Betaine supplementation to adequate nutrient diet does not affect the growth performance of quails divergently selected based on bodyweight

A Ratriyanto¹,²*, N Styanti¹, N Widyas¹ and S Prastowo¹,²

¹ Department of Animal Science, Faculty of Agriculture, Universitas Sebelas Maret, Surakarta, Indonesia
² Center for Biotechnology and Biodiversity Research and Development, Universitas Sebelas Maret, Surakarta, Indonesia

Corresponding author: ratriyanto@staff.uns.ac.id

Abstract. This study aimed to determine the effect of body weight clustering and betaine supplementation to adequate nutrient diet on the growth performance of quails. Nine hundred seven-day-old quails (Coturnix coturnix japonica) were allotted to a 3×2 factorial completely randomized design. Three bodyweight clusters included Random (21.1±1.2 g), Low (17.9±0.4 g), and High (22.4±0.4 g). Each bodyweight cluster was fed a diet without (0%) and with betaine supplementation (0.14%), resulting in six combination treatments. Each treatment consisted of five replicates of 30 quails. The basal diet was formulated with sufficient protein (22%) and metabolizable energy (2800 kcal/kg). The observed variables included feed intake, body weight, feed conversion, and protein and energy efficiency ratio. The results revealed that there was no interaction between body weight and betaine supplementation on all variables. The High body weight group consumed more feed and produced a higher body weight on 42 days of age than other treatments (p<0.05). However, betaine supplementation did not affect all growth trait variables. In conclusion, betaine supplementation to nutrient adequate diet is not effective in improving growth performance of quails divergently selected based on body weight.

1. Introduction
Quail farming has several advantages, one of which is growing and developing in a relatively fast time. Quails aged 42 days are sexually mature and produce 250-300 eggs per year [1]. The 0-6 week period determines quail performance for the laying period. Efforts that need to be carried out to increase quail productivity are maintenance of the early growth period. The optimal performance can be pursued through a selection program based on body weight. The optimal body weight during the starter period will be directly related to the sexual maturity of the quail, thereby accelerating sexual maturity and making the quail produce eggs faster. Bodyweight is a critical factor in the selection of quail since it is related to other traits and can be easily measured. Japanese quail rapidly respond to selection for higher body weight [2].

Quail body weight tends to vary; thus, it is necessary to group according to body weight. The body weight clustering can be used to determine the optimal performance of quail. Bodyweight selection can also increase selection efficiency compared to other selection methods [3]. In addition, quail
productivity can be optimized by modifying the nutrient content of the ration through supplementation of feed additives, such as betaine.

Betaine has an osmotic function for intestinal epithelial cells and microflora; thus, betaine can increase nutrient digestibility [4,5]. It also has a role as a methyl groups donor, which is involved in energy and protein metabolism in the body. A previous study revealed that betaine supplementation at 0.1% to the diet containing sufficient methionine could increase the growth of female broilers [6]. Based on the description above, it is necessary to conduct research that examines the potential use of betaines based on body weight clustering in feed related to quail growth performance. This study aimed to determine the effect of initial body weight clustering and betaine supplementation on the growth performance of quail.

2. Materials and methods

2.1. Materials and experimental design

The study used 900 female quails aged seven days. The quails were distributed into 30 cage units, each consisting of 30 quails. This research was conducted experimentally using a 3×2 factorial completely randomized design. The first factor was bodyweight, including Random (20.33±1.46 g), Low (17.6±0.48 g), and High (23.01±0.9 g). The second factor is the level of betaine supplementation at 0% and 0.14%. The experimental diet was obtained by supplementing betaine to the basal diet at the expense of rice bran [7].

Table 1. Nutrient composition in the basal diet

| Nutrients                  | Basal diet |
|----------------------------|------------|
| Metabolizable energy (kcal/kg) | 2,800      |
| Crude protein (%)          | 22.01      |
| Methionine                 | 0.40       |
| Calcium (%)                | 1.04       |
| Phosphorus (%)             | 0.41       |

2.2. Data collection and analysis

Nine hundred female quail aged seven days were weighed to determine initial body weight at the beginning of the study. Quails were distributed into 30 cages clustered into random, high, and low body weights, each consisting of 30 quails. At the age of 7-11 days, quails were given commercial feed; aged 12-13 days, quails were fed commercial feed mixed with treatment feed in a 50%: 50% ratio. The experimental diets were fed from 14-42 days of age. The observed variables included feed intake, body weight gain, feed conversion, energy efficiency ratio, and protein efficiency ratio.

The data obtained were subjected to analysis of variance, and if there was a difference between treatments (p<0.05), further tested with Duncan's Multiple Range Test [8]. Data analysis was performed using the R program.

3. Results and discussion

The results showed no interaction between the initial body weight cluster and betaine supplementation on feed intake, body weight, feed conversion, protein efficiency ratio, and energy efficiency ratio (Table 2). This finding indicated that betaine has a similar effect on growth traits in all bodyweight clusters. Betaine did not increase feed intake in each bodyweight cluster, which can be attributed to the same metabolizable energy and crude protein content in the experimental diets. In line with that, Ferket and Gernat [9] stated that the energy and protein level would determine the feed intake in poultry.

