the requirement of potassium for White Pekin ducks was not listed in the booklet of the nutrient requirements of poultry by the National Research Council (1994). It is therefore needed to establish potassium requirement for ducks in order to raise ducks more efficiently.

Experiments on potassium requirement for growing chickens have been performed. In the early days, Gillis (1948) indicated that the minimal requirement of potassium for the maximal growth of White Leghorn chicken (0-28 days-old) was 0.20-0.24%. Later, Gillis (1950) again reported that the potassium requirement could be reduced to 0.2% when the diet contained enough phosphorus (0.6%). Leach et al. (1959) fed chicks (Vantress × Plymouth Rock) with glucose-soyprotein based diet and obtained potassium requirement of 0.3% for the maximal growth of the chicks. As the level of dietary protein increased, the requirement of potassium also increased to 0.40% (Leach et al., 1959). National Research Council (NRC, 1994) thus recommended that potassium requirement of broilers was 0.30%.

Mule ducks are the intergenetic hybrids resulting from the crosses of Muscovy drake and Kaiya duck (White Pekin drake × Domestic duck) and have been playing an important role in poultry meat production in Taiwan. In order to improve the production efficiency, it is essential to establish the nutrient requirements for mule ducks. Consequently the experiments were initiated to determine the optimal potassium requirement for mule ducklings.

## Materials and Methods

Two experiments were conducted. In experiment 1, corn-soybean meal based diet (table 1, diet I) was used. The graded levels of $K_2CO_3$ were added to the basal diet to evaluate the effect of potassium levels on the growth performance of ducklings. In experiment 2, a low potassium diet (table 1, diet II) based on corn-isolated soybean protein was used. As in the first experiment, graded levels of $K_2CO_3$ were supplemented to the basal diet to determine the optimal dietary potassium level for ducklings.

[1] Address reprint requests to Dr. T. F. Shen, Department of Animal Science, National Taiwan University, Taipei 106, Taiwan.

Received March 4, 1996
Accepted July 5, 1996

TABLE 1. THE COMPOSITION OF BASAL DIETS

| Ingredients | Diet | |
|---|---|---|
| | I (%) | II (%) |
| Corn | 65.00 | 45.00 |
| Soybean meal, 44% | 29.00 | – |
| Isolated soybean protein, 84% | – | 15.00 |
| Amino acid premix[a] | – | 3.30 |
| Corn starch | – | 8.22 |
| Dicalcium phosphate | 1.77 | 1.85 |
| Limestone, pulverized | 0.98 | 1.00 |
| Vitamin premix | 0.30[b] | 0.30[d] |
| Mineral premix | 0.20[c] | 0.20[e] |
| Choline chloride, 50% | 0.05 | 0.30 |
| L-Lysine, HCl | 0.18 | – |
| DL-Methionine | 0.12 | – |
| Iodized salt | 0.40 | 0.30 |
| Soybean oil | 1.00 | 5.00 |
| Cellulose | variable | variable |
| Potassium carbonate | variable | variable |
| Total | 100.00 | 100.00 |
| Calculated value | | |
| Crude protein (%) | 18.7 | 18.7 |
| ME (kcal/kg) | 2,890 | 2,890 |
| Potassium (%) | 0.786 | 0.178 |
| Analyzed value | | |
| Moisture (%) | 12.39 | 9.23 |
| Potassium (%) | 0.802 | 0.191 |

[a] Supplied per kg of diet: L-His, 0.16 g; L-Lys, 1.81 g; DL-Met, 3.42 g; L-Thr, 0.38 g, L-Trp, 0.83 g; L-Glu, 26.40 g.

[b] Supplied per kg of diet: Vit. A, 8,250 IU; Vit. $D_3$, 600 ICU; Vit. E, 15 IU; Vit. $K_3$, 3 mg; Thiamin, 3 mg; Riboflavin, 6 mg; Vit. $B_6$, 2.9 mg; Vit. $B_{12}$, 0.02 mg; Pantothenic acid, 9.6 mg; Niacin, 60 mg; Biotin, 0.1 mg; Folic acid, 1 mg.

[c] Supplied per kg of diet: Mn, 60 mg; Zn, 82 mg; Fe, 50 mg; Cu, 10 mg; Se, 0.15 mg.

[d] Supplied per kg of diet: Vit. A, 8,250 IU; Vit. $D_3$, 800 ICU; Vit. E, 15 IU; Vit. $K_3$, 3 mg; Thiamin, 3 mg; Riboflavin, 8 mg; Vit. $B_6$, 2.9 mg; Vit. $B_{12}$, 0.04 mg; Pantothenic acid, 9.6 mg; Niacin, 60 mg; Biotin, 0.1 mg; Folic acid, 1.3 mg.

[e] Supplied per kg of diet: Mn, 72 mg; Zn, 80 mg; Fe, 90 mg; Cu, 10 mg; Se 0.15 mg.

Day-old mule ducklings obtained from a commercial hatchery were used in the experiments. The ducklings were randomly distributed into their respective pens of 10 birds in each pen with the same number of both sexes. Two pens were located for each treatment. The birds of each pen were raised in an electrically heated battery brooder with a wire floor (60 × 90 cm) and were fed mash diets containing various levels of potassium. During the experiment, feed and water were supplied *ad libitum*. Temperature in each brooder was maintained at 32 ± 1℃ for the first week and after one week the heater was disconnected. At the termination of the experiment at 3 weeks of age, the ducklings were fasted for 12 hrs and individual body weight was measured. Body weight gain and feed efficiency were used as the criteria for the determination of the optimal potassium level in the diet for mule ducklings. At the end of the experiment, blood samples from two males and two females in each pen were collected for the measurement of potassium content in the plasma.

The moisture content of diets was determined according to the procedures described in AOAC (1984). Potassium levels in the diets and in plasma were measured by using atomic absorption spectrophotometer (Perkin Elmer 3100). The data obtained on growth performance of ducklings were subjected to statistical analysis for variance among treatments and treatment means were compared according to Duncan's new multiple range test (Steel and Torrie, 1980). The minimum potassium requirement for optimal growth and feed efficiency was determined by regression analysis of weight gain or feed efficiency against potassium level of the diets.

## Results and Discussion

### Experiment 1

The effects of adding potassium to corn-soybean based diet on the growth performance, feed efficiency and plasma potassium concentration of mule ducklings from 0 to 3 weeks of age are shown in table 2. The ducklings fed on corn-soybean based diet without adding potassium had better weight gain at three weeks of age. As the potassium levels in the diet were increased, the weight gain was decreased. There was significantly different ($p < 0.05$) in weight gain when the amounts of potassium added were above 0.30% as compared to the control group. From the growth data, it is clearly shown that the content of potassium in the corn-soybean based diet is good enough for maintaining the maximal growth of mule ducklings.

Dry matter feed intake of ducklings was not significantly affected by the dietary potassium levels. However, the control group had the highest efficiency of feed utilization (gain/dry matter) as compared to the other groups which had additional potassium in the diets. As to the concentration of potassium in the plasma, the addition of potassium (0-0.4%) to the diets did not have definite effect. The K values fluctuated among treatments.

TABLE 2. THE EFFECTS OF ADDING POTASSIUM TO CORN-SOYBEAN BASED DIET ON THE GROWTH PERFORMANCE, FEED EFFICIENCY AND PLASMA POTASSIUM CONCENTRATION OF MULE DUCKLINGS FROM 0 TO 3 WEEKS OF AGE (EXP. 1)

| Item | K added (%) | | | | |
|---|---|---|---|---|---|
| | 0.00 | 0.10 | 0.20 | 0.30 | 0.40 |
| Dietary K level (%) | 0.80 | 0.90 | 1.00 | 1.10 | 1.20 |
| Wt. gain[1], g | 535.7 ±54.7[a] | 520.4 ±47.2[ab] | 507.2 ±64.1[b] | 490.9 ±64.7[b] | 482.6 ±60.0[b] |
| Dry matter intake (g/duck) | 1,028.5 ±79.5 | 1,073.7 ±30.7 | 1,081.1 ±38.4 | 1,017.5 ±23.9 | 1,050.4 ±42.7 |
| Gain/DM intake | 0.52± 0.05[a] | 0.48± 0.04[b] | 0.47± 0.06[b] | 0.48± 0.06[b] | 0.46± 0.05[b] |
| Plasma K concentration (meq/l) | 6.3 ± 0.8[ab] | 6.0 ± 0.7[ab] | 5.8 ± 0.6[b] | 5.8 ± 1.1[b] | 6.8 ± 1.1[a] |

[1] Each value is the mean of 20 observations ± standard deviation.
[ab] Data in the same row with different superscripts differ significantly ($p < 0.05$).