Bodyweight clustering affected feed intake and body weight at 42 days of age (p<0.05). Feed intake sequentially increased from Low, Random, and High body weight. Accordingly, the High body weight group generated the highest 42-day body weight. The High body weight cluster had the highest feed intake compared to other bodyweight clusters. According to Taskin [3], the bodyweight of livestock is
directly proportional to the feed intake. The higher the body weight, the higher the feed intake. The initial body weight clustering affected body weight at 42 days of age (p<0.020). Quails from the High bodyweight cluster resulted in higher body weight at 42 days of age than the Low bodyweight cluster (127.60 g vs. 121.62 g). However, the Random bodyweight cluster resulted in a similar 42-day-old bodyweight with the Low and High body weight clusters. The present result illustrated that when maternal body weights increase in selected populations of high body weight quails, the body weight increases at the onset of the laying phase.

However, bodyweight clustering did not affect daily body weight gain (2.88 g to 2.92 g). In line with this study, bodyweight selection in quail under 12 weeks of age did not show a significant response to daily body weight gain [10]. Bodyweight clustering also did not affect feed conversion and the energy and protein efficiency ratios associated with the non-significant effect in weight gain in this study. This finding indicated that all bodyweight clusters have a similar ability in converting the feed to gain. In line with this study, Taskin et al. [3] did not observe any influence of body weight selection on feed conversion. The energy and protein efficiency ratios show the efficiency of energy and protein utilization for growth. The higher the energy and protein efficiency ratio values, the more efficient the birds used energy and protein [11].

| Treatment | Feed Intake (g) | BW 42 days (g) | ADG (g) | FCR | EER  | PER |
|-----------|----------------|----------------|---------|-----|------|-----|
| Interaction between body weight and betaine | | | | | | |
| Random × 0% | 12.52 | 125.17 | 2.92 | 4.17 | 1.06 | 8.32 |
| Random × 0.14% | 12.43 | 123.82 | 2.83 | 4.28 | 1.03 | 8.12 |
| Low × 0% | 12.34 | 123.20 | 2.92 | 4.11 | 1.08 | 8.46 |
| Low × 0.14% | 12.17 | 120.05 | 2.84 | 4.16 | 1.06 | 8.34 |
| High × 0% | 12.76 | 127.91 | 2.92 | 4.25 | 1.04 | 8.19 |
| High × 0.14% | 12.87 | 127.30 | 2.92 | 4.29 | 1.03 | 8.10 |
| p Value | 0.63 | 0.80 | 0.72 | 0.87 | 0.89 | 0.92 |

Effect of body weight

| Treatment | Feed Intake (g) | BW 42 days (g) | ADG (g) | FCR | EER  | PER |
|-----------|----------------|----------------|---------|-----|------|-----|
| Random | 12.48<sup>b</sup> | 124.50<sup>ab</sup> | 2.87 | 4.23 | 1.05 | 8.22 |
| Low | 12.25<sup>b</sup> | 121.62<sup>b</sup> | 2.88 | 4.14 | 1.07 | 8.40 |
| High | 12.82<sup>a</sup> | 127.60<sup>a</sup> | 2.92 | 4.27 | 1.04 | 8.14 |
| p Value | 0.003 | 0.02 | 0.638 | 0.20 | 0.22 | 0.20 |

Effect of betaine

| Treatment | Feed Intake (g) | BW 42 days (g) | ADG (g) | FCR | EER  | PER |
|-----------|----------------|----------------|---------|-----|------|-----|
| Betaine 0% | 12.54 | 125.43 | 2.92 | 4.18 | 1.06 | 8.32 |
| Betaine 0.14% | 12.34 | 123.72 | 2.86 | 4.24 | 1.04 | 8.19 |
| p Value | 0.67 | 0.29 | 0.19 | 0.29 | 0.21 | 0.26 |

ADG: average daily gain, FCR: feed conversion ratio, EER: energy efficiency ratio, PER: protein efficiency ratio.

<sup>a</sup>Superscripts with different letters showed significant differences (p<0.05)

Betaine supplementation did not affect the growth traits of quails, as indicated by similar feed intake, body weight, and nutrient efficiency. The body weight at 42 days of age obtained in this study was in the normal range (121.6 to 127.5 g), which agrees with the observation obtained by Zulkifli et al. [12]. Body weight gain is influenced by feed intake, and betaine supplementation did not influence daily body weight gain because feed intake tended to be the same. As observed previously by Ratriyanto and Mentari [6] there was no improvement in the feed intake of broilers receiving betaine supplementation when the diet contained the same protein and energy content. According to Eklund et al. [13] betaine is a nitrogen-containing substance; thus, betaine supplementation will cause more energy to excrete betaine from the body.

The similar responses in feed intake and body weight gain following betaine supplementation led to similar feed conversion between the supplemented and non-supplemented groups. Sufficient nutrition intake results in good feed conversion so that the addition of betaine in a diet containing adequate
nutrients has no effect. Betaine supplementation at 0.1% as a methyl group donor in the diet containing sufficient methionine could not improve feed efficiency in broilers [6]. Accordingly, betaine did not affect energy and protein efficiency ratios. This finding indicates that the protein and energy in the basal and the treatment diet are relatively similar, resulting in similar energy and protein utilization. Kamran et al. [14] stated that betaine supplementation did not affect female broilers' energy and protein efficiency ratios because the energy and protein consumption produced were relatively similar.

4. Conclusion
Based on the study results, it can be concluded that there is no interaction between bodyweight clustering and betaine supplementation on growth traits of quails. Initial body weight affects the feed intake and body weight at 42 days, where a high initial body weight had the highest feed intake and body weight at 42 days. The diets given in this study were sufficient in nutrients so that betaine supplementation did not affect the growth performance of quails.

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