**Experiment 2**

The effect of the supplementation of potassium to a low potassium corn-isolated soybean protein diet on the growth performance of ducklings is shown in table 3. From the data shown, it could be seen that the growth rate of ducklings was significantly increased ($p < 0.05$) with the increases in the dietary potassium levels from 0.19% to 0.51%. The addition of potassium over 0.32% up to 0.64% did not further affect the growth rate of ducklings. These data on weight gain were subjected to regression analysis and plotted against potassium levels in the diet. The result showed that the minimum potassium requirement for weight gain was 0.492%.

As for feed intake (table 3), there was no significant difference among treatments. However, the group fed diet containing 0.51% potassium had the best feed efficiency which was significantly higher than the control group (K, 0.19%). By using regression analysis on feed efficiency against potassium levels in the diet, the minimun requirement of potassium for feed efficiency was 0.489% as obtained by bent-stick model. The influence of potassium level in the diet on the plasma potassium content is also shown in table 3. The results indicated that among the dietary potassium levels studied, there were no differences among the treatment groups.

TABLE 3. THE EFFECTS OF ADDING POTASSIUM TO CORN-ISOLATED SOYBEAN PROTEIN BASED DIET ON THE GROWTH PERFORMANCE, FEED EFFICIENCY AND PLASMA POTASSIUM CONCENTRATION OF MULE DUCKLINGS FROM 0 TO 3 WEEKS OF AGE (EXP. 2)

| Item | K added (%) | | | | |
|---|---|---|---|---|---|
| | 0.00 | 0.16 | 0.32 | 0.48 | 0.64 |
| Dietary K level (%) | 0.19 | 0.35 | 0.51 | 0.67 | 0.83 |
| Wt. gain[1] (g) | 461.0 ±121.5[b] | 494.3 ±80.8[ab] | 532.1 ±87.0[a] | 516.4 ±78.4[ab] | 513.2 ±75.8[ab] |
| Dry matter intake (g/duck) | 991.4 ± 17.7 | 1,012.2 ± 6.8 | 984.1 ±19.4 | 997.5 ±10.1 | 983.6 ±23.4 |
| Gain/DM intake | 0.46± 0.12[b] | 0.49± 0.08[ab] | 0.54± 0.09[a] | 0.52± 0.08[ab] | 0.52± 0.08[ab] |
| Plasma K concentration (meq/l) | 5.1 ± 1.3 | 5.5 ± 0.5 | 5.0 ± 0.7 | 5.3 ± 0.7 | 5.4 ± 1.0 |

[1] As footnote of table 2.
[ab] As footnote of table 2.

From results of experiments 1 and 2, it could be concluded that potassium is a nutrient required by ducklings for the optimal growth. Potassium existing in the corn-soybean based diet (0.802%) (table 1, diet I) was enough to maintain the optimal growth of ducklings, the addition of potassium to the diet did not improve the growth rate of ducklings (table 2). From the data obtained in experiment 2, the minimal requirement of potassium was 0.49% (analyzed value) for both maximum weight gain and best feed efficiency. This result was slightly higher than those previously obtained in chicks (Gillis, 1948; Gillis, 1950; Leach et al. 1959), and NRC (1994)

recommendation for the broiler chickens (0-3 weeks) was 0.30% for potassium. The difference might be due to the differences in kind of bird, growth rate, dietary phosphorus or protein content of the diet. The conclusion obtained from this study is quite close to our previous estimation listed in the booklet of nutrient requirements of ducks (Shen, 1988) which recommends potassium requirement at 0.45% of the dietary dry matter.

## Acknowledgements

The authors are gratefull to the Council of Agriculture of the Republic of China for their financial support. Without their support, this research may not be completed.

## Literature Cited

Association of Official Analytical Chemists. 1984. Official Methods of Analysis. 14th Ed. Arlington, Virginia, USA.

Gillis, M. B. 1948. Potassium requirement of the chick. J. Nutr. 36:351-357.

Gillis, M. B. 1950. Further studies on the role of potassium in growth and bone formation. J. Nutr. 42:45-57.

Leach, R. M. Jr., R. Dam, T. R. Zeigler and L. C. Norris. 1959. The effect of protein and energy on the potassium requirement of the chick. J. Nutr. 68:89-100.

National Research Council. 1994. Nutrient requirements of poultry. 9th Ed, National Academy of Sciences, Washington, DC.

Shen, Tian-fuh. Ed. 1988. Nutrient requirements of ducks. Dept. Animal Husbandry, National Taiwan University (in Chinese).

Steel, R. D. G. and J. H. Torrie. 1980. Principle and procedures of statistics. 2nd Ed. McGraw-Hill Book Co., New York